

BS EN 14080:2013

Incorporating corrigendum June 2014



BSI Standards Publication

Timber structures — Glued laminated timber and glued solid timber — Requirements

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National foreword

This British Standard is the UK implementation of EN 14080:2013. Together with BS EN 15497:2014 it supersedes BS EN 385:2001, which is withdrawn. It also supersedes BS EN 386:2001, BS EN 387:2001, BS EN 390:1995, BS EN 391:2002, BS EN 392:1995, BS EN 1194:1999 and BS EN 14080:2005 which are withdrawn.

BSI, as a member of CEN, is obliged to publish EN 14080 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval as a European Standard. The committee expressed the following concerns:

- General UK practice up until now has been to include a wider list of species, including hardwoods, from which glulam is to made, (as stated in the previously published standard BS EN 336), than is presented in EN 14080;
- The upper limits of thickness permitted for laminations that are used in the manufacture of softwood glued solid timber (GST) could lead to service issues arising from excessive distortion or splitting in certain environments, especially those in which there are fluctuations in moisture content.

An informative National Annex entitled 'Guidance on the implementation of BS EN 14080:2013 in the UK' has been included, which provides further information.

The UK participation in its preparation was entrusted to Technical Committee B/518, Structural timber.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPEAN STANDARD
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EUROPÄISCHE NORM

EN 14080

June 2013

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English Version

**Timber structures - Glued laminated timber and glued solid
timber - Requirements**

Structures en bois - Bois lamellé collé et bois massif
reconstitué - Exigences

Holzbauwerke - Brettschichtholz und Balkenschichtholz -
Anforderungen

This European Standard was approved by CEN on 1 May 2013.

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.

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Foreword

This document (EN 14080:2013) 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 December 2013, and conflicting national standards shall be withdrawn at the latest by December 2013.

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 supersedes EN 391:2001, EN 392:1995, EN 14080:2005, EN 387:2001, EN 385:2001, EN 390:1994, EN 1194:1999 and EN 386:2001 (see below).

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This standard supersedes the following standards:

- EN 387:2001, *Glued laminated timber — Large finger joints — Performance requirements and minimum production requirements*;
- EN 390:1994, *Glued laminated timber — Sizes, permissible deviations*;
- EN 1194:1999, *Timber structures — Glued laminated timber — Strength classes and determination of characteristic values*;
- EN 14080:2005, *Timber structures — Glued laminated timber — Requirements*.

Regarding glued laminated timber this standard supersedes the following standards:

- EN 385:2001, *Finger jointed structural timber — Performance requirements and minimum production requirement* (superseded by the present document and prEN 15497);
- EN 386:2001, *Glued laminated timber — Performance requirements and minimum production requirements*;

NOTE For glulam made of hardwood species a European Standard is under preparation.

- EN 391:2001, *Glued laminated timber — Delamination test of glue lines*;
- EN 392:1995, *Glued laminated timber — Shear test of glue lines*.

The above standards have been merged into this standard and changed considerably. The list below shows the relevant changes and amendments.

The following have been included:

- Block glued glulam and glued solid timber;
- Requirements for emulsion polymer isocyanate adhesives and for gap-filling adhesives;

- A uniform denomination for lamination strength classes has been included. These T-classes are related to strength classes given in other European Standards;
- Rules for estimation mechanical properties of glued laminated timber resawn by length;
- Provisions for Resistance to fire;
- Maximum deviations for curved glued laminated products;
- New values for tensile and compression strength perpendicular to the grain, for shear strength and shear modulus, modulus of elasticity parallel and perpendicular to the grain for glued laminated timber with values for rolling shear strength and modulus.

The scope covers glued laminated products made from coniferous species listed in this standard and poplar.

For moisture curing one-component polyurethane adhesives normative reference is now made to EN 15416-5 and EN 15425.

For phenolic and aminoplastic adhesives reference is made to prEN 301 and prEN 302.

With respect to durability against biological attack reference is made to EN 15228.

The performance requirements for finger joints in laminations have been changed.

Requirements have been introduced for the machinery for the separate application of resin and hardener to finger joints in laminations.

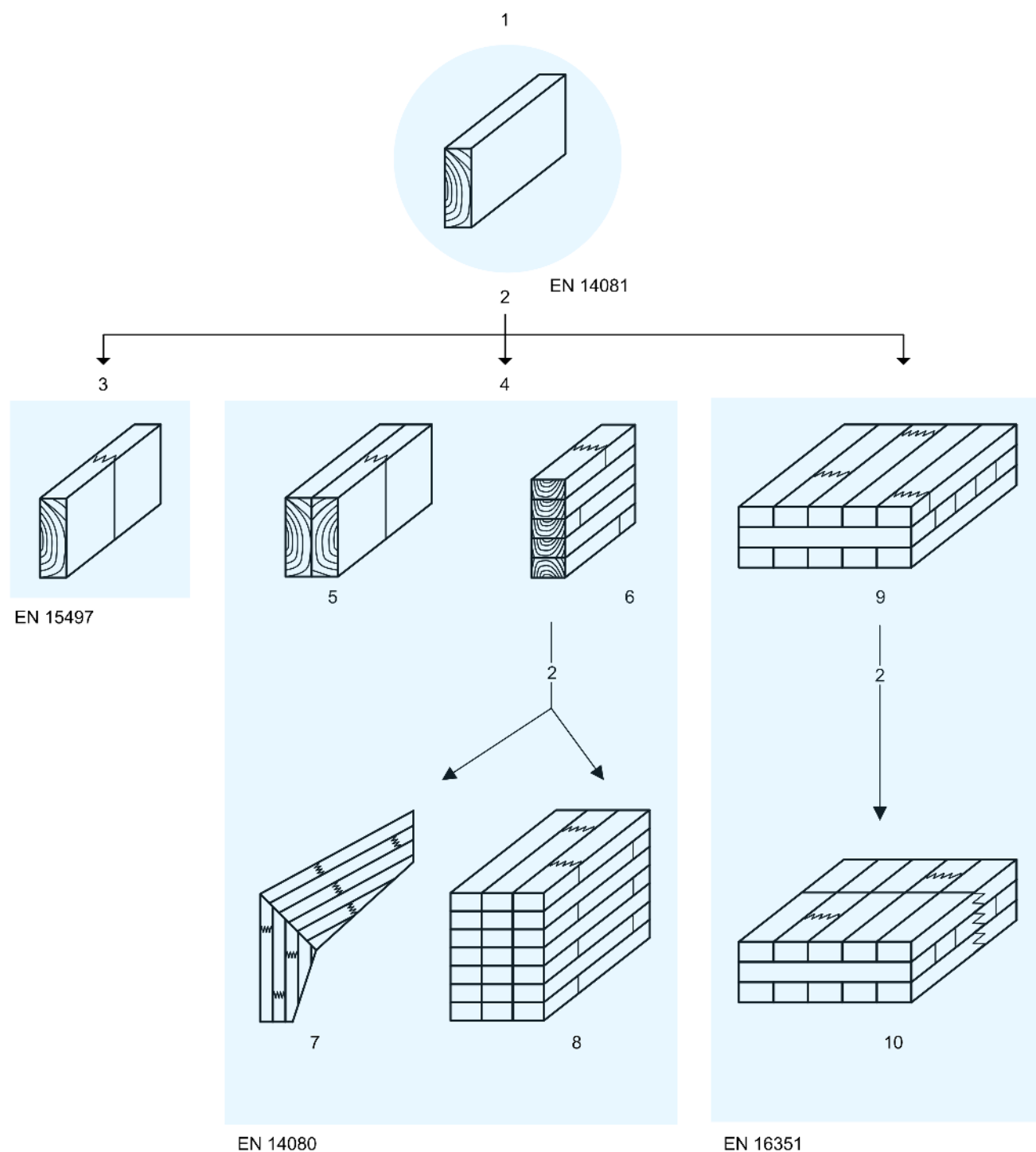
The rules for laminations laid side by side and for grooves in laminations have been changed.

The required cramping pressure for the production of large finger joints has been changed.

The evaluation of conformity section and the Annex ZA has been changed according to the revised answer to the mandate.

The rules for marking and labelling have been adopted to the changes mentioned above.

Figure 1 shows the relation of European Standards for structural timber products 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 for structural timber products prepared by CEN/TC 124

According to the CEN/CENELEC Internal Regulations, the national standards organisations 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.

1 Scope

This European Standard sets the performance requirements of the following glued laminated products:

- Glued laminated timber (glulam);
- Glued solid timber;
- Glulam with large finger joints;
- Block glued glulam

for use in buildings and bridges.

It also lays down minimum production requirements, provisions for evaluation and attestation of conformity and marking of glued laminated products.

This European Standard is applicable for glued laminated timber made of coniferous species listed in this standard or poplar consisting of two or more laminations having a thickness from 6 mm up to 45 mm (inclusive).

It may be possible to produce glulam made from specific hardwood species based on some provisions of this European Standard. In this case, Annex ZA does not apply.

This European Standard is applicable for glued solid timber made of coniferous species listed in this standard or poplar consisting of two to five laminations having a thickness greater than 45 mm and less than or equal to 85 mm.

This European Standard is applicable for large finger joints in glued laminated timber with a finger length of at least 45 mm.

This European Standard is applicable for block glued glulam having solid rectangular cross sections.

This European Standard also gives the requirements for glued laminated products treated against biological attack. Glued laminated products treated with fire retardants are not covered.

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.

prEN 301:2011, *Adhesives, phenolic and aminoplastic, for load-bearing timber structures — Classification and performance requirements*

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

prEN 302-2:2011, *Adhesives for load-bearing timber structures — Test methods — Part 2: Determination of resistance to delamination*

prEN 302-3:2011, *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*

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

prEN 302-5:2011, *Adhesives for load-bearing structures — Test methods — Part 5: Determination of maximum assembly time under referenced conditions*

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

EN 338:2009, *Structural timber — Strength-classes*

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 384, *Structural timber — Determination of characteristic values of mechanical properties and density*

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 1995-1-1:2004, *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 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test 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 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 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*

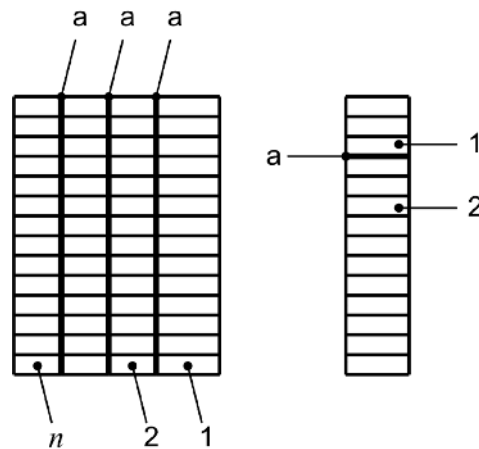
EN 15425:2008, *Adhesives — One-component polyurethane adhesives for load bearing timber structures — Classification and performance requirements*

3 Terms and definitions

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

- 3.1
actual size**
measured size of a glued laminated product at a related measured/estimated moisture content
- 3.2
bonding strength**
structural effectiveness of adhesives between timber components when subjected to stresses
- 3.3
block glued glulam**
structural member having a solid rectangular cross section comprising two or more glulam components bonded together with a gap filling adhesive

Note 1 to entry: See Figure 2.



Key

- 1 glulam component 1
- 2 glulam component 2
- n* glulam component *n*
- a* glue line between glulam components

Figure 2 — Examples for block glued glulam

- 3.4
combined glued laminated timber**
glued laminated timber with a cross section comprising inner and outer laminations of different strength classes or manufacturer specific strength class
- 3.5
combined glulam with asymmetrical layup**
combined glued laminated timber having an asymmetrical cross sectional layup
- 3.6
corrected size**
size of a glued laminated product corrected by calculation from its actual size to its size at the reference moisture content
- 3.7
curved glued laminated member**
member made of glulam or glulam with large finger joints or block glued glulam having a precamber greater than 1 % of its span

Note 1 to entry: See Figure 12.

3.8

delamination length

sum of the lengths of delaminated glue lines on both end-grain surfaces of a test piece

3.9

developed length

length of a curved member measured at the outermost side of the lamination having the largest radius

3.10

finger angle

inclination α of each side of the fingers of a finger joint

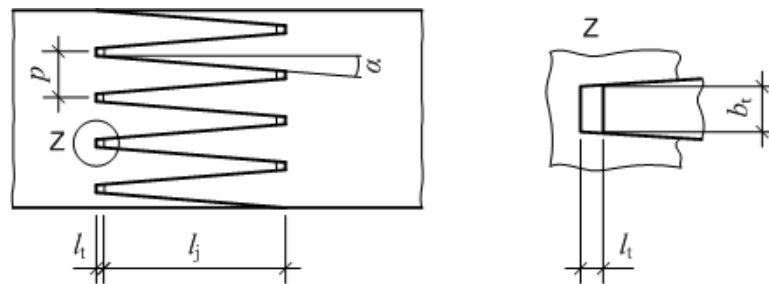
Note 1 to entry: See Figure 3.

3.11

finger joint

interlocking end joint formed by machining a number of similar, tapered, symmetrical fingers in the ends of boards, 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 glued laminated timber components are defined as large finger joints (see also 3.20).



Key

l_j finger length

p pitch

α finger angle

l_t tip gap

b_t tip width

Figure 3 — Typical profile of a finger joint

3.12

finger length

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

Note 1 to entry: See Figure 3.

3.13

finished thickness

thickness after planing

3.14

gap filling adhesive

adhesive that has been tested with a glue line thickness of 2 mm

3.15
glued laminated timber

glulam

structural timber member composed by at least two essentially parallel laminations which may comprise of one or two boards side by side having finished thicknesses from 6 mm up to 45 mm (inclusive)

Note 1 to entry: See Figure 4.

Note 2 to entry: Due to planing of the glued laminated timber member an outermost lamination may have reduced thicknesses compared to the inner laminations.

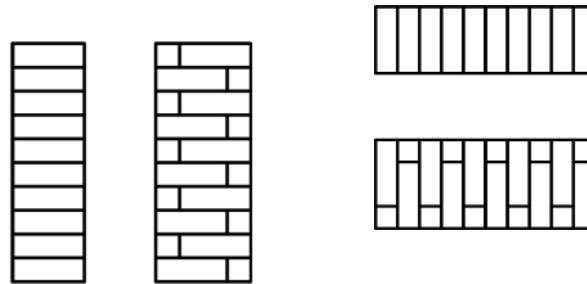


Figure 4 — Glued laminated timber

3.16
glued laminated products

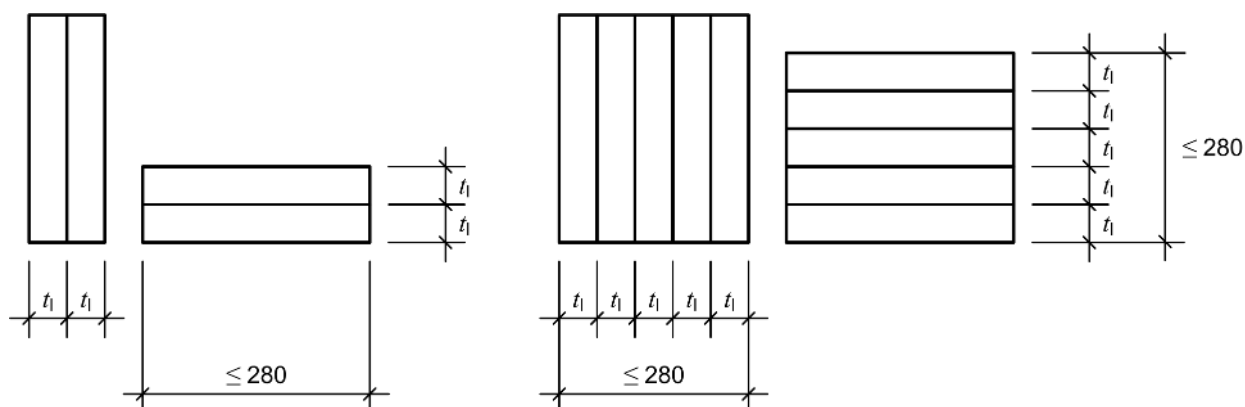
glued laminated timber (glulam), glulam with large finger joints, block glued glulam and glued solid timber for structural uses

3.17
glued solid timber

structural timber member with overall cross-sectional sizes not exceeding 280 mm comprising two to five essentially parallel laminations bonded having the same strength class or manufacturer specific strength class and a finished lamination thickness greater than 45 mm up to 85 mm (inclusive)

Note 1 to entry: See Figure 5.

Note 2 to entry: Due to planing of the glued solid timber member an outermost lamination may have reduced thicknesses compared to the inner laminations.



Key

t_l lamination thickness

$45 < t_l \leq 85$

Figure 5 — Examples for glued solid timber made of two and five laminations

3.18

homogeneous glued laminated timber

glued laminated timber with a cross section whose laminations are a single strength class or a manufacturer specific strength class

3.19

laminations

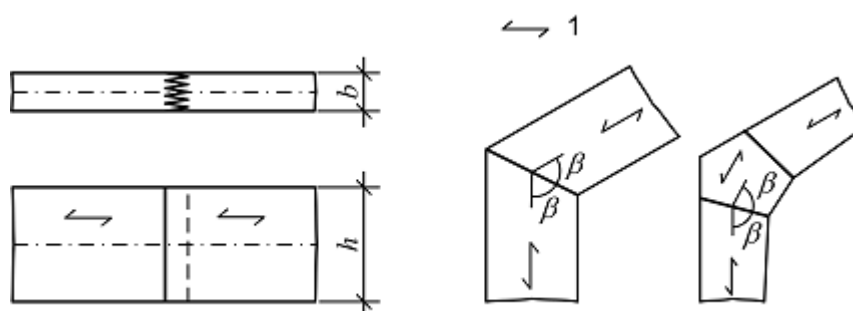
boards, usually finger jointed, being part of glued laminated timber or glued solid timber

3.20

large finger joint

finger joint through the full cross sectional area at the ends of glulam components bonded together at any angle β from 45° up to 90° (inclusive)

Note 1 to entry: See Figure 6.



Key

1 direction of grain

β angle between the large finger joint and the grain direction

Figure 6 — Large finger joints in a beam and in frame corners

3.21

lay up

cross sectional arrangement of laminations

3.22

manufacturer specific strength class

set of characteristic strength, stiffness and density properties declared by a manufacturer

3.23

longitudinal warping

maximum gauge of a member or component measured over a length of 2 000 mm

3.24

maximum delamination length

largest delamination length in any single glue line within the test piece

3.25

mean moisture content

mean value of the moisture content of glued laminated timber and glulam components estimated from at least three measurements

Note 1 to entry: See G.3.

3.26

minimum mean density

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

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

3.27

pitch

distance between centres of adjacent finger tips

Note 1 to entry: See Figure 3.

3.28

ratio of resin to hardener

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

3.29

reduction factor

ratio between tip width and pitch

Note 1 to entry: See Figure 3.

3.30

reference moisture content

moisture content at which target sizes are established

3.31

relative tip gap

ratio between tip gap and finger length

Note 1 to entry: See Figure 3.

3.32

resawn glulam

glued laminated timber resawn into parts by length

3.33

target size

size specified (at the reference moisture content) to which deviations are to be related

3.34

T-class

strength class defined by the characteristic tensile strength parallel to the grain, the mean modulus of elasticity parallel to the grain and the characteristic density

Note 1 to entry: The required values are given in Table 1.

Note 2 to entry: T-classes may for example be achieved from specific settings in EN 14081-4 or by relation to C-Classes according to EN 338 as given in Table 1.

3.35

tip width

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

Note 1 to entry: See Figure 3.

3.36

total delamination length

sum of delamination lengths of all glue lines within a test piece

3.37

wood failure

rupture in or between wood fibres

3.38

wood failure percentage

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

4 Symbols

4.1 Main symbols

A	area, in mm^2 ;
b	width of cross section, in mm;
b_t	tip width, in mm (see Figure 3);
d	diameter, in mm;
$Delam_{\max}$	maximum delamination, in %;
$Delam_{\text{tot}}$	total delamination, in %;
e	relative tip gap;
E	modulus of elasticity, in N/mm^2 ;
f	strength, in N/mm^2 ;
F_u	ultimate load, in N;
G	shear modulus, in N/mm^2 ;
h	depth of cross section, in mm;

k_v	factor for modifications of results from shear tests with glue lines;
k_{15}	statistical factor;
k	moisture deformation factor;
l	length, in mm;
l_a	actual size, in mm;
l_{cor}	corrected size, in mm;
l_j	finger joint length, in mm;
$l_{max,delam}$	maximum delamination length, in mm;
$l_{glue\ line}$	length of one glue line, normally the width b , in mm;
l_t	tip gap, in mm (see Figure 3);
$l_{tot,delam}$	total delamination length, in mm;
$l_{tot,glue\ line}$	entire length of glue lines on the two end-grain surfaces of each test piece, in mm;
n_{lam}	number of laminations;
p	pitch, in mm (see Figure 3);
r	radius of curvature, in mm;
t	lamination thickness, in mm;
u	moisture content, in %;
u_a	actual moisture content, in %;
u_{ref}	reference moisture content, in %;
v	reduction factor of a finger joint;
α	finger angle, in degree (see Figure 3);
β	angle between the large finger joint and the grain in degree (see Figure 6);
ρ	density, in kg/m ³ .

4.2 Subscripts

c	compression;
dc	declared value;
g	properties of glued laminated timber;
gs	properties of glued solid timber;
h	depth effect;
j	properties of finger joints in laminations;

k	characteristic;
l	properties of laminations;
lfj	properties of large finger joints;
m	bending;
mean	mean value;
min	minimum;
r	rolling shear;
s	properties of resawn glulam;
t	tensile;
v	shear;
0	parallel to the grain;
05	5 %-fractile;
90	perpendicular to the grain.

5 Requirements for glued laminated products

5.1 Mechanical resistance of glued laminated timber

5.1.1 General

In this European Standard “Mechanical resistance” covers the following essential characteristics: modulus of elasticity and bending, compressive, tensile and shear strength.

Mechanical resistance of glued laminated timber shall be determined from and declared on the basis of:

- geometrical data (e.g. cross-sectional sizes of laminations and layups) and material properties (strength, stiffness and density properties of laminations and strength properties of finger joints)

NOTE By this method mechanical resistance of glued laminated timber products is indirectly declared so that it can be calculated later under a structural design for a specific end-use situation, using calculation method(s) applicable to the market where it is intended to be used.

- or from tests.

5.1.2 Timber

Timber shall be strength graded according to EN 14081-1.

5.1.3 Related material properties

The characteristic strength, stiffness and density properties of glued laminated timber shall be verified either:

- from classifications from layups and lamination properties according to 5.1.4, or

- from calculations taking into account the cross sectional layup and documented properties of boards and finger joints according to 5.1.5 or
- from full scale tests according to 5.1.6.

The characteristic strength, stiffness and density properties may be declared by reference to a strength class according to Table 3 or 4 or to a manufacturer's specific strength class. If a manufacturer's specific class name starting with GLxx is chosen (where "xx" is the characteristic bending strength) it shall be accompanied by the Company name, e.g. GL 30 Any Company. For glulam having an asymmetrical layup, "ca" has to be added to the class name, e.g. GL28 ca. The class name of resawn glulam shall be marked by "s", e.g. GL24 cs. For brick bonded glulam according to I.5.2, the denomination of strength class shall be accompanied by "brick-bonded".

The characteristic bending strength shall be valid for glulam with a depth h of 600 mm and a lamination thickness of $t = 40$ mm. If the lamination thickness is less than 40 mm, the bending strength may be multiplied by k as given in Formula (1). For lamination thicknesses $40 \text{ mm} < t \leq 45 \text{ mm}$ it is not necessary to take any strength modification into account.

$$k = \min \left\{ \left(\frac{40}{t} \right)^{0,1} ; 1,05 \right\} \quad (1)$$

where

t is the lamination thickness in mm.

The characteristic tensile strength parallel to the grain shall be valid for glulam with depth h of 600 mm or width b of 600 mm.

The characteristic tensile strength perpendicular to the grain shall be valid for glulam with a stressed volume of $0,01 \text{ m}^3$.

The 5%-fractile of a shear modulus or a modulus of elasticity shall be estimated from the mean value by applying the ratio of $G_{g,k}/G_{g,\text{mean}} = 5/6$ and $E_{0,g,k}/E_{0,g,\text{mean}} = 5/6$, respectively.

For glued laminated timber members made of at least ten laminations the product ($E_{0,g,k} G_{g,k}$) may be increased by a factor $k = 1,40$.

5.1.4 Verification from classification of standardised beam lay-ups and lamination properties of glued laminated timber

5.1.4.1 Properties of the boards

The requirements of the boards given in Table 1 shall be fulfilled.

Table 1 — Characteristic strength and stiffness properties for T-classes in N/mm² and densities in kg/m³ for boards or planks for glued laminated timber

T - class of boards^a	$f_{t,0,l,k}$	$E_{t,0,l,mean}$	$\rho_{l,k}$
T8 (C14)	8	7 000	290
T9	9	7 500	300
T10 (C16)	10	8 000	310
T11 (C18)	11	9 000	320
T12 (C20)	12	9 500	330
T13 (C22)	13	10 000	340
T14 (C24)	14	11 000	350
T14,5	14,5	11 000	350
T15	15	11 500	360
T16 (C27)	16	11 500	370
T18 (C30)	18	12 000	380
T21 (C35)	21	13 000	390
T22	22	13 000	390
T24 (C40)	24	13 500	400
T26	26	14 000	410
T27 (C45)	27	15 000	410
T28	28	15 000	420
T30 (C50)	30	15 500	430
^a The C-Classes according to EN 338:2009 meet at least the required values of the respective T-classes.			

5.1.4.2 Strength of finger joints

The required characteristic values of the flat wise bending strength of finger joints $f_{m,j,k}$ in laminations shall be taken from Table 2 or 3. If the finger joints are tested in tension the required characteristic value of the tensile strength of finger joints shall be taken as $f_{m,j,k}/1,4$.

5.1.4.3 Beam lay-up and strength class

Provided the beam lay-up is in accordance with Table 2 or 3 the glued laminated timber fulfils the requirements of a strength class given in Table 4 or 5.

The zones of the cross section are defined in Figure 7.

Dimensions in millimetres

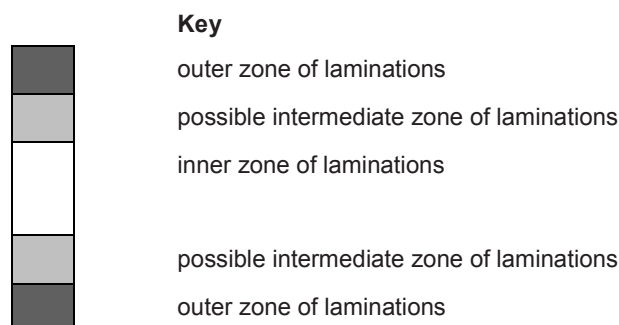


Figure 7 — Example of a beam lay-up of combined glued laminated timber

For combined glued laminated timber the outer zones of lamination grades (see Figure 7) shall be at least the proportion given in Table 2, but at least two laminations for glulam with more than 10 laminations and at least one lamination for glulam with up to 10 laminations.

Table 2 — Beam lay-up of combined glued laminated timber and minimum values for bending strength of finger joints in laminations in N/mm²

Glued laminated timber Strength class	Outer zones of laminations			Intermediate zones of laminations			Inner zone of laminations		
	Strength class	Proportion [%]	$f_{m,j,k}$ [N/mm ²]	Strength class	Proportion [%]	$f_{m,j,k}$ [N/mm ²]	Strength class ^a	Proportion [%]	$f_{m,j,k}$ [N/mm ²]
GL 20c	T13	2x33	21	-	-	-	T8	34	18
GL 22c	T13	2x33	26	-	-	-	T8	34	18
GL 24c	T14	2x33	31	-	-	-	T9	34	19
GL 26c	T16	2x33	34	-	-	-	T11	34	22
GL 28c	T18	2x25	37	-	-	-	T14	50	28
GL 28c	T21	2x17	36	-	-	-	T14	66	26
GL 28c	T21	2x17	38	-	-	-	T13	66	25
GL 28c	T21	2x25	35	-	-	-	T11	50	22
GL 28c	T21	2x20	35	T14	2x20	28	T11	20	22
GL 28c	T22	2x20	35	-	-	-	T13	60	25
GL 30c	T22	2x17	40	-	-	-	T15	66	27
GL 30c	T22	2x17	41	-	-	-	T14	66	28
GL 30c	T22	2x20	40	T14	2x20	30	T11	20	22
GL 30c	T22	2x17	42	T14	2x23	31	T11	20	22
GL 32c	T24	2x17	44	-	-	-	T18	66	31
GL 32c	T26	2x17	45	-	-	-	T14	66	26
GL 32c	T26	2x10	48	T18	2x20	32	T11	40	22

Table 3 — Beam lay-up of homogeneous glued laminated timber and minimum values for bending strength of finger joints in laminations in N/mm²

Strength class glued laminated timber	Strength class laminations	$f_{m,j,k}$
GL 20h	T10	25
GL 20h	T11	22
GL 22h	T13	25
GL 24h	T14	30
GL 26h	T16	33
GL 28h	T18	36
GL 30h	T21	38
GL 30h	T22	37
GL 32h	T24	41
GL 32h	T26	38

Table 4 — Characteristic strength and stiffness properties in N/mm² and densities in kg/m³ for combined glulam

Property ^a	Symbol	Glulam strength class						
		GL 20c	GL 22c	GL 24c	GL 26c	GL 28c	GL 30c	GL 32c
Bending strength	$f_{m,g,k}$	20	22	24	26	28	30	32
Tensile strength	$f_{t,0,g,k}$	15	16	17	19	19,5	19,5	19,5
	$f_{t,90,g,k}$	0,5						
Compression strength	$f_{c,0,g,k}$	18,5	20	21,5	23,5	24	24,5	24,5
	$f_{c,90,g,k}$	2,5						
Shear strength (shear and torsion)	$f_{v,g,k}$	3,5						
Rolling shear strength	$f_{r,g,k}$	1,2						
Modulus of elasticity	$E_{0,g,mean}$	10 400	10 400	11 000	12 000	12 500	13 000	13 500
	$E_{0,g,05}$	8 600	8 600	9 100	10 000	10 400	10 800	11 200
	$E_{90,g,mean}$	300						
	$E_{90,g,05}$	250						
Shear-modulus	$G_{g,mean}$	650						
	$G_{g,05}$	540						
Rolling shear modulus	$G_{r,g,mean}$	65						
	$G_{r,g,05}$	54						
Density ^b	$\rho_{g,k}$	355	355	365	385	390	390	400
	$\rho_{g,mean}$	390	390	400	420	420	430	440

^a Properties given in this table have been calculated according to 5.1.5 on the basis of the layups given in Table 2. If different layups for a certain strength class lead to different characteristic values the lowest values are given here.

^b Calculated as the weighted mean of the densities of the different lamination zones, see 5.1.5.3, 5th paragraph.

Table 5 — Characteristic strength and stiffness properties in N/mm² and densities in kg/m³ for homogeneous glulam

Property	Symbol	Glulam strength class						
		GL 20h	GL 22h	GL 24h	GL 26h	GL 28h	GL 30h	GL 32h
Bending strength	$f_{m,g,k}$	20	22	24	26	28	30	32
Tensile strength	$f_{t,0,g,k}$	16	17,6	19,2	20,8	22,3	24	25,6
	$f_{t,90,g,k}$	0,5						
Compression strength	$f_{c,0,g,k}$	20	22	24	26	28	30	32
	$f_{c,90,g,k}$	2,5						
Shear strength (shear and torsion)	$f_{v,g,k}$	3,5						
Rolling shear strength	$f_{r,g,k}$	1,2						
Modulus of elasticity	$E_{0,g,mean}$	8 400	10 500	11 500	12 100	12 600	13 600	14 200
	$E_{0,g,05}$	7 000	8 800	9 600	10 100	10 500	11 300	11 800
	$E_{90,g,mean}$	300						
	$E_{90,g,05}$	250						
Shear modulus	$G_{g,mean}$	650						
	$G_{g,05}$	540						
Rolling shear modulus	$G_{r,g,mean}$	65						
	$G_{r,g,05}$	54						
Density	$\rho_{g,k}$	340	370	385	405	425	430	440
	$\rho_{g,mean}$	370	410	420	445	460	480	490

5.1.5 Verification from cross sectional layup and properties of boards and finger joints

5.1.5.1 Properties of the boards

If the boards comply with one of the relevant strength classes, the strength, stiffness and density properties may be taken from Table 1.

If the boards or planks do not comply with Table 1, the characteristic values of the tensile strength parallel to the grain $f_{t,0,l,k}$, the mean modulus of elasticity parallel to the grain $E_{t,0,l,mean}$ and the characteristic density $\rho_{l,k}$ shall be derived from tests according to EN 408 and calculated in accordance with EN 384.

5.1.5.2 Strength of finger joints

The characteristic flat wise bending strength or tensile strength of the finger joints shall be declared by the glued laminated timber manufacturer. The declared strength of finger joints shall be verified by tests in accordance with Annex E.

5.1.5.3 Determination of characteristic values for glued laminated timber

The strength and stiffness properties of homogeneous glued laminated timber shall be determined from the strength and stiffness properties of the laminations using the formulae given in Table 6.

The characteristic bending strength, the characteristic tensile and compression strengths parallel to the grain, the mean modulus of elasticity and the characteristic density of a combined glued laminated timber shall be

determined from the respective values of the different lamination zones considered as homogeneous glued laminated timber by means of the elastic composite beam theory.

For combined glued laminated timber the outer zones of lamination grades shall be at least two laminations for glulam with more than 10 laminations and at least one lamination for glulam with up to 10 laminations.

The strength verification shall be made at all relevant points of the cross section.

Table 6 — Characteristic strength and stiffness properties in N/mm² and densities in kg/m³ of homogeneous glued laminated timber

Property	Characteristic values
Bending strength (N/mm ²) $f_{m,g,k}$	The characteristic bending strength shall be calculated using the following expression: $f_{m,g,k} = -2,2 + 2,5 f_{t,0,l,k}^{0,75} + 1,5 \left(f_{m,j,k} / 1,4 - f_{t,0,l,k} + 6 \right)^{0,65}$ The expression shall only be used for a characteristic flat wise bending strength of the finger joint in the range: $1,4 f_{t,0,l,k} \leq f_{m,j,k} \leq 1,4 f_{t,0,l,k} + 12$ The formula is also applicable to glulam without finger joints provided $f_{m,j,k}$ is taken as: $f_{m,j,k} = 1,4 f_{t,0,l,k} + 12$
Tensile strength (N/mm ²) $f_{t,0,g,k}$	The characteristic tensile strength shall be taken as 80 % of the characteristic values of the bending strength $f_{m,g,k}$.
$f_{t,90,g,k}$	0,5
Compression strength (N/mm ²) $f_{c,0,g,k}$	The characteristic compression strength shall be taken as $f_{m,g,k}$ in N/mm ² where $f_{m,g,k}$ is the characteristic bending strength of the glued laminated timber.
$f_{c,90,g,k}$	2,5
Shear strength (N/mm ²) $f_{v,g,k}$	3,5
$f_{r,g,k}$	1,2
Modulus of elasticity (N/mm ²) $E_{0,g,mean}$	The mean modulus of elasticity shall be taken as $E_{0,g,mean} = 1,05 E_{t,0,l,mean}$.
$E_{90,g,mean}$	300
Shear modulus (N/mm ²) $G_{g,mean}$	650
$G_{r,g,mean}$	65
Density (kg/m ³) $\rho_{g,k}$	1,1 $\rho_{l,k}$
$\rho_{g,mean}$	$\rho_{l,mean}$

Glulam may have an asymmetrical layup. In that case, the verification of the bending strength in the outer compressive zone may be disregarded if the followings conditions are met:

- the difference in nominal bending strength between the outer compressive zone and the adjacent zone of laminations (see Figure 7) does not exceed 8 N/mm²;
- the ratio of the moduli of elasticity $E_{0,g,mean}$ of the outer tensile and compressive zone of laminations, respectively, does not exceed 1,25.

The density of a combined glulam shall be taken as the weighted densities of the lamination zones estimated as the densities of homogeneous glulam according to Table 6.

5.1.6 Verifications from full scale tests with glued laminated timber

5.1.6.1 Properties of the boards

The characteristic values of the tensile strength parallel to the grain $f_{t,0,l,dc,k}$ or the bending strength $f_{m,l,dc,k}$, the mean modulus of elasticity parallel to the grain $E_{t,0,l,dc,mean}$ and the characteristic density $\rho_{l,dc,k}$ of the boards shall be estimated and declared by tests according to Annex E.

5.1.6.2 Strength of finger joints

The characteristic flatwise bending strength of the finger joints $f_{m,j,dc,k}$ shall be estimated and declared by tests according to Annex E.

The declared characteristic flatwise bending strength of the finger joints $f_{m,j,dc,k}$ shall be not less than $1,4 f_{t,0,j,dc,k}$.

5.1.6.3 Strength, stiffness and density properties of glued laminated timber derived from testing

5.1.6.3.1 Combined glued laminated timber

Combined glued laminated timber shall be assigned to one of the strength classes given in Table 4 or to any other manufacturer specific strength class if the characteristic bending strength parallel to the grain $f_{m,g,k}$, the mean modulus of elasticity parallel to the grain $E_{0,g,mean}$ and the characteristic density derived from full scale tests according to Annex F and the characteristic tensile strength $f_{t,0,g,k}$ and the compression strength $f_{c,0,g,k}$ parallel to the grain tested according to EN 408 and derived according to EN 14358 are not less than the declared values. Characteristic tensile strength $f_{t,0,g,k}$ and compression strength $f_{c,0,g,k}$ parallel to the grain may be taken as the values for the lamination zone having the lowest characteristic tensile strength parallel to the grain $f_{t,0,l,k}$.

The other strength and stiffness properties of a manufacturer specific strength class shall be calculated using the expressions given in Table 6.

5.1.6.3.2 Homogeneous glued laminated timber

Homogenous glued laminated timber shall be assigned to one of the strength classes given in Table 5 or to any other manufacturer specific strength class if the characteristic bending strength parallel to the grain $f_{m,g,k}$, the mean modulus of elasticity parallel to the grain $E_{0,g,mean}$ and the characteristic density $\rho_{g,k}$ derived from full scale tests according to Annex F are not less than the declared values.

The other strength and stiffness properties of a manufacturer specific strength class shall be calculated using the formulae given in Table 6.

5.1.7 Resawn glulam

Glulam may be sawn perpendicular to the glue lines into 2 or 3 parts (resawn glulam) (see Figure 8).

Each part shall have a minimum width b_s of 38 mm and a maximum depth to width ratio of $h/b_s \leq 8$.

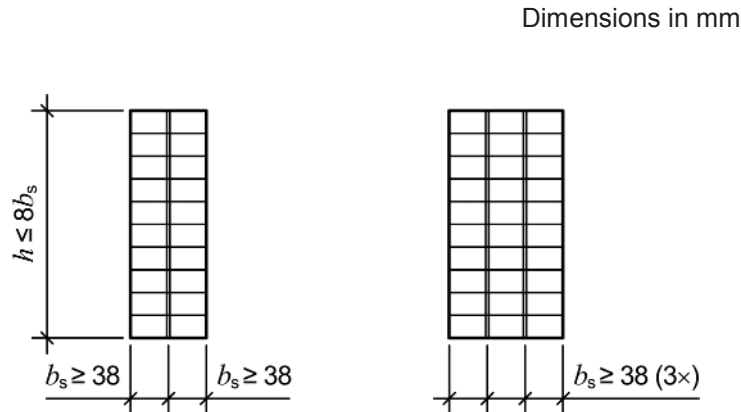


Figure 8 — Cross sections in resawn glulam

Depending on the grading procedure and the lay-up the characteristic strength properties of the resawn glulam shall be determined by either method a) or b), as follows.

- a) If the grading procedures reliably ensure that all laminations of the resawn glulam meet the declared properties, the strength, stiffness and density properties of the resawn glulam shall be determined from these declared properties of the laminations;
- b) If the following two requirements are fulfilled, then the characteristic bending strength $f_{m,s,k}$ of the resawn glulam in bending shall be determined from the characteristic bending strength $f_{m,g,k}$ of the full-size glulam by either Formula (2) or (3):
 - 1) the characteristic tensile strength of the lamination is at least 18 N/mm² and maximum 30 N/mm², and;
 - 2) the characteristic tensile strength of the inner laminations is not more than 8 N/mm² smaller than the characteristic tensile strength of the outer laminations.

$$f_{m,s,k} = f_{m,g,k} - \frac{96}{f_{t,0,l,k} - 6} + 4 \text{ (in N/mm}^2\text{) for 1 cut} \quad (2)$$

$$f_{m,s,k} = f_{m,g,k} - \frac{96}{f_{t,0,l,k} - 6} \text{ (in N/mm}^2\text{) for 2 cut} \quad (3)$$

where

$f_{m,s,k}$ is the characteristic bending strength of the resawn glulam;

$f_{m,g,k}$ is the characteristic bending strength of glulam before it has been resawn;

$f_{t,0,l,k}$ is the characteristic tensile strength of the outer laminations.

The mean modulus of elasticity parallel to the grain $E_{0,s,mean}$ of the resawn glulam shall be determined from the mean modulus of elasticity $E_{0,g,mean}$ of the full-size glulam from Formula (4)

$$E_{0,s,mean} = E_{0,g,mean} - 500 \text{ (in N/mm}^2\text{)} \quad (4)$$

The other mechanical properties shall be determined from Table 6. The density values are equal to those of the full-size glulam.

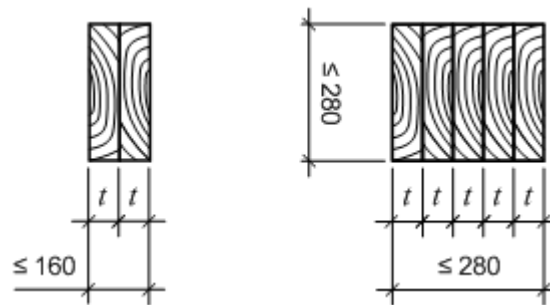
5.2 Mechanical resistance of glued solid timber

5.2.1 General

The provisions of 5.1.1 apply.

This section is valid for glued solid timber having cross sectional sizes and layups as given in Figure 9.

Dimensions in mm



Key

t = lamination thickness $45 < t \leq 85$

Figure 9 — Glued solid timber with two or five laminations

Due to planing of the glued solid timber an outermost lamination may have reduced thicknesses compared to the inner laminations.

5.2.2 Timber

The provisions of 5.1.2 apply.

5.2.3 Related material properties

Glued solid timber is made of laminations complying with one strength class or manufacturer specific strength class.

The characteristic strength, stiffness and density properties of the glued solid timber shall be verified from full scale tests or from classifications from lamination properties.

The characteristic tensile strength perpendicular to the grain shall be valid for glued solid timber with a stressed volume of $0,01 \text{ m}^3$.

The 5%-fractile of a shear modulus or a modulus of elasticity shall be estimated from the mean value by applying a ratio of $G_{gs,k}/G_{gs,mean} = 5/6$ and $E_{0,gs,k}/E_{0,gs,mean} = 5/6$, respectively.

The characteristic rolling shear strength shall be taken as $f_{r,gs,k} = 1 \text{ N/mm}^2$.

The characteristic rolling shear modulus shall be taken as $G_{r,gs,mean} = 0,1 G_{gs,mean}$.

5.2.4 Verification from classification of lamination properties of glued solid timber

5.2.4.1 Properties of the laminations

If the laminations comply with one of the relevant strength classes the strength, stiffness and density properties shall be taken from EN 338.

If laminations are used, which do not comply with EN 338, the characteristic values of the bending strength $f_{m,l,k}$ and the density $\rho_{l,k}$ and the mean value of the modulus of elasticity parallel to the grain $E_{0,l,mean}$ shall be derived from tests according to EN 408 and calculated according to the principles given in EN 384.

5.2.4.2 Strength of finger joints

The finger joints shall fulfil the requirements given in Formula (5).

$$f_{m,j,k} \geq k_f f_{m,l,k} \quad (5)$$

where

$f_{m,j,k}$ is the characteristic bending strength of the finger joints (in N/mm²);

k_f is a factor taking into account the direction of the load;

k_f is 1 for edge-wise bending;

k_f is 1,2 for flat-wise bending;

$f_{m,l,k}$ is the characteristic edge-wise bending strength of the laminations (in N/mm²).

5.2.4.3 Strength, stiffness and density properties of glued solid timber

The characteristic strength and stiffness properties as well as the density of the glued solid timber shall be taken as the properties of the laminations.

Alternatively to k_{sys} from EN 1995-1-1:2004, 6.6(4) the characteristic edge-wise bending strength of the glued solid timber $f_{m,gs,k}$ may be taken as 1,1 $f_{m,l,k}$, where $f_{m,l,k}$ is the characteristic bending strength of the laminations.

5.2.5 Verifications from full scale tests with glued solid timber

5.2.5.1 Properties of the laminations

The properties of the boards shall be declared. The declared characteristic values of the bending strength $f_{m,l,dc,k}$, the mean modulus of elasticity parallel to the grain $E_{t,0,l,dc,mean}$ and the characteristic density $\rho_{l,dc,k}$ shall be estimated and verified by tests according to Annex E.

5.2.5.2 Strength of finger joints

The properties of the finger joints shall be declared. The declared characteristic flat wise bending strength of the finger joints $f_{m,j,dc,k}$ shall be estimated and verified by tests according to Annex E.

The declared characteristic flatwise bending strength of the finger joints $f_{m,j,dc,k}$ shall be not less than $k_f f_{m,l,k}$, where $k_f f_{m,l,k}$ is defined as in 5.2.4.2.

5.2.5.3 Strength, stiffness and density properties of glued solid timber derived from testing

Glued solid timber can be assigned to one of the strength classes given in EN 338 or to a manufacturer specific strength class if its characteristic bending strength parallel to the grain $f_{m,gs,k}$, its modulus of elasticity parallel to the grain $E_{0,gs,mean}$ and density $\rho_{gs,k}$ derived from tests according to Annex F are not less than the declared values.

If assigned to a strength class corresponding to the values of a strength class given in EN 338, the other strength and stiffness properties shall be taken from EN 338:2009, Annex A.

If assigned to a manufacturer specific strength class, the other strength and stiffness properties shall either be determined by testing or shall be taken from EN 338:2009, Annex A. For the determination of $f_{v,k}$ according to

EN 338:2009, Annex A, the lowest value derived by a classification by either $f_{m,l,k}$ or $\rho_{l,k}$ or $E_{0,l,mean}$ shall be taken.

5.3 Additional requirement for mechanical resistance of glulam with large finger joints

The mechanical resistance of glulam with large finger joints shall be declared as the mechanical resistance of its glulam components, the characteristic bending strength of the large finger joints and the geometrical data.

The declared characteristic bending strength $f_{m,l,fj,dc,k}$ of a large finger joint in a straight beam shall be verified by edge-wise bending tests with large finger joints in straight beams in accordance with Annex F.

5.4 Additional requirement for mechanical resistance of block glued glulam

The mechanical resistance of block glued glulam shall be declared as the mechanical resistance of its glulam components and the geometrical data.

5.5 Bonding strength and durability of bonding strength of glued laminated products

5.5.1 General

Durable and reliable bonds can only be achieved under accurately defined conditions of production. That general requirement shall be considered satisfied, if the respective minimum production requirements given in Annex I are fulfilled.

Bonding strength is declared as:

- strength of finger joints and bonding strength of glue lines between laminations for glued laminated timber and glued solid timber;
- and bending strength of large finger joints for glulam with large finger joints;
- and bonding strength of glue lines between glulam components for block glued glulam.

Durability of bonding strength is declared by reference to species and adhesive type and adhesive family.

5.5.2 Species

Glued laminated products shall consist of only one species throughout.

This European Standard covers glued laminated products made from one of the following species:

Spruce (*Picea abies*, PCAB), Fir (*Abies alba*, ABAL), Scots pine redwood (*Pinus sylvestris*, PNSY), Douglas fir (*Pseudotsuga menziesii*, PSMN), Western Hemlock (*Tsuga heterophylla*, TSHT), Corsican pine and Austrian black pine (*Pinus nigra*, PNNL), European larch (*Larix decidua*, LADC), Siberian larch (*Larix sibirica*, LASI), Dahurian larch (*Larix gmelinii* (Rupr.) Kuzen.), Maritime pine (*Pinus pinaster*, PNPN), Poplar (Applicable clones: *Populus x euramericana* cv "Robusta", "Dorskamp", "I214" and "I4551", POAL), Radiata-Pine (*Pinus radiata*, PNRD), Sitka-spruce (*Picea sitchensis*, PCST), Southern Yellow pine (*Pinus palustris*, PNPL), Western Red Cedar (*Thuja plicata*, THPL), Yellow Cedar (*Chamaecyparis nootkatensis*, CHNT).

Spruce and Fir may be considered as one species.

NOTE 1 Letter codes according to EN 13556, if available, are given after the botanical name.

NOTE 2 Not all of the species listed above have a national grade related to a European strength class in EN 1912.

5.5.3 Adhesives for the production of glued laminated products

5.5.3.1 General

Adhesives shall provide durable bonds in glued laminated products throughout the lifetime of the structure for the required service class according to EN 1995-1-1. For glued laminated products used in service class 1 adhesives, which can be assigned to an adhesive type I or II according to prEN 301:2011, Table 1, or EN 15425:2008, Table 1, shall be used. For glued laminated products used in service class 2 or 3 adhesives, which can be assigned to an adhesive type I according to prEN 301:2011, Table 1, or EN 15425:2008, Table 1, shall be used.

The applicability of adhesives in different service classes may be further limited by national provisions valid at the place of use.

Emulsion polymer isocyanate adhesives shall also be assigned to an adhesive type according to EN 15425:2008, Table 1.

Taking into account the restrictions given in the referred sub-clauses, the following adhesive families are applicable:

- a) phenolic and aminoplastic adhesives (e.g. MF, MUF, PRF, UF) in accordance with 5.5.3.2;
- b) moisture curing one-component polyurethane adhesives (PUR) in accordance with 5.5.3.3;
- c) emulsion polymer isocyanate adhesives (EPI) in accordance with 5.5.3.4.

If a preservative treatment is done before the bonding of the laminations it shall be documented that the requirements are fulfilled for the combination of the preservative and adhesive.

The applicability of an adhesive for a glued laminated product or its components covered by this European Standard shall be taken from Table 7.

Table 7 — Applicability of adhesives for components and products

	Relevant requirements for the application of		
	Phenolic and aminoplastic adhesives	Moisture curing one-component polyurethane adhesives	Emulsion polymer isocyanate adhesives
Finger joints in laminations for glulam and glued solid timber	5.5.3.2.1 and 5.5.3.2.2 (if relevant)	5.5.3.3	5.5.3.4
Glue lines between laminations for glulam and glued solid timber	5.5.3.2.1	5.5.3.3	5.5.3.4
Large finger joints	5.5.3.2.1 mixed before used	Not applicable	Not applicable
Glue lines between glulam components of block glued glulam	5.5.3.2.3	Not applicable	Not applicable