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 Together with BS EN 15497:2014 it supersedes BS EN 385:2001, which is withdrawn.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BS EN 387:2001, BS EN 390:1995, BS EN 391:2002, BS EN 392:1995, BS EN 1194:1999 and BS EN 14080:2005 which are withdrawn.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.

Published by BSI Standards Limited 2014

ISBN 978 0 580 86920 4

ICS 79.060.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 January 2014.

Amendments/corrigenda issued since publication

Date	Text affected
30 June 2014	Supersession details corrected in national foreword

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14080

June 2013

ICS 79.060.99

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.

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.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 14080:2013: E

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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.

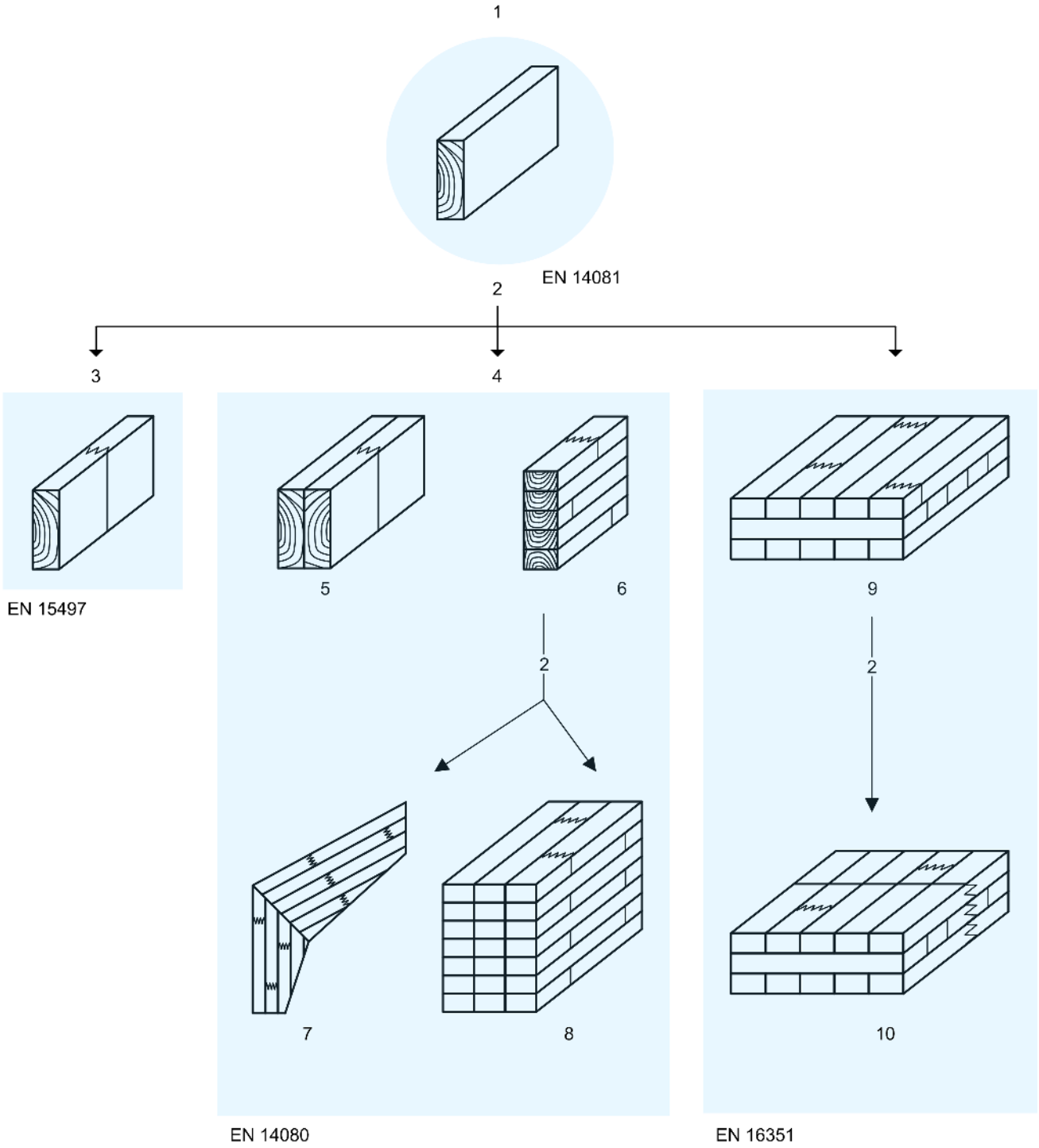
The rules for laminations laid side by side and for grooves in laminations have been changed.

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

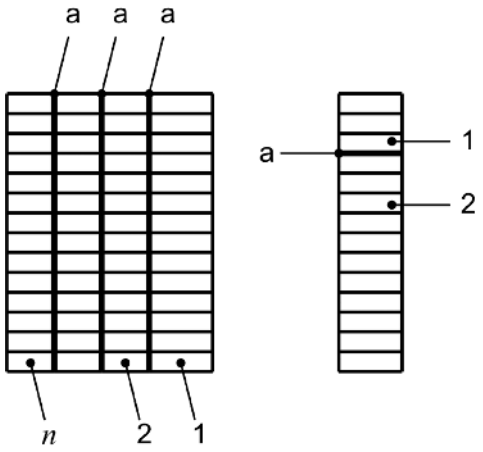
For the purposes of this document, the following terms and definitions apply.

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

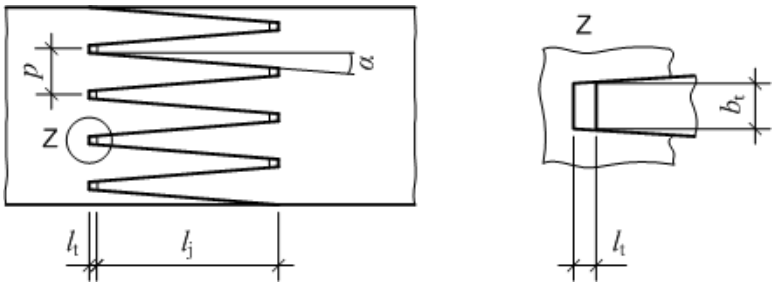
3.9
developed length
length of a curved member measured at the outermost side of the lamination having the largest radius

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.

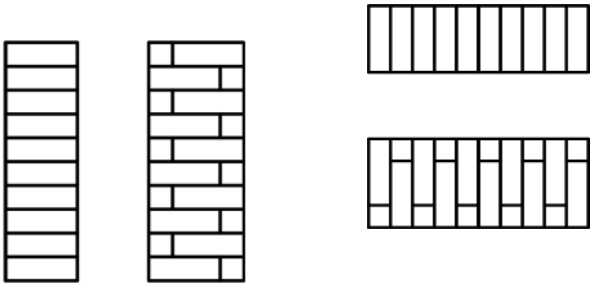


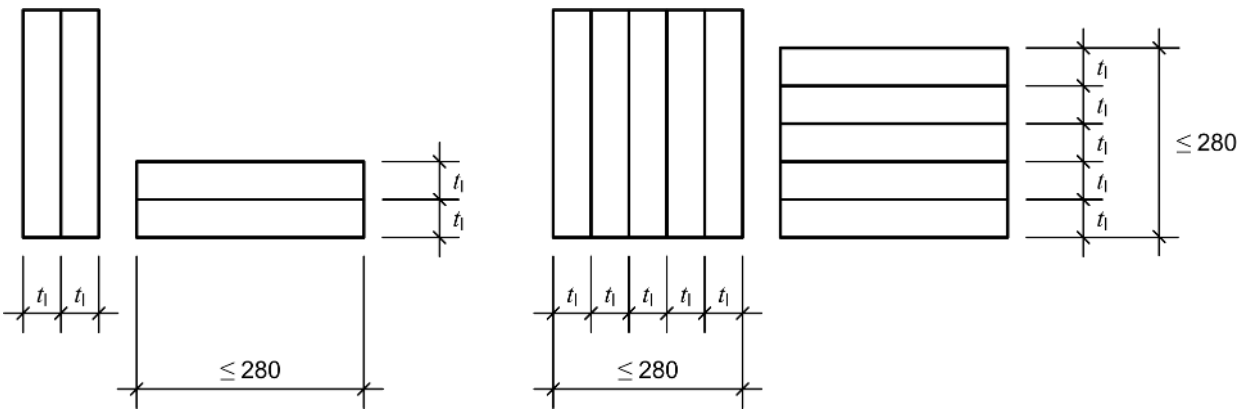
Figure 4 — Glued laminated timber

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

$45 < t_l \leq 85$

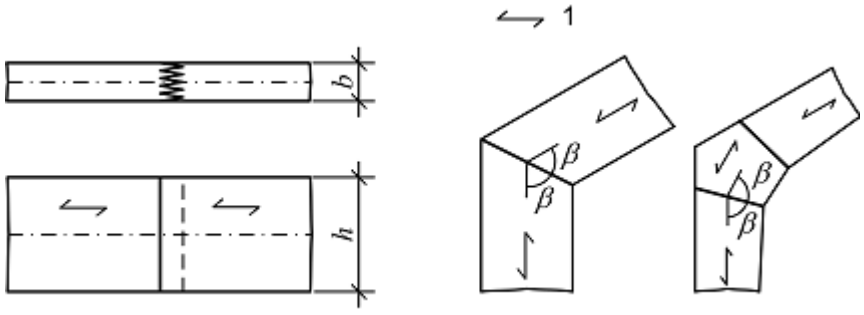
Figure 5 — Examples for glued solid timber made of two and five laminations

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 %;

$Delam_{tot}$ 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 or 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 mm < t ≤ 45 mm it is not necessary to take any strength modification into account.

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

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 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 $G_{g,k}/G_{g,mean}$ = 5/6 and $E_{0,g,k}/E_{0,g,mean}$ = 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/mm^2 and densities in kg/m^3 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

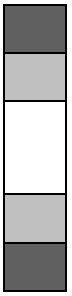
The required characteristic values of the flat wise bending strength of finger joints $f_{m,j,k}$ in laminations shall be taken from Table 2 or 3. If the finger joints are tested in tension the required characteristic value of the tensile strength of finger joints shall be taken as $f_{m,j,k}$/ 1,4.

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



Key

outer zone of laminations

possible intermediate zone of laminations

inner zone of laminations

possible intermediate zone of laminations

outer zone of laminations

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/mm^2

Glued laminated timber	Outer zones of laminations			Intermediate zones of laminations			Inner zone of laminations		
Strength class	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/mm^2

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/mm^2 and densities in kg/m^3 for combined glulam

		Glulam strength class						
Property[a]	**Symbol**	**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 an 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/mm^2 and densities in kg/m^3 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/mm^2;

— 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 $h/b_s \leq 8$.

Dimensions in mm

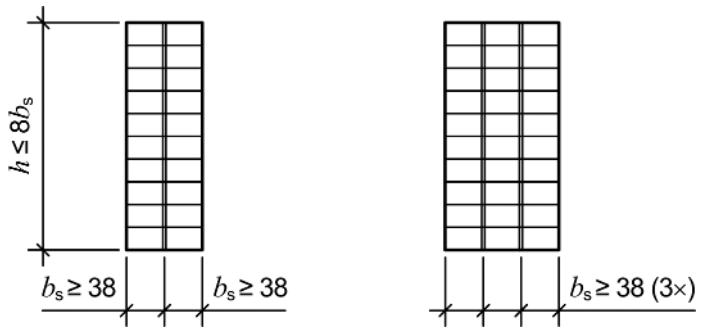


Figure 8 — Cross sections in resawn glulam

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/mm^2 and maximum 30 N/mm^2, and;

   2) the characteristic tensile strength of the inner laminations is not more than 8 N/mm^2 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.

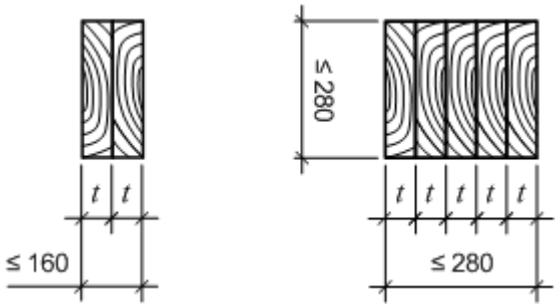
5.2 Mechanical resistance of glued solid timber

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 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 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).

$$f_{m,j,k} \geq k_f \, f_{m,l,k} \tag{5}$$

where

$f_{m,j,k}$ is the characteristic bending strength of the finger joints (in N/mm^2);

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/mm^2).

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 $f_{m,lfj,dc,k}$ 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

5.5.3.2 Phenolic and aminoplastic adhesives

5.5.3.2.1 General requirements

Phenolic and aminoplastic adhesives shall fulfil the requirements of prEN 301 and shall be tested according to prEN 302-6.

5.5.3.2.2 Additional requirements for adhesives for separate application of resin and hardener for the production of finger joints in laminations

prEN 301:2011, Table 2, applies with the following amendment: Footnote c from prEN 301:2011, Table 2, has also to be applied for the 3rd line, 5th row of that Table.

In addition, the following tests shall be performed and the respective requirements fulfilled taking into account a sufficient range of tolerance of the ratio of resin and hardener which shall not be taken less than ± 30 mass proportion related to the hardener:

— Delamination tests with 10 finger jointed specimens according to B.1 and B.3 shall be performed. The specimens shall be produced with separate application of resin and hardener using the nominal ratio of resin and hardener and the application equipment intended to be used. The total delamination percentage of each specimen shall be less than 15 %. The mean value of the total delamination percentage of all 10 specimens shall be less than 10 %;

— Bending tests with finger joints according to Annex E shall be performed. A total of 40 specimens, 20 with the minimum and 20 with the maximum ratio of resin and hardener as given by the range of tolerance for the respective adhesive, shall be produced with separate application of resin and hardener using the intended application equipment: The test results shall fulfil the requirements given in 5.1 (for finger joints in laminations in glulam) or 5.2 (for finger joints in laminations in glued solid timber), respectively.

5.5.3.2.3 Additional requirements for gap filling adhesives

The minimum conventional pressing time of a glue line having a thickness of 1 mm shall be determined as specified in prEN 302-6.

5.5.3.3 Moisture curing one-component polyurethane adhesives

Moisture curing one-component polyurethane adhesives shall fulfil the requirements of EN 15425 and B.2 taking into account the conditions given in B.1.

The requirements given in prEN 302-2:2011, 5.1, 2nd paragraph apply. For moisture curing one-component polyurethane adhesives to be used in finger joints in larch wood the delamination test according to prEN 302-2 may be replaced by tests according to B.3 with larch wood.

The influence of the climate on the conventional pressing time shall be verified in accordance with EN 15416-5.

5.5.3.4 Emulsion polymer isocyanate adhesives

5.5.3.4.1 General

Emulsion polymer isocyanate adhesives shall only be used for glued laminated products to be used in service classes 1 and 2.

Emulsion polymer isocyanate adhesives shall be tested in accordance with EN 15425 and B.2 taking into account the conditions given in B.1 and the respective requirements shall be fulfilled.

The influence of the climate on the conventional pressing time shall be verified in accordance with prEN 302-6. If the maximum glue line thickness in use is 0,2 mm these tests shall be performed with specimens having a glue line thickness of 0,2 mm.

5.5.3.4.2 Systems tested with a maximum glue line thickness of 0,3 mm

Testing according to EN 15425 and B.1 and B.2 may be done with a maximum glue line thickness of 0,3 mm instead of 0,5 mm:

— if the glue line thicknesses in the finished glued laminated products do not exceed 0,2 mm;

— and if, in the case that the adhesive is used for glue lines between laminations, the adhesive is only used for straight glued laminated products and the sizes are limited to a width of 180 mm, a depth of 300 mm and a cross sectional area of 45.000 mm^2.

For tests with a maximum glue line thickness of 0,3 mm the requirements given in EN 15425 shall apply with the following exceptions:

— For bonding strength in longitudinal tensile strength tests according to prEN 302-1 with a glue line thickness of 0,3 mm, the requirements given in Table 8 shall be met.

— For creep deformation tests with specimens loaded in bending shear according to EN 15416-3, the specimens shall have a glue line thickness of 0,2 mm.

Table 8 — Required mean shear strength in N/mm² for lap shear tests according to EN 15425 for samples glued with EPI having a glue line thickness of 0,3 mm

	Adhesive type	
Treatment	Type I	Type II
A1	9,5	9,5
A2	5,5	5,5
A3	7,6	7,6
A4	5,5	NR [a]
A5	7,6	NR [a]
A6	NR [a]	8,3
A7	7,2	NR [a]
[a] Treatment cycle not required (NR)		

5.5.4 Finger joints in laminations

Durable and reliable finger joints in laminations 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 I.4 are fulfilled.

5.5.5 Bonding of laminations

5.5.5.1 General

Durable and reliable bonds between laminations for the production of glued laminated timber or glued solid timber can only be achieved under accurately defined conditions of production. That general requirement shall be considered satisfied for glued laminated timber to be used in all service classes and for glued solid timber to be used in service classes 1 and 2, if the minimum production requirements given in I.5 are fulfilled.

5.5.5.2 Bonding strength of glue lines

5.5.5.2.1 General

The bonding strength of glue lines shall be either verified by delamination test or by shear test.

For glued laminated timber to be used in service class 3 according to EN 1995-1-1 delamination test method A or B, given in Annex C, shall be used for the purpose of factory production control.

The applicability of test methods for bonding strength of glue lines for glued laminated timber to be used in different service classes may be limited by further national provisions valid at the place of use.

5.5.5.2.2 Glue line integrity

Where the glue line integrity is tested by the delamination test method A, B or C, given in Annex C, the total delamination percentage of each cross sectional specimen shall meet the requirements given in Table 9.

Table 9 — Maximum values for the total delamination in %

Type [a]	**Number of cycles**	**1**	**2**	**3**
Glued laminated timber, Glulam with large finger joints and block glued glulam	Method A	–	5	10
	Method B	4	8	–
	Method C	10	–	–
Glued solid timber with lamination thicknesses from 60 mm up to 85 mm (inclusive)	Method A	–	10	15
	Method B	8	12	–
	Method C	15	–	–
[a] For Glued solid timber having lamination thicknesses from 45 mm up to 60 mm linear interpolation applies.				

For all delamination methods the maximum delamination percentage of a single glue line shall be less than or equal 30 %.

5.5.5.2.3 Shear strength of glue lines

Where the shear strength of the glue lines is tested according to Annex D, each test result shall comply with the following requirements with regard to the shear strength and the wood failure percentage.

The shear strength of each glue line shall be at least 6 N/mm², see Table 10, individual values. A shear strength of 4 N/mm^2 shall be regarded as acceptable if the wood failure percentage is 100, see Table 10, individual values.

The average wood failure percentage of a cross sectional specimen and any individual values shall exceed the minimum wood failure percentages stated in Table 10.

Table 10 — Minimum wood failure percentages relating to the shear strength f_v [a]

	Average			Individual values		
Shear strength f_v, in N/mm^2	**6**	**8**	**$f_v \geq 11$**	**$4 \leq f_v < 6$**	**6**	**$f_v \geq 10$**
Minimum wood failure percentage, in % [b]	90	72	45	100	74	20

[a] For values in between linear interpolation shall be used.

[b] For average values the minimum wood failure percentage shall be: 144 – (9 f_v). For the individual values the minimum wood failure percentage for the shear strength $f_v \geq 6{,}0$ N/mm^2 shall be: 153,3 – (13,3 f_v).

5.5.6 Bonding of large finger joints

Durable and reliable large finger joints can only be achieved under accurately defined conditions of production. That general requirement shall be considered satisfied for large finger joints to be used in service class 1 or 2, if the minimum production requirements given in I.6 are fulfilled.

5.5.7 Bonding of block glued glulam

5.5.7.1 General

Durable and reliable bonds between glulam components of block glued glulam can only be achieved under accurately defined conditions of production. That general requirement shall be considered satisfied for block glued glulam, if the minimum production requirements given in I.7 are fulfilled.

5.5.7.2 Bonding strength of glue lines between glulam components

The bonding strength of glue lines between glulam components shall be verified either by shear tests or by delamination tests.

The results from shear tests according to Annex D shall meet the requirements given in 5.5.5.2.3.

The results from delamination tests according to Annex C shall meet the requirements given in 5.5.5.2.2.

5.6 Durability of other characteristics against biological attack

5.6.1 Glued laminated products without preservative treatment

The natural durability of the glued laminated products shall be taken as the natural durability according to EN 350-2 of the timber from which they are made.

5.6.2 Glued laminated products with preservative treatment

Only treatments according to EN 15228:2009, 4.5, which do not affect the strength, stiffness and density properties shall be used.

If either preservative treated timber is used for the components of the glued laminated product, or the glued laminated product itself is preservative treated, the information given in EN 15228:2009, Clause 6, shall be declared.

The use of timber preservatives may be restricted by provisions valid in the place of use.

5.7 Resistance to fire

The Resistance to fire of glued laminated products shall be indirectly declared on the basis of geometrical data (member sizes, cross sectional layup) and material properties (strength, stiffness and density properties.

NOTE By this method resistance to fire of glued laminated products is indirectly declared so that it can be calculated later under a fire engineering design for specific end-use situation taking into account additional parameters, e.g. charring rates, given in the respective fire design code.

5.8 Reaction to fire

The class of reaction to fire performance (including the additional classification on smoke production and flaming droplets/particles, if any) of glued laminated products, either preservative treated against biological attack or not, shall be determined and declared by either method a) or b), as follows:

a) without the need for further testing (CWFT), as given in Table 11, if the glued laminated product concerned is proved to meet the requirements of the class given therein; or

b) based on testing of the glued laminated product concerned according to the standards referred to in EN 13501-1, when such a product does not meet the requirements of Table 11 or where a higher classification than the one in a) is sought.

The influence of a preservative treatment against biological attack on the performance of reaction to fire shall be taken into account as laid down in EN 15228:2009, 4.4.

For reaction to fire glued solid timber is considered as glulam with larger lamination thickness.[1)]

Reaction to fire class of glulam with large finger joints or block glued glulam shall be considered as the reaction to fire class of the glulam components.[2)]

Table 11[3)] — Classes of reaction to fire performance for glulam[a]

Product	**Product details**	**Minimum mean density[b]** (kg/m^3)	**Minimum overall thickness** (mm)	**Class[c]** (excluding floorings)
Glulam	Glued laminated timber products in accordance with EN 14080	380	40	D-s2, d0

[a] Applies to all species and adhesives covered by the product standards.
[b] Conditioned according to EN 13238.
[c] Class as provided for in Table 1 of the Annex to Decision 2000/147/EC.

When Reaction to Fire is determined by testing the product shall be tested according to EN 13823 (SBI test) and mounted and fixed in accordance with the following:

— the whole area of both wings in the SBI apparatus shall be covered with pieces of the product concerned, mounted edge to edge (butt jointed), without jointing or bonding and orientated horizontally or vertically;

— supported by battens of the product concerned of a size minimum (40 × 80) mm, fixed to the test backing boards at 400 mm to 600 mm centres horizontally or vertically (perpendicular to the orientation of the product pieces), so that the resulting spacing between backing board and product is 80mm;

— see also Figure 10.

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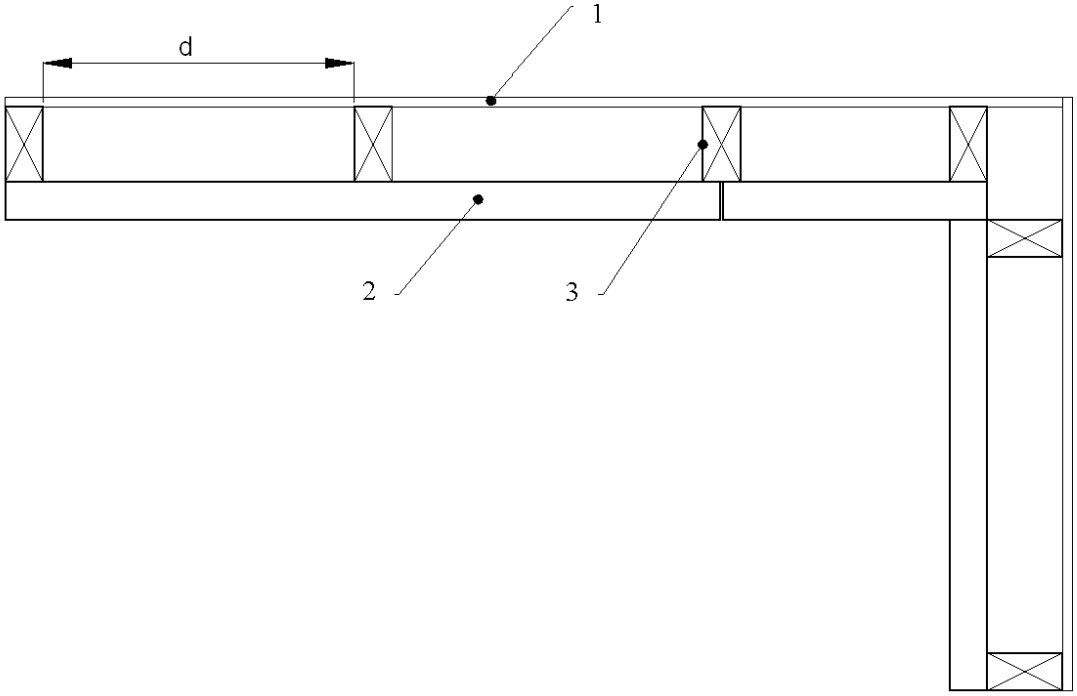
1) A Commission´s decision on the applicability of Table 11 for glued solid timber has been filed.

2) A Commission´s decision on the applicability of Table 11 for glulam with large finger joints and block glued glulam has been filed.

3) This table is the same as given in the Commission Decision 2005/610/EC of 2005-08-09 *(see OJEU L208 of 2005-08-11)*.

NOTE Test results are valid for glued laminated products having at least the density and the minimum overall thickness of the specimens tested.



Key

1	backing board	3	batten (cross section of 40mm x 80mm)
2	glued laminated product		400 mm ≤ d ≤ 600 mm

Figure 10 — Top view of fixing system for Reaction to Fire test according to EN 13823

5.9 Formaldehyde emission

The release of formaldehyde shall be declared as Class E1 or E2 according to Annex A.

5.10 Release/content of other dangerous substances

National regulations on dangerous substances may require verification and declaration on release and sometimes on content of other dangerous substances in addition to those dealt with in other clauses when construction products covered by this standard are placed on those markets.

In the absence of European harmonised tests methods verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction web site on EUROPA accessed through: http://ec.europa.eu/enterprise/construction/cpd-ds/.

5.11 Deviation in sizes

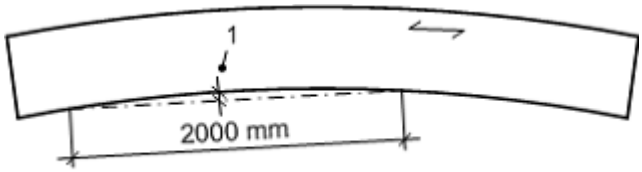
5.11.1 Maximum deviations

Any corrected sizes (see 5.11.2) for glued laminated timber, glulam with large finger joints and block glued glulam shall deviate from the nominal sizes by not more than stated in Table 12.

The maximum deviations for curved members, given in Table 12, shall apply for such members having a ratio of the radius of curvature r to the depth h of $r/h \geq 20$, being planed on two opposite sides. For ratios $r/h < 20$ the maximum deviation should be subject to individual arrangements.

Table 12 — Maximum deviations from nominal sizes for glued laminated timber, glulam with large finger joints and block glued glulam

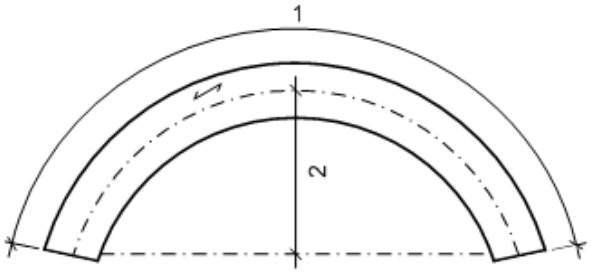
Nominal sizes for		**Maximum deviations**	
		Straight members	Curved members
Width of cross section	for all widths	± 2 mm	
Depth of cross section	$h \leq 400$ mm	+ 4 mm to – 2 mm	
	$h > 400$ mm	+ 1 % to – 0,5 %	
Maximum deviation of the angles of the cross section from the right angle		1:50	
Length of a straight member or developed length of a curved member	$l \leq 2$ m	± 2 mm	
	2 m ≤ l ≤ 20 m	± 0,1 %	
	$l > 20$ m	± 20 mm	
Longitudinal warping measured as the maximum gauge over a length of 2 000 mm disregarding precamber (see Figure 11)		4 mm	–
Gauge per m developed length (see Figure 12)	≤ 6 Laminations	–	± 4 mm
	> 6 Laminations	–	± 2 mm



Key

1 gauge

Figure 11 — Longitudinal warping of straight glued laminated timber, glulam with large finger joints and block glued glulam



Key

1 developed length

2 gauge

Figure 12 — Basic dimensions of curved glued laminated members

Any corrected sizes for glued solid timber shall deviate from the nominal sizes by not more than the values given in Table 13.

Table 13 — Maximum deviations from nominal sizes for glued solid timber

Nominal sizes for		Maximum deviations
Thicknesses and widths	≤ 100 mm	± 1 mm
	> 100 mm	± 1,5 mm
Maximum deviation of the angles of the cross section from the right angle		1:50
Length	l ≤ 10 m	± 3 mm
	l > 10 m	± 5 mm

5.11.2 Corrected sizes and moisture deformation factor

The actual sizes of glued laminated products are influenced by swelling and shrinkage due to changes of moisture content.

The swelling and shrinkage ratios of a certain species can be regarded as constant values in the perpendicular to grain and parallel to grain directions of the timber.

If the actual moisture content of the glued laminated products differs from the reference moisture content, a corrected size shall be calculated from the actual size by Formula (6):

$$l_{cor} = l_a (1 + k (u_{ref} - u_a)) \quad (6)$$

where

l_{cor} is the corrected size (in mm);

l_a is the actual size (in mm);

k is the moisture deformation factor according to Table 14 to take into account deformations by moisture changes;

u_{ref} = 12 % for all glued laminated products

Specific end-uses may require to deliver the glued laminated products with a moisture content different from the reference moisture content u_{ref}.

u_a is the actual moisture content measured according to Annex G (in %).

Table 14 — Moisture deformation factor k for a change in moisture content of 1 %[a]

Direction of grain	Moisture deformation factor k
perpendicular	0,0025
parallel	0,0001

[a] The values are valid for coniferous wood and poplar having a moisture content from 6 % up to 25 % (inclusive). The moisture deformation factor *k* perpendicular to the grain is an average of both tangential and radial deformation.

6 Evaluation of conformity

6.1 General

The compliance of glued laminated products with the requirements of this standard and with the declared values (including classes) shall be demonstrated by:

— initial type testing;

— factory production control by the manufacturer, including product assessment.

The manufacturer shall always retain the overall control and shall have the necessary means to take responsibility for the product.

6.2 Initial Type Testing

6.2.1 General

Initial Type Testing shall be performed to demonstrate compliance with this European Standard.

All essential characteristics set out in bold letters in Table 15 for which the manufacturer declares performances, are subject to Initial Type Testing. In addition, the need to perform Type Tests applies to all other characteristics included in the standard when the manufacturer claims compliance, unless the standard gives provisions (e.g. use of previously existing data, CWFT and conventionally accepted performance) for declaring performances without performing tests."

Tests previously performed in accordance with the provisions of this standard, may be taken into account provided that they were made to the same or a more rigorous test method, under the same system of attestation of conformity on the same product or products of similar design, construction and functionality, such that the results are applicable to the product in question.

NOTE 1 Same system of attestation of conformity means testing by an independent third party, under the responsibility of a product certification body.

For the purposes of testing, the manufacturer's products may be grouped into families, where it is considered that the results for one or more characteristics from any one product within the family are representative of the same characteristics for all products within that same family.

Products may be in different families for different characteristics.

In addition, Initial Type Testing shall be carried out for all characteristics included in the standard for which the manufacturer declares performances:

— at the beginning of the production of a new or modified glued laminated products (unless a member of the same family), or

— at the beginning of a new or modified method of production (where this may affect the stated properties); or

— they shall be repeated for the appropriate characteristic(s), whenever a change occurs in the glued laminated products design, in the raw material or in the supplier of the components, or in the production process (subject to the definition of a family), which would affect significantly one or more of the characteristics.

NOTE 2 In this context "design" means "product design".

Where components are used whose characteristics have already been determined, by the component manufacturer, on the basis of compliance with other product standards, these characteristics need not be re-

assessed. The specifications of these components shall be documented, as shall be included in the inspection scheme for ensuring their compliance.

Products marked in accordance with appropriate harmonised European specifications may be presumed to have the performances stated with the marking, although this does not replace the responsibility on the glued laminated products designer to ensure that the glued laminated products as a whole is correctly designed and its component products have the necessary performance values to meet the design.

6.2.2 Test samples, testing and compliance criteria

The number of samples of glued laminated products to be tested/assessed shall be in accordance with Table 15.

Table 15 — Initial type testing for glued laminated products[a]

Characteristics	Requirement clause	Test-/Assessment method	Test sample	Acceptance criteria
Mechanical resistance of glued laminated timber expressed as modulus of elasticity, bending strength, compressive strength, tensile strength and shear strength				
Strength, stiffness and density properties of timber	5.1.2	EN 14081-1	General, for timber graded by the manufacturer of the glued laminated products: EN 14081-1:2005+A1:2011, 6.2	EN 14081-1:2005+A1:2011, 6.2
			General, for timber not graded by the manufacturer of the glued laminated products: -	Check labelling of timber according to EN 14081-1:2005+A1:2011, Clause 7
			Additionally for glulam for which mechanical resistance has been derived from full scale tests: For each grade and species 30 boards shall be tested according to EN 408 and $f_{m,k,l,dc}$ shall be determined according to EN 14358.	5.1.6.1
Finger joints in laminations	5.1.4.2 or 5.1.5.2	Annex E (test)	General, for each combination of species, adhesive and declared strength value: – For laminations complying with Table 1: 15 finger joints in laminations – For laminations not complying with Table 1: 100 finger joints in laminations from at least three batches	5.1.4.2 or 5.1.5.2
	5.1.6.2		For glulam for which mechanical resistance has been derived from full scale tests, for each combination of species, adhesive and cross-sectional layup: – For laminations complying with Table 1 : 30 finger joints in laminations – For laminations not complying with Table 1: 100 finger joints in laminations from at least three batches	5.1.6.2

Table 15 *(continued)*

Characteristics	Requirement clause	Test-/Assessment method	Test sample	Acceptance criteria
Mechanical resistance of glued laminated timber expressed as modulus of elasticity, bending strength, compressive strength, tensile strength and shear strength				
Bending strength, compressive strength, tensile strength, shear strength, modulus of elasticity, density of glued laminated timber	5.1.6.3	or 5.1.6.3 (test)	Only for glulam for which mechanical resistance is derived from full scale tests: 30 glulam specimens	5.1.6.3
Additionally for resawn glulam	5.1.7	5.1.7 (check)	-	5.1.7
Geometrical data	5.11	5.11 (check)	General	5.11
Mechanical resistance of glued solid timber expressed as modulus of elasticity, bending strength, compressive strength, tensile strength and shear strength				
Strength, stiffness and density properties of timber	5.2.2	EN 14081-1	General, for timber graded by the manufacturer of the glued laminated products: EN 14081-1:2005+A1:2011, 6.2	EN 14081-1:2005+A1:2011, 6.2
			General, for timber not graded by the manufacturer of the glued laminated products: -	Check labelling of timber according to EN 14081-1:2005+A1:2011, Clause 7
			Additionally for glued solid timber for which mechanical resistance is derived from full scale tests: For each grade and species 30 boards shall be tested according to EN 408 and $f_{m,k,l,dc}$ shall be determined according to EN 14358.	5.2.5.1
Strength of finger joints in laminations	5.5.4.2 or 5.2.5.2	Annex E (test)	General, for each combination of species, adhesive and declared strength value – for laminations complying with Table 1: 15 finger joints in laminations – for laminations not complying with Table 1: 100 finger joints in laminations from at least three batches	5.2.4.2 or 5.2.5.2
Bending strength, compressive strength, tensile strength, shear strength, modulus of elasticity, density of glued solid timber	5.2.5.3	5.2.5.3 (test)	Only for glued solid timber for which mechanical resistance is derived from full scale tests: 30 glued solid timber specimens	5.2.5.3
Geometrical data	5.11	5.11 (check)	-	5.11

Table 15 *(continued)*

Characteristics	Requirement clause	Test-/Assessment method	Test sample	Acceptance criteria
Mechanical resistance of glulam with large finger joints as modulus of elasticity, bending strength, compressive strength, tensile strength and shear strength of glulam components and bending strength of large finger joints				
Mechanical resistance of glulam components and geometrical data	5.3	As for mechanical resistance of glued laminated timber (see 5.1)		
Bending strength of large finger joints	5.3	Annex F (test)	for each species and adhesive 10 from two different batches	Annex F (test)
Mechanical resistance of block glued glulam as modulus of elasticity, bending strength, compressive strength, tensile strength and shear strength of glulam components				
Mechanical resistance of glulam components and geometrical data	5.4	As for mechanical resistance of glued laminated timber (see 5.1)		
Bonding strength expressed as				
Strength of finger joints in laminations for glued laminated timber	5.1.4.2 or 5.1.5.2 or 5.1.6.2	As for mechanical resistance of glued laminated timber		
Strength of finger joints in laminations for glued solid timber	5.2.4.2 or 5.2.5.2.	As for mechanical resistance of glued solid timber		
Glue line integrity of laminations in glued laminated timber or glued solid timber	5.5.5.2.2	According to Annex C (test)	for each combination of species and adhesive 10 full cross sectional specimens	5.5.5.2.2
Bending strength of large finger joints	5.3	As for mechanical resistance of glulam with large finger joints		
Bonding strength of glue lines of block glued glulam	5.5.7.2	Annex C (test) or Annex D (test)	2 specimens	5.5.5.2.2 5.5.5.2.3
Durability of bonding strength as				
Species	5.5.2	5.5.2 (check)	-	5.5.2
Moisture of timber to be bonded[b]	G.1	G.1 (test)	100 timber pieces for each species	G.1

Table 15 *(continued)*

Characteristics	Requirement clause	Test- /Assessment method	Test sample	Acceptance criteria
Durability of bonding strength as				
Adhesive characteristics	5.5.3.1 and 5.5.3.2.1 General requirements for phenolic and aminoplastic adhesives[b]	prEN 302-1, -2, -3, -4 and -6 (test)	acc. to prEN 302-1, -2, -3, -4 and -6	The requirements for the respective adhesive type class and subclass given in prEN 301 shall be fulfilled and the conventional pressing time according to prEN 302-6 shall be declared.
	5.5.3.2.2 Additional requirements for phenolic and aminoplastic adhesives for separate application of resin and hardener for the production of finger joints in laminations	prEN 302-1, -2, -3 and B.3[b]	5.5.3.2.2	5.5.3.2.2
		and B.3	5.5.3.2.2	5.5.3.2.2
		and Annex E	5.5.3.2.2	5.1 or 5.2
	5.5.3.2.3 Additional requirements for gap filling adhesives[b]	prEN 302-6	prEN 302-6	prEN 302-6
	5.5.3.1 and 5.5.3.3 Moisture curing one-component polyurethane adhesives[b]	EN 15425 (test)	EN 15425	EN 15425
		and B.2 (test)	80	B.2
		and prEN 302-2:2011, 5.1, 2nd para. (test) or	prEN 302-2:2011, 5.1, 2nd para.	prEN 302-2:2011, 5.1, 2nd para.
		For adhesives only to be used for finger joints in larch laminations: B.3	Analogue to 5.5.3.2.2, 1st dash	B.3
		and EN 15416-5 (test)	EN 15416-5	The conventional pressing time acc. to EN 15416-5 shall be declared
	5.5.3.1 and 5.5.3.4 Emulsion polymer isocyanate adhesives[b]	EN 15425 (test)	EN 15425	5.5.3.4
		and B.2 (test)	80	B.2
		and prEN 302-6 (test)	prEN 302-6	The conventional pressing time according to prEN 302-6 shall be declared

Table 15 *(continued)*

Characteristics	Requirement clause	Test- /Assessment method	Test sample	Acceptance criteria
Durability of other characteristics against biological attack				
Without preservative treatment: Natural durability	5.6.1	5.6.1 (check)	–	requirements for the declared durability-class according to EN 350-2 shall be fulfilled
With preservative treatment	5.6.2	5.6.2 (test)	acc. to EN 15228	acc. to EN 15228
Resistance to fire as				
Resistance to fire	5.7	Declared as for mechanical resistance of the glued laminated product,		
Reaction to fire				
Reaction to fire	5.8	Table 11 (CWFT) (check)	–	Table 11
		or tested acc. to methods referred in EN 13501-1	according to EN 13501-1	Classes according to EN 13501-1
Release of formaldehyde				
Formaldehyde emission	5.9	Annex A	Annex A	Class E1 or E2
Release of other dangerous substances				
Release of other dangerous substances	5.10	As relevant, according to 5.10		

[a] Where further references to Annex I are made in Clause 5, the corresponding requirements shall also be included into the Initial Type Testing.

[b] The manufacturer of the adhesive or the moisture meter, respectively, usually provides the manufacturer of the glued laminated product with some documentations on tests previously performed by notified product certification bodies (shared Initial Type Testing results).

6.2.3 Test reports

All Initial Type Tests and their results shall be documented in test reports. All test reports shall be retained by the manufacturer for at least 10 years after the last date of production of the glued laminated products to which they relate.

6.3 Factory production control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market comply with the declared performance of the characteristics and that the minimum production requirements of Annex I are fulfilled.

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This production control system documentation shall ensure a common understanding of conformity evaluation and enable the achievement of the required product characteristics and the effective operation of the production control system to be checked. Factory production control therefore brings together operational techniques and all measures allowing maintenance and control of the compliance of the product with this European Standard.

6.3.2 Requirements

6.3.2.1 General

The manufacturer is responsible for organising the effective implementation of the FPC system. Tasks and responsibilities in the production control organisation shall be documented and this documentation shall be kept up-to-date.

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product conformity, shall be defined. This applies in particular to personnel that needs to initiate actions preventing product non-conformities from occurring, actions in case of non-conformities and to identify and register product conformity problems. Personnel performing work affecting product conformity shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

In each factory the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate conformity of the product at appropriate stages;

— identify and record any instance of non-conformity;

— identify procedures to correct instances of non-conformity.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the conformity of the product. This involves:

a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-conformity.

Where subcontracting takes place, the manufacturer shall retain the overall control of the product and ensure that he receives all the information that is necessary to fulfil his responsibilities according to this European Standard.

If the manufacturer has part of the product designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, the FPC of the subcontractor may be taken into account, where appropriate for the product in question.

The manufacturer who subcontracts all of his activities may in no circumstances pass these responsibilities on to a subcontractor.

NOTE Manufacturers having an FPC system, which complies with EN ISO 9000 series standard and which addresses the requirements of this European Standard are recognised as satisfying the FPC requirements of the Council Directive 89/106/EEC.

6.3.2.2 Equipment

6.3.2.2.1 Testing

All weighing, measuring and testing equipment according to Annex H shall be calibrated or verified and regularly inspected according to documented procedures, frequencies and criteria.

6.3.2.2.2 Manufacturing

All equipment according to Annex H used in the manufacturing process should be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

6.3.2.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their compliance. In case supplied kit components are used, the attestation of conformity level of the component shall be that given in the appropriate harmonised technical specification for that component.

6.3.2.4 Design process

The factory production control system shall document the various stages in the design of products, identify the checking procedure and those individuals responsible for all stages of design. During the design process itself, a record shall be kept of all checks, their results, and any corrective actions taken.

This record shall be sufficiently detailed and accurate to demonstrate that all stages of the design phase, and all checks, have been carried out satisfactorily.

NOTE In this context "design" does not mean a structural design by a civil engineer but e.g. the choice of components or cross sectional layup of a glued laminated product.

6.3.2.5 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

The manufacturer´s documentation, procedures and instructions shall be relevant to the production and process control of the products, and shall be adequately described in a works' quality manual, covering:

a) quality aims and organisational structure, responsibilities and powers of the management with regard to conformity of the products;

b) procedures for specifying and verifying the compliance of the timber and the bonding;

c) manufacturing, production control and other techniques, processes and systematic actions to be taken.

For the bonding processes the following shall be recorded:

1) production line;

2) date and number of production;

3) species;

4) strength class or manufacturer specific strength class;

5) dimensions of the member;

6) moisture content of individual boards;

7) time for start of adhesive application;

8) time for start and end of cramping procedure;

9) cramping pressure;

10) adhesive, e.g. resin and hardener;

11) mixing ratio, if relevant;

12) quantity of adhesive applied (g/m^2);

13) information on preservative treatment in accordance with EN 15228 if the laminations have been treated with a preservative against biological attack of timber;

14) temperature and relative humidity for the timber storage facilities, the facilities for the production of the bonds and the facilities for the adhesive application and the curing;

15) adjustment of the moisture meter according to the specification of the moisture meter manufacturer;

16) name of the responsible member of the personnel.

d) inspections and tests that shall be carried out before, during and after manufacture, and the frequency with which they are to be carried out.

All documentation shall be registered so that the raw materials and production conditions for the products are traceable, at least to the production week and year. The documentations of the different tests may be kept at separate places. All documentation shall be kept for at least 10 years.

6.3.2.6 Product testing and evaluation

Production control operations include some or all of the following operations:

a) the specification and verification of raw materials and constituents;

b) the controls and tests to be carried out during manufacture according to a frequency laid down;

c) the verifications and tests to be carried out on finished products (further testing of samples) according to a frequency which may be laid down in technical specifications and adapted to the product and its conditions of manufacture.

Concerning b) and c) the manufacturer shall establish procedures to ensure that the stated values of the characteristics he declares are maintained and the minimum production requirements given in Annex I are fulfilled. The characteristics and the means of control shall be as given in Table 16.

Table 16 — Factory production control for glued laminated products

Property	Clause, indicating the relevant test or evaluation method	Acceptance criteria	Minimum frequency
Mechanical resistance of glued laminated products			
Strength, stiffness and density properties of timber	5.1.2	General, for timber graded by the manufacturer of the glued laminated products: EN 14081-1:2005+A1:2011, 6.3	According to EN 14081-1:2005+A1:2011, 6.3
		General, for timber not graded by the manufacturer of the glued laminated products: -	Check suppliers declaration according to EN 14081-1:2005+A1:2011, Clause 7, on receipt
	E.5	Additionally for glulam for which mechanical resistance has been derived from full-scale tests: $f_{m,k,l}$ determined according to E.5 shall be greater than or equal to $f_{m,k,l,dc}$ (determined within ITT)	2 boards per shift and line, layup, strength class or manufacturer specific strength class
Finger joints in laminations	Annex E	see E.3 and declared values according to 5.1.4.2 or 5.1.5.2 or 5.1.6.2 (glulam) or 5.2.4.2 or 5.2.5.2 (glued solid timber)	at least 3 per shift and line, highest strength class or manufacturer specific strength class and adhesive
Geometrical data	5.11	5.11	Check at each change of cross section
Bonding strength			
Finger joints in laminations	5.1.4.2 or 5.1.5.2 or 5.1.6.2 (glulam) or 5.2.4.2 or 5.2.5.2 (glued solid timber)	As for mechanical resistance	
Bonding strength of glue lines in glued laminated timber or glued solid timber	Annex C	see 5.5.5.2.2	for each shift in which gluing is carried out one full cross sectional specimen for each 20 m^3 of production or part thereof.[a]
	or Annex D	see 5.5.5.2.3	
	I.5.8	I.5.8	
Large finger joints	I.6.6	I.6.6	at each change of dimension, at least one per shift
Bonding strength of block glued glulam	method B as given in Annex C	see 5.5.5.2.2	for each shift in which gluing is carried out, each species and adhesive at least two drill cores having a geometry as given in Figure D.7 or one end-cut[b]
	or Annex D	see 5.5.5.2.3	
	I.7.4	I.7.4	

Table 16 *(continued)*

Property	Clause, indicating the relevant test or evaluation method	Acceptance criteria	Minimum frequency
Durability of bonding strength			
Species	5.5.2	5.5.2	Check the suppliers declaration at each reception
Adhesive	5.5.3	-	Adhesives for the production of finger joints or glue lines between laminations: Check the suppliers declaration at each reception Adhesives for large finger joints or glue lines between components of block glued glulam: At each shift in which products are produced
Moisture content of timber to be jointed	G.1	G.1	Measurement according to the quality manual of the manufacturer of the glued laminated product
	and G.2 (if relevant)	G.2	At least one measurement per month
Durability of other characteristics against biological attack			
Species or preservative treatment	5.6	-	Checking the species of each reception or checking preservative treatment according to EN 15228:2009, 5.3
Resistance to fire			
Resistance to fire	5.7		Control of the product´s geometric data and its properties (i.e. characteristics relevant to mechanical resistance, as given above)
Reaction to fire			
Reaction to fire	5.8		For 5.8 a) (CWFT): Control the minimum mean density, minimum overall thickness and preservative treatment (if any) at least once per shift. For 5.8 b) (testing): Check at each reception that the relevant parameters of the tests are fulfilled at least once per shift.

Table 16 *(continued)*

Property	Clause, indicating the relevant test or evaluation method	Acceptance criteria	Minimum frequency
Release of formaldehyde			
Formaldehyde emission	5.9	Class E1 or E2	Control at any reception of adhesives that only adhesives for which an initial classification has been carried out within the Initial Type Testing are used.
Release of other dangerous substances			
Release of other dangerous substances	5.10	As relevant, according to 5.7	

[a] If all tests for a three months period satisfy the requirements the number of samples may be reduced to not less than half of the number prescribed above.

[b] The bonding over the full contact area shall be deemed satisfactory if the mean cramping pressure is at least 0,3 N/mm^2, the depths of the glulam components are not exceeding 600 mm and the width of the smaller glulam component is less than or equal to 200 mm. In this case no specimen needs to be sampled.

6.3.2.7 Non-complying products

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

6.3.2.8 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence.

6.3.2.9 Handling, storage and packaging

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing damage or deterioration.

6.3.3 Product specific requirements

The FPC system shall:

— address this European Standard and

— ensure that the products placed on the market comply with the declared performance characteristics.

The FPC system shall include a product specific FPC, which identifies procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) the controls and tests to be carried out prior to and/or during manufacture according to a frequency laid down in the FPC test plan, and/or

b) the verifications and tests to be carried out on finished products according to a frequency laid down in the FPC test plan.

If the manufacturer uses only finished products, the operations under b) shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

If the manufacturer carries out parts of the production himself, the operations under b) may be reduced and partly replaced by operations under a). Generally, the more parts of the production that are carried out by the manufacturer, the more operations under b) may be replaced by operations under a).

In any case the operation shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

NOTE Depending on the specific case, it can be necessary to carry out the operations referred to under a) and b), only the operations under a) or only those under b).

The operations under a) refer to the intermediate states of the product as on manufacturing machines and their adjustment, and measuring equipment etc. These controls and tests and their frequency shall be chosen based on product type and composition, the manufacturing process and its complexity, the sensitivity of product features to variations in manufacturing parameters, etc.

The manufacturer shall establish and maintain records that provide evidence that the production has been sampled and tested. These records shall show clearly whether the production has satisfied the defined acceptance criteria and shall be available for at least three years.

These records shall be available for inspection.

Where the product fails to satisfy the acceptance measures, the provisions for non-complying products shall apply, the necessary corrective action shall immediately be taken and the products or batches not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the name of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this European Standard, the corrective measures taken to rectify the situation (e.g. a further test carried out, modification of manufacturing process, destruction or correction of product) shall be indicated in the records.

Individual products or batches of products and the related manufacturing documentation shall be completely identifiable and traceable.

6.4 Initial inspection of factory and of FPC

Initial inspection of factory and of FPC shall be carried out when the production process has been finalised and is in operation. The factory and FPC documentation shall be assessed to verify that the requirements of 6.3.2 and 6.3.3 are fulfilled.

During the inspection it shall be verified:

a) that all resources necessary for the achievement of the product characteristics required by this European Standard are in place and correctly implemented, and

b) that the FPC-procedures in accordance with the FPC documentation are followed in practice, and

c) that the product complies with the Initial Type Testing samples, for which compliance with this European Standard has been verified.

All locations where final assembly or at least final testing of the relevant product is performed shall be assessed to verify that the above conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or production process, and it is verified that the general requirements are fulfilled when assessing one product, production line or production process, then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or production process.

All assessments and their results shall be documented in the initial inspection report.

6.5 Continuous surveillance of FPC

Surveillance of the FPC shall be undertaken twice per year and shall usually be unannounced. The surveillance of the FPC shall include a review of the FPC test plan(s) and production processes(s) for each product to determine if any changes have been made since the last assessment or surveillance. The significance of any changes shall be assessed.

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated or verified.

The records of tests and measurement made during the production process and to finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples submitted to Initial Type Testing and that the correct actions have been taken for non-compliant devices.

6.6 Procedure for modifications

If modifications are made to the product, production process or FPC system that could affect any of the product characteristics required by this standard, then all the characteristics for which the manufacturer declares performance, which may be affected by the modification, shall be subject to Initial Type Testing, except as described in 6.2.1 and 6.3.2.7.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which may be affected by the modification.

All assessments and their results shall be documented in a report.

7 Marking and labelling

7.1 General

Each glued laminated product, which complies with this European Standard, shall be durably marked on its surface or on a durable label affixed on it, with the information as given below.

When regulatory marking provisions require information on some of the items listed in 7.2 and 7.3 the requirements of these subsections concerning these items are deemed to be met.

Where the glued laminated product is cut into parts each part has to be re-marked.

In exceptional cases, the end use may require marking to be omitted for aesthetic reasons. In such cases, when the customer specifically requests or orders the glued laminated products to be free from marks, each delivery shall be dispatched under the cover of a document stating the following minimum information.

— customer’s name and address;

— customer’s purchase order number;

— dimensions and quantities of the delivered glued laminated timber or glued solid timber.

7.2 Glued laminated products

The following information shall be given for glued laminated timber, glued solid timber and block glued glulam:

a) identity of the manufacturer, logo or name;

b) strength, stiffness and density values of the glued laminated timber or the glued solid timber;

NOTE 1 This is usually done by reference to a strength class according to Table 3 or 4 or to a manufacturer specific strength class.

NOTE 2 For the designation of manufacturer specific strength classes, glulam with asymmetrical layup, resawn and brick-bonded glulam see also 5.1.3.

NOTE 3 Coded marking, e.g. continuous scratching of all laminations, is allowed.

c) "Brick-bonded", if member has a cross sectional layup according to I.5.2;

d) the topside of a glued laminated product having an asymmetrical cross-sectional layup shall be clearly marked with "Top" unless there is no danger to mistake which side is the topside (e.g. for curved members);

e) production week and year or traceability code;

f) adhesive type according to prEN 301 or EN 15425 and adhesive family according to 5.5.3.1;

g) bonding strength test method declared as "A", "B", "C", if tested by delamination method A, B or C or by "S" if tested by block shear test;

h) "PT", if the glued laminated timber or glued solid timber is treated against biological attack.

7.3 Additional for glulam with large finger joints

a) Characteristic bending strength of the large finger joint.

Annex A
(normative)

Release of Formaldehyde

A.1 General

Glued laminated products may release formaldehyde.

A.2 Classification

A.2.1 Glued laminated timber or glued solid timber

A.2.1.1 Requirements

Where formaldehyde-containing adhesives are used, the subsequent release of formaldehyde from glued laminated timber or glued solid timber shall be assessed by testing as specified in A.2.1.2 and the corresponding class according to Table A.1 declared or classified as E2 without testing. The evaluation of release of formaldehyde shall be carried out for each type of adhesive used.

The maximum steady state emission values for glued laminated timber or for glued solid timber shall be used, when assessing the formaldehyde release as Classes E1 or E2 according to Table A.1.

Table A.1 — Release of formaldehyde classes

Formaldehyde release classes	**Maximum steady state emission values** (in mg HCHO/m^3 air)
E1	≤ 0,124
E2	> 0,124

Glued laminated products, produced with an adhesive not containing formaldehyde, may be assigned to class E1 without testing.

NOTE 1 In conventional structures under typical conditions of use, glued laminated products, conforming to formaldehyde release class E1 is unlikely to result in an indoor air concentration exceeding 0,1 ppm formaldehyde.

NOTE 2 In certain Member States only glued laminated products of class E1 are allowed.

A.2.1.2 Test procedure

The testing in a chamber shall be carried out according to EN 717-1 with a loading factor of 0,3 m^2/m^3. A test chamber with a volume of at least 1m^3 shall be used.

The ends of the specimens shall be sealed.

A.2.1.3 Test report

A test report according to EN 717-1 shall be given.

A.2.2 Classification for glulam with large finger joints and block glued glulam

Glulam with large finger joints and block glued glulam shall be assigned to the formaldehyde emission class of the glulam components from which they are made. Only the highest formaldehyde emission class of the components shall be declared.

Annex B
(normative)

Additional test methods and requirements for adhesives

B.1 General

The adhesives to be tested shall be ready for use and shall be, if the manufacturer of the glued products intends to mix them before application in the subsequent production, mixed according to the instructions of the adhesive manufacturer. They shall have the viscosity in which they are used in practice. If no other specifications are given by the adhesive manufacturer the hardener shall be stirred in for 5 min using a stirring device.

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

B.2.1 General description

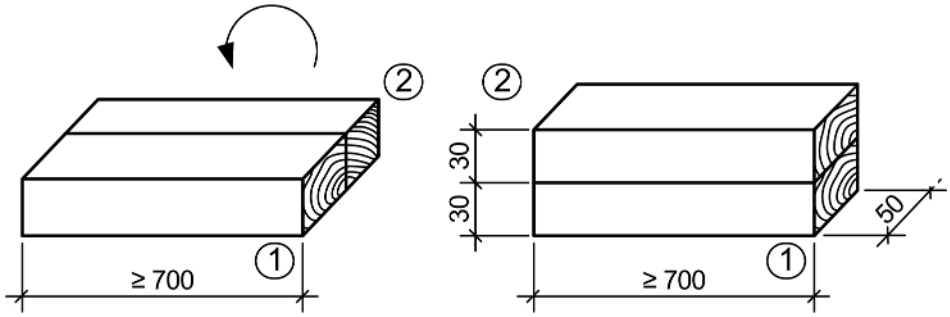
The tests shall be performed with specimens according to prEN 302-3. As a divergence to prEN 302-3, the specimens are made from beech wood with glue line thickness of 0,1 mm and 0,5 mm. The beech wood boards from which the specimens are cut shall be free from knots, straight grained and shall have a density larger than 650 kg/m^3 at 20 °C/65 % rh. The timber prior to specimen manufacture shall be conditioned in a climate chamber at storage conditions of (20 ± 2) °C and (65 ± 5) % rh. The moisture content shall be (12 ± 1) %.

B.2.2 Production of the specimens

In total, 5 sticks with a cross section of 50 mm × 60 mm and a length of at least 700 mm, enabling the cutting of 8 test specimens and 2 reserve specimens from each stick of the specimen type described in prEN 302-3, shall be manufactured for each glue line thickness. The ten specimens for each test are made up of two specimens (see Figure B.2) from each stick. Figure B.2 gives a view of the stick and of the cutting scheme for its subdivision into 10 specimens for the determination of the tensile strength perpendicular to the glue line. The manufacture and build-up of the sticks shall follow the scheme shown in Figure B.1a) and B.1b). The annual ring orientation of both components glued together shall be roughly co-linear and shall be in the range of 30° to 60°.

NOTE For details of cutting see prEN 302-3:2011, Clause 5, and Figure B.1.

Dimensions in mm



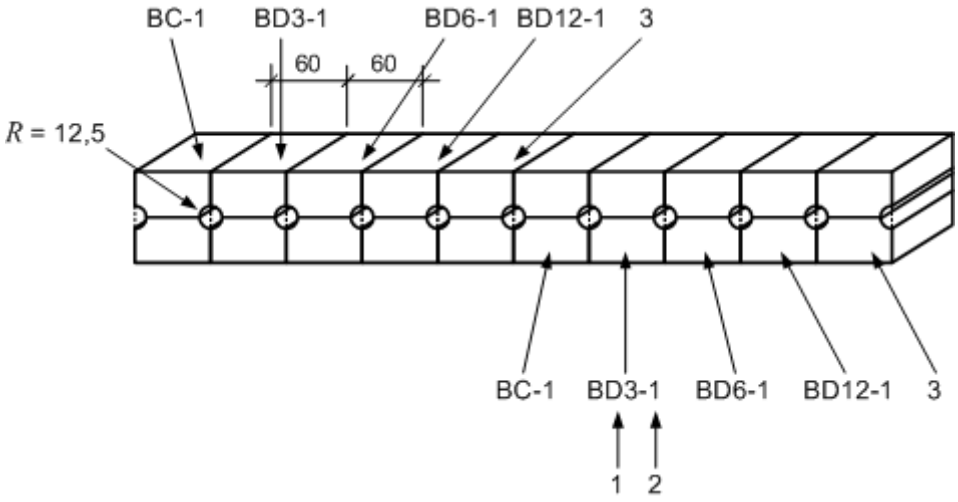
Key

1 and 2 positions of corners before cutting and after planing

a) Dimensions before cutting **b) Dimensions after planing**

Figure B.1 — Cutting scheme of the parts of the test sticks

Dimensions in mm



Key

1 test batch (BC= control batch, BD *x* = batch for a test after a duration of *x* months)

2 current specimen number

3 reserve sample

Figure B.2 — Cutting scheme for test stick and numbering of specimens

B.2.3 Test procedure and climate conditions

The test procedure shall consist of the following test series:

a) short-term testing of a control batch BC of 10 specimens in ramp loading. The specimens are tested after fourteen days of conditioning in (20 ± 2) °C and (65 ± 5) % rh subsequent to gluing;

b) long-term testing of 3 batches BD3, BD6, BD12, each with 10 specimens, whereby each batch shall be subjected to a different duration of loading time being 3, 6 and 12 months. All batches shall be subjected

to the same constant stress level specified below. At the end of each loading period, all specimens of the respective batch not having failed shall be tested for residual tensile strength perpendicular to the glue line in ramp loading.

Constant stress equal in all 3 duration of load times shall be 1 N/mm^2 related to the net cross section of 25 mm $\times$ 50 mm.

The test climate shall be at natural outdoor conditions in Europe between latitude 45 and 60 degrees protected with light penetrable covering (glass house).

An alternative test procedure is to use a climate chamber with cyclically stepped climate varying stepwise with 24 h step length between two climates (10 ± 2)ºC with (90 ± 5) %rh and (35 ± 2)ºC with (40 ± 5) % rh.

The specimens tested for residual strength after removal of the constant long-term load shall be conditioned at least for 2 weeks in climate (20 ± 2)ºC and (65 ± 5) %rh before ramp loading.

The climate shall be recorded.

B.2.4 Requirements

The mean tensile strength perpendicular to the grain of the control batch BC and of each of the batches BD3, BD6 and BD12 tested for residual strength after 3, 6 and 12 months of duration of load shall not be less than 5 N/mm^2. In each batch tested in long-term loading only one specimen may fail within each of the respective load duration periods. In case a specimen has failed in long-term loading, the mean value of the residual strength of the respective batch shall be calculated from the remaining 9 specimens.

B.2.5 Report

A test report according to prEN 302-3 and records of the climate during testing shall be given.

B.3 Delamination test for finger joints in laminations

B.3.1 Production of the specimens

The finger joints shall be produced in accordance with I.4.

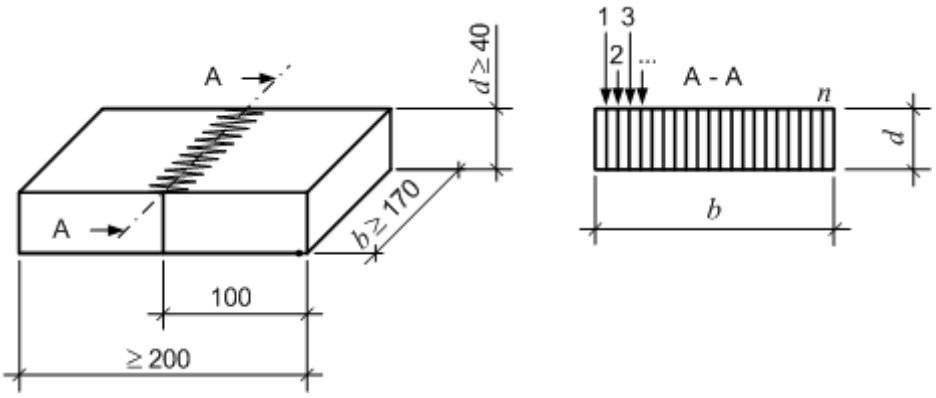
The finger length shall be less than 25 mm.

For the production of the finger joints spruce (*Picea abies L.*) shall be used. The boards shall have a thickness of at least 45 mm and a width of at least 185 mm before jointing and planing. Within a bothway distance of at least 100 mm from the finger base, measured in the direction of the axis of the board, the boards shall be clear of knots having a diameter larger than 6 mm and other features that might negatively affect the strength of a finger joint such as reaction wood. The boards shall have a mean density of (425 ± 25) kg/m³.

A sufficient number of finger joints shall be produced so that 10 specimens can be sampled for each proportion of resin and hardener to be tested.

After a curing time of at least seven days the jointed boards shall be planed to a thickness of at least 40 mm and to a width of at least 170 mm. Specimens with a length of 100 mm (measured in the direction of the axis of the board) shall be cut. The specimens shall be cut in a way that part of the finger joint, having a length of (l_j/2 ± 1 mm), where l_j is the length of the finger joint (in mm), is part of the specimens and that the joint becomes visible at the end grain of the cross cut (see Figure B.3).

Dimensions in mm



Key

1, 2, 3 number of finger tip

a) Dimensions b) Numbering of finger tips

Figure B.3 — Specimens for delamination tests with finger joints in laminations

B.3.2 Testing

Before testing the specimens are weighed and the moisture content u measured using a moisture meter in accordance with EN 13183-2 or EN 13183-3.

The corrected weight at a moisture content u = 19 % shall be calculated.

The total length $l_{\text{tot, glue line}}$ of the glue lines visible on both wide faces of the cross cut finger joint shall be measured.

The specimens shall be subject to the following cyclic conditions: The specimens are completely immersed in boiling water for 6 h and in cold water (20 ± 5) °C for 1 h subsequently. After this the specimens are dried in a drying duct at a temperature of (60 ± 3) °C to a moisture content of u < 19 %, but at least for 18 h.

B.3.3 Results

Within one hour after the end of the last drying cycle the total length of the delaminations $l_{\text{tot, delam}}$ shall be marked and measured at the cross cut of the specimens.

Isolated openings of glue lines having a length of less than 3 mm may be disregarded.

The total delamination of a test piece shall be calculated from the ratio of the total length of the delaminations and the total length of the glue lines.

B.3.4 Report

The following items shall be reported:

a) reference to this European Standard;

b) date of the test;

c) identification of test pieces; any other relevant information, e.g. about preconditioning;

d) type of adhesive, e.g. resin and hardener;

e) effective proportion of resin and hardener (if relevant);

f) moisture content;

g) corrected weight at a moisture content of 19 %;

h) the total delamination according to B.3.3;

i) any relevant observation linked to the testing;

j) name of the person responsible for the testing.

Annex C
(normative)

Delamination test of glue lines

C.1 Principle

A gradient is introduced in the moisture content of the wood to build up internal stresses. This will result in tensile stresses perpendicular to the glue lines between laminations of glulam, glued solid timber and block glued glulam. Inadequate glue line integrity will result in delamination of the glue lines.

C.2 Apparatus

C.2.1 Pressure vessel

A pressure vessel shall be used, which safely withstands a pressure of at least 600 kPa (700 kPa absolute pressure) and a vacuum of at least 85 kPa (15 kPa absolute pressure) and is equipped with pumps or similar device capable of giving a pressure of at least 600 kPa (700 kPa absolute pressure) and of drawing a vacuum of at least 85 kPa (15 kPa absolute pressure).

NOTE 100 kPa is equal to 1 bar.

C.2.2 Drying duct

A drying duct shall be used where air is circulated at a velocity from 2 m/s up to 3 m/s (inclusive), and at a temperature and a relative humidity as given in Table C.1.

Table C.1 — Climate in the drying duct for the different methods

	Method A	Method B	Method C
Temperature (^{o}C)	60 to 70	65 to 75	25 to 30
Relative humidity, rh (%)	< 15	8 to 10	25 to 35

C.2.3 Balance

Balance shall be capable for determining mass with a tolerance of ± 5 g.

C.2.4 Metal wedge and hammer

Metal wedge and hammer shall be capable of splitting glue lines open.

C.3 Sampling and preparation of test pieces

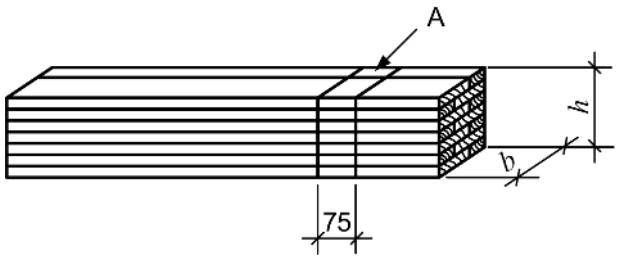
The test pieces shall be prepared or selected in such a manner that they are representative of the production run.

Each test piece shall be taken from a full cross section of the specimens to be tested, prepared by cutting perpendicular to the grain of the wood. It shall be (75 ± 5) mm in length (along the grain).

The end grain surfaces of the test piece shall be cut with a sharp saw or tool that produces a smooth surface.

If the width b of the cross section is greater than 300 mm the test piece may be lenghtwise cut into two or more test pieces each at least 130 mm wide. If the depth h is greater than 600 mm the test piece(s) may be cut into two or more pieces each with a depth of at least 300 mm (see Figure C.1).

Dimensions in mm



Key

A test piece

b width

h depth

Figure C.1 — Test piece cut from glued laminated timber having a width *b* of more than 300 mm

C.4 Procedures

C.4.1 General

Before subjecting the test pieces to the test cycles, measure the total length in millimetres of glue lines on both end-grain surfaces of the test piece.

Subject the test pieces to the appropriate test cycle as described in C.4.3, C.4.4 or C.4.5. Two test cycles shall be carried out for method A and one for method B or C.

An extra cycle may be carried out for method A or B if the total delamination according to C.5.2 is larger than the maximum value prescribed in Table 9 (see 5.5.5.2.2).

C.4.2 Measurement and evaluation of delamination

C.4.2.1 Measurement of delamination

The delamination measurement and the evaluation of the result shall take place not later than 1 h after the final drying treatment. The total glue line delamination on both end-grain surfaces shall be measured in millimetres.

NOTE 1 The use of a magnifying glass with a tenfold magnification and strong lighting are recommended to determine whether the opening in the glue line is a valid delamination or not.

NOTE 2 A feeler gauge 0,08 mm to 0,10 mm thick is convenient for probing into the joint to determine if separation in the glue line exists.

C.4.2.2 Glue line openings to be regarded as delaminations

The following glue line openings shall be considered as being delaminations:

a) a cohesive crack within the adhesive layer;

b) a failure of the glue line precisely between the adhesive layer and the wood substrate. No wood fibres are left attached to the adhesive layer;

c) a wood failure which is invariable within the first one or two layers of cells beyond the adhesive layer in which the fracture path is not influenced by the grain angle and the growth-ring structure. It is characterised by a fine, woolly appearance of the wood fibres, which border the interface between the wood surface and the adhesive layer.

C.4.2.3 Glue line openings not to be regarded as delaminations

The following glue line openings shall not be considered as being delaminations:

a) a solid wood failure which is invariably more than two cell layers away from the adhesive layer, in which the fracture path is strongly influenced by the grain angle and the growth-ring structure;

b) isolated openings in the glue line which are less than 2,5 mm long and more than 5 mm away from the nearest delamination;

c) openings in the glue line which are found along knots or resin pockets which border the glue line, or openings in the glue line which are caused by hidden knots in the glue line. When the cause of an opening in the glue line due to the presence of a knot is suspected through the test, the glue line shall be opened with a wedge and a hammer and be inspected for the presence of a concealed knot. Should the cause of a glue line opening be due to a concealed knot, the opening shall not be considered a delamination.

C.4.3 Test cycle for method A

Place the test piece in the pressure vessel and weigh them down. Add water at a temperature between 10 ^{o}C and 20 ^{o}C in sufficient quantity so that the pieces are completely submerged through the test. Separate the test pieces by stickers, wire screens, or other means in such a manner that all end-grain surfaces are freely exposed to the water. Draw a vacuum between 70 kPa and 85 kPa (i.e. an absolute pressure between 15 kPa and 30 kPa at sea level) and hold it for 5 min. Then release the vacuum and apply a pressure between 500 kPa and 600 kPa (between 600 kPa and 700 kPa absolute pressure) for 1 h. Whilst the test pieces are still completely immersed, repeat this vacuum pressure cycle making a two-cycle impregnation period requiring a total of 130 min.

Dry the test pieces for a period approximately 21 h to 22 h in a climate according to Table C.1 in the drying duct. During drying the test pieces shall be placed at least 50 mm apart with the end-grain surfaces parallel to the stream of air.

The delaminations shall be observed and recorded.

C.4.4 Test cycle for method B

Place the test piece in the pressure vessel and weigh them down. Admit water at a temperature of 10 ^{o}C to 20 ^{o}C in sufficient quantity so that the pieces are completely submerged through the test. Separate the test pieces by stickers, wire screens, or other means in such a manner that all end-grain surfaces are freely exposed to the water. Draw a vacuum between 70 kPa and 85 kPa (i.e. an absolute pressure between 15 kPa and 30 kPa at sea level) and hold it for 30 min. Release the vacuum and apply a pressure between 500 kPa and 600 kPa (between 600 kPa and 700 kPa absolute pressure) for 2 h.

Dry the test pieces for a period of approximately 10 h to 15 h in a climate according to Table C.1 in the drying duct. During drying the test pieces shall be placed at least 50 mm apart with the end-grain surfaces parallel to the stream of air.

The actual time in the drying duct shall be controlled by the mass of the test pieces. Delamination shall be observed and recorded when the mass of the test pieces has returned to within 100 % to 110 % of the original mass. The drying time shall be recorded.

The delaminations shall be observed and recorded.

C.4.5 Test cycle for method C

Place the test piece in the pressure vessel and weigh them down. Admit water at a temperature of 10 °C to 20 °C in sufficient quantity so that the pieces are completely submerged through the test. Separate the test pieces by stickers, wire screens, or other means in such a manner that all end-grain surfaces are freely exposed to the water. Draw a vacuum between 70 kPa and 85 kPa (i.e. an absolute pressure between 15 kPa and 30 kPa at sea level) and hold it for 30 min. Release the vacuum and apply a pressure between 500 kPa and 600 kPa (between 600 kPa and 700 kPa absolute pressure) for 2 h. Whilst the test pieces are still completely immersed, repeat this vacuum pressure cycle giving a two-cycle impregnation period requiring a total of 5 h.

Dry the test pieces for a period of 90 h in a climate according to Table C.1 in the drying duct. During drying, the test pieces shall be placed at least 50 mm apart with the end-grain surfaces parallel to the stream of the air.

The delaminations shall be observed and recorded.

C.5 Results

C.5.1 General

For each test piece the delamination shall be calculated. If an extra cycle is performed calculate the results before and after the extra cycle.

C.5.2 Total delamination

The total delamination $Delam_{tot}$ of a test piece shall be calculated from Formula (C.1):

$$Delam_{tot} = 100 \frac{l_{tot,delam}}{l_{tot,glue\ line}} \quad \text{(in \%)} \tag{C.1}$$

where

$l_{tot,\ delam}$ is the total delamination length (in mm),

$l_{tot,\ glue\ line}$ is the entire length of all glue lines on the two end-grain surfaces of each test piece (in mm).

C.5.3 Maximum delamination

The maximum delamination $Delam_{max}$ of a single glue line in a test piece shall be calculated from Formula (C.2):

$$Delam_{max} = 100 \frac{l_{max,delam}}{2 \cdot l_{glue\ ine}} \quad \text{(in \%)} \tag{C.2}$$

where

$l_{max,\ delam}$ is the maximum delamination length (in mm),

$l_{glue\ line}$ is the length of one glue line (in mm).

C.6 Report

The following items shall be reported:

a) reference to this European Standard;

b) date of the test;

c) identification of test pieces and glued laminated products from which they have been cut; any other relevant information, e.g. about preconditioning;

d) preservative treatment (if relevant);

e) species of timber;

f) type of adhesive, e.g. resin and hardener;

g) effective proportion of resin and hardener (if relevant);

h) sizes of the test piece;

i) test method (A, B or C);

j) the total delamination and the maximum delamination after the prescribed number of cycles and any additional cycle that was necessary;

k) any relevant observation linked to the testing;

l) name of the person responsible for the testing.

Annex D
(normative)

Shear test of glue lines

D.1 Principle

Under ramp loading a shear stress is applied at the glue line between laminations of glued laminated timber or glued solid timber or at the glue line between glulam components of block glued glulam until failure occurs.

D.2 Apparatus

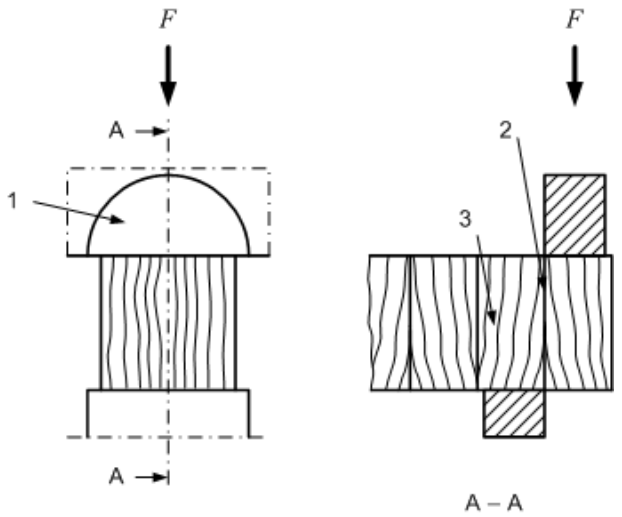
D.2.1 Testing machine

A testing machine shall be used, which is checked and adjusted according to the information given by the manufacturer of the testing machine and capable of applying a compressive force to the shearing tool (see Figure D.1).

The accuracy of measuring the maximum load shall be better than ± 3 %.

D.2.2 Shearing tool

A shearing tool as illustrated in Figure D.1 shall be used. The cylindrical bearing shall be self-aligning so that the test piece is loaded at the end-grain with a stress field uniform in the width direction.



Key

1 cylindrical bearing
2 sheared plane
3 test bar to be clamped as necessary

F = ramp load

Figure D.1 — Shearing tool with a test bar inserted

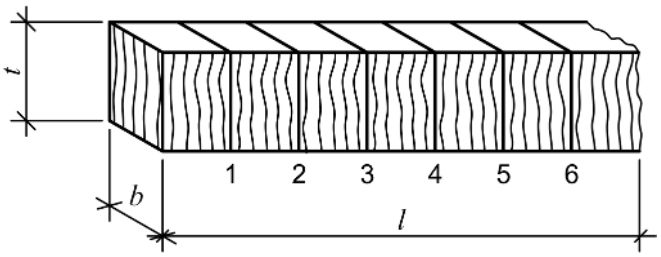
D.3 Test pieces for glulam and glued solid timber

D.3.1 Preparation of test pieces

Special care shall be taken in preparing test pieces to ensure that the loaded surfaces are smooth and parallel to each other and perpendicular to the direction of the glue line.

The test pieces shall be of the form shown in either Figure D.2 or D.3. That depicted in Figure D.2 shows the common test piece.

Where drill cores have been taken the boreholes shall be filled durably and tightly with glued in wood having the same grain direction as the glulam components.



Key

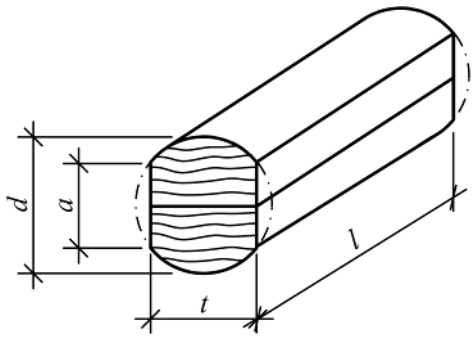
b width, dimensions 40 mm to 50 mm

l length

t thickness, dimensions 40 mm to 50 mm

1 to 6 number of glue line within the specimen

Figure D.2 — Test bar and numbering of the glue lines



Key

a straight edges, (23 ± 5) mm

d diameter, (35 ± 5) mm

l length, 50 mm to 120 mm

t thickness, (26 ± 3) mm

Figure D.3 — Drill core with machined parallel plane surfaces

D.3.2 Sampling of test pieces (test bars)

The specimens shall be representative for manufacture.

Test bars shall be cut from the full cross sectional specimens. At least three glue lines in each of the lower, middle and upper part shall be tested. If there are less than 10 laminations all glue lines shall be tested.

It is recommended that the full cross sectional specimens are taken within areas of the glued laminated timber or glued solid timber where sufficient cramping pressure has been established.

The shear testing shall include the total cross sectional width of the glued laminated timber or glued solid timber. The number of test bars to be taken shall be as given in Table D.1.

Table D.1 — Number of test bars

	Number of test bars		
Width of full cross section (in mm) (see Figure D.4)	$b \leq 100$	$100 < b \leq 160$	$b > 160$
Number of test bars	1	2	3

Dimensions in mm

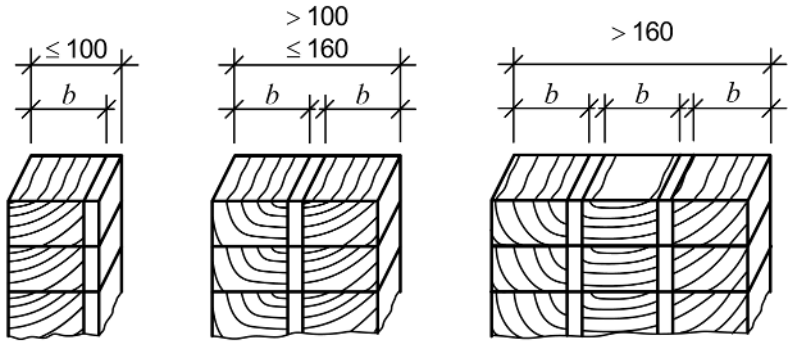
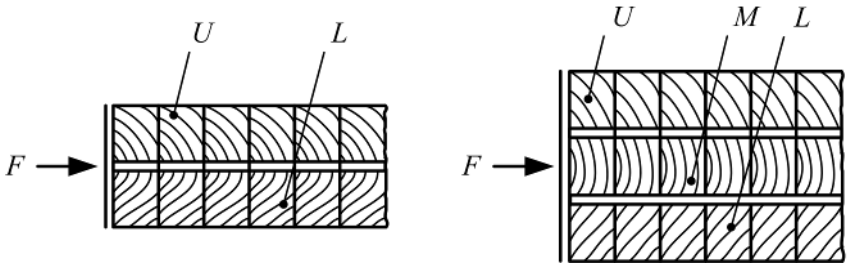


Figure D.4 — Test bars to be cut from a full cross sectional specimen



Key

U = upper L = lower

M = middle F = cramping force

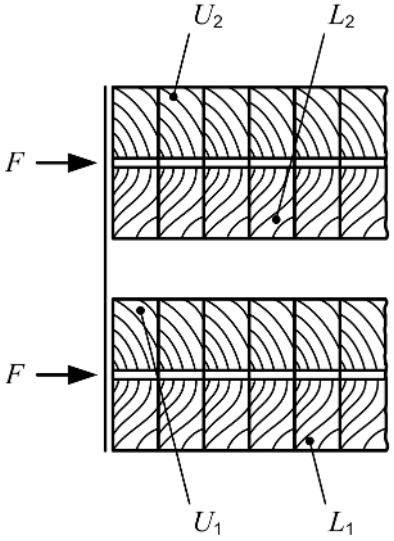
Figure D.5 — Suggested identification showing the location of the test bars in the cross section in a glued laminated timber

If two or more pieces of glulam or glued solid timber are cramped in one operation, see Figure D.6, the test bars necessary according to the testing quantity quoted in Table D.1 have to be taken from each of the pieces.

For testing glue lines within the glued laminated timber or glued solid timber drill cores shall be sampled. The drill cores shall be cut out perpendicular to the face of the pieces in such a way that the glue line to be tested is situated in the middle of the core.

NOTE For guidance of the drilling tool use an appropriate support.

The drill cores shall be machined at two faces perpendicular to the glue line as shown in Figure D.3 and divided lengthwise so that the test pieces have a rectangular shearing area.



Key

U_1 = upper, lower member

L_1 = lower, lower member

U_2 = upper, upper member

L_2 = lower, upper member

F = cramping force

Figure D.6 — Additional identification with numbers showing the location of the glued laminated timber during the cramping

D.3.3 Marking of test pieces (test bars)

Every test bar shall be marked with a durable identification. This shall indicate the location of the test bar within the cross section of the glued laminated timber or glued solid timber.

The relationship between identification and location should be as shown in Figure D.5. The front side of the pieces should be marked with *U* and the back side with *L*. The glue lines of the pieces should be numbered beginning with the bottom edge of the pieces (see Figure D.2).

If two pieces of glulam or glued solid timber are cramped in one operation, the test bars from the lower pieces should be marked additionally with 1 and those from the upper pieces with 2.

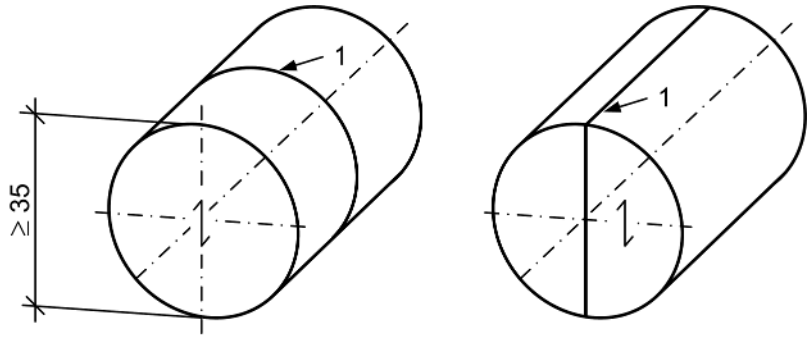
EXAMPLE An example of this marking is shown in Figure D.6.

D.4 Test pieces for glue lines between glulam components of block glued glulam

Drill cores comprising the glue line between the glulam components for shear tests shall comply with Figure D.7 a) or b).

Where drill cores have been taken the boreholes shall be filled durably and tightly with glued in wood having the same grain direction as the glulam components.

Dimensions in mm



Key

1 glue line

grain direction

a) glue line perpendicular to the axis of the drill core **b) glue line parallel to the axis of the drill core**

Figure D.7 — Geometry of the drill core

D.5 Procedure

The test pieces shall be conditioned to an equilibrium moisture content in the standard climate 20/65, i.e. temperature (20 ± 2) °C and a relative humidity (65 ± 5) %.

NOTE Standard climate as defined in ISO 554.

For factory production control the moisture content of the wood shall be uniform over the test piece and between 8 % and 13 %.

Measure the dimensions from which the sheared area is determined to the nearest of 0,5 mm. Use, for example, a sliding gauge.

Place the test piece in the shearing tool so that it is loaded in the direction of the grain. The glue line shall be positioned so that the distance between the shearing tool and the sheared plane nowhere exceeds 1 mm.

For testing of glue lines between glulam components using gap filling adhesives the shear plane shall be located in the timber-adhesive interface.

The loading shall be undertaken at a constant rate of deformation and so that failure occurs after no less than 20 s.

Estimate the amount of wood failure percentage rounded off to the nearest number divisible by 5.

From each tested bar with at least 5 remaining glue lines a part shall be marked with the order number, number of the glued laminated product, gluing date and position of the test piece and stored for a period of at least 2 years.

D.6 Results

The shear strength f_v shall be determined with two significant digits from Formula (D.1):

$$f_v = k_v \frac{F_u}{A} \quad \text{(D.1)}$$

where

F_u is the ultimate load (in N);

A is the sheared area (in mm^2);

$A = b\,t$ for a test bar;

$A = l\,t$ for a drill core;

b is the width (in mm);

k_v factor: $k_v = 0{,}78 + 0{,}0044\,t$;

NOTE The factor k_v modifies the shear strength for test pieces where the thickness in the grain direction of the sheared area is less than 50 mm.

l is the length (in mm);

t thickness (in mm).

D.7 Report

The following items shall be reported:

a) Reference to this European Standard;

b) date of the completion of the test;

c) identification of test pieces and members from which they have been cut; any other relevant information, e.g. about preconditioning;

d) preservative treatment (if relevant);

e) species of timber;

f) type of adhesive, e.g. resin and hardener;

g) effective proportion of resin and hardener (if relevant);

h) sizes of the test piece;

i) ultimate load and shear strength for each glue line in each test piece;

j) any relevant observation made during or after testing;

k) name of the person responsible for the testing.

Annex E
(normative)

Tests with laminations with or without finger joints (including compliance criteria)

E.1 Sampling of finger joints in laminations

E.1.1 General

The specimens shall be representative of the manufacture. The whole jointed cross section of the lamination shall be tested. The finger joints shall be in the middle of the specimens.

E.1.2 For Initial type testing

The cross section of the specimens shall be equal to the typical size the manufacturer intends to finger joint.

E.1.3 For Factory production control

The specimens taken in a shift shall, as far as possible, be taken evenly distributed in time and shall be representative for the lamination sizes produced during the shift.

E.2 Testing of finger joints in laminations

E.2.1 General

Finger joints in glulam shall be tested in flat-wise bending or in tension, finger joints in glued solid timber shall be tested in flat-wise or edge-wise bending according to EN 408, with the following exceptions:

— the knot free length of the joints shall bothway be at least 3 d;

— tension specimens shall be tested with the full width and a knot free length of at least 200 mm.

E.2.2 Additionally for initial type testing

Additionally for initial type testing the following applies:

— the surface shall be planed on four sides;

— testing may be done without conditioning the specimens as described in EN 408. If the specimens are not conditioned according to EN 408, they shall have a moisture content of u = (12 ± 3) %. The moisture content shall be reported.

E.2.3 Additionally for factory production control

Additionally for factory production control the following applies:

— the ultimate load should be reached within (60 ± 15) s;

— the accuracy of measuring the maximum load shall be better than ± 3 % of this load;

— testing may be done without conditioning the specimens as described in EN 408 and without measuring the moisture content;

— the density need not to be determined;

— bending tests shall be done with a span of 15 t, where t is the lamination thickness.

E.3 Compliance criteria of finger joints in laminations

E.3.1 For Initial type testing

The characteristic strength value and the coefficient of variation shall be calculated according to EN 14358.

E.3.2 For factory production control

For each production line, declared strength value and shift, either the declared bending strength or the declared tensile strength, shall be acceptable if one of the following requirements a) or b) is met.

a) Of the last 100 joints tested, the values of the flat-wise bending strength $f_{m,j,k}$ or the tensile strength $f_{t,j,k}$ of each single joint shall relate to the threshold value $f_{m,k,j,dc}$ or $f_{t,0,k,j,dc}$ respectively:

   Not more than 5 shall be below the threshold value and

   No value shall fall below 80 % of the threshold value.

b) The characteristic strength $k_{15}\, f_{j,15,mean}$ of the last 15 finger joints tested in flat-wise bending or tension shall be higher than or equal to the declared characteristic strength $f_{j,dc,k}$.

   Where k_{15} is a statistical factor, taken from Table E.1 and $f_{j,15,mean}$ is the mean strength of the last 15 finger joints.

Table E.1 — Factor k_{15}

Coefficient of variation according to EN 14358	**≤ 0,10**	**0,15**	**0,20**	**0,25**	**0,30**
k_{15}	0,82	0,74	0,67	0,61	0,55

E.4 Report of tests with finger joints in laminations

The following items shall be reported:

a) production line;

b) reference to this European Standard;

c) date of production;

d) date of the test;

e) species;

f) strength class or manufacturer specific strength class;

g) preservative treatment (if relevant);

h) type of adhesive, e.g. resin and hardener;

i) effective proportion of resin and hardener (if relevant);

j) density and moisture content (only for Initial Type Testing);

k) width and thickness of the lamination;

l) finger joint profile;

m) finger joint orientation;

n) ultimate test load at failure;

o) bending or tensile strength;

p) description of the failure mode (wood failure percentage);

q) mean value $f_{m,j,mean}$ or $f_{t,0,j,mean}$ and coefficient of variation (if relevant);

r) name of the person responsible for the testing.

E.5 Tests with laminations without finger joints

For tests with laminations without finger joints the appropriate provisions from E.1 to E.4 apply.

Annex F
(normative)

Bending tests with glued laminated timber, glued solid timber and glulam with large finger joints (including compliance criteria)

F.1 Sampling

The specimens shall be representative of the manufacture.

For glued laminated timber or glued solid timber the specimens shall be tested with a typical cross sectional size normally supplied by the manufacturer. A finger joint shall be placed where the bending tensile stress is the maximum.

For glulam with large finger joints the specimens shall be produced as straight beams with cross sectional dimensions of depth of 600 mm. The large finger joints shall be placed in the middle of the specimens.

F.2 Testing

Bending tests shall be done as edge-wise bending tests in accordance with EN 408.

It is allowed to do the testing without conditioning the specimens as described in EN 408 if the specimens have a moisture content of u = (12 ± 3) %.

F.3 Evaluation

If the overall height or depth of the glued laminated timber or glulam with large finger joints is less than 600 mm the bending strength parallel to the grain $f_{m,g,k}$ (for glulam) or $f_{m,s,k}$ (for resawn glulam), determined by testing, shall be multiplied by k_h (see Formula (F.1)):

$$k_h = \max\begin{cases}\left(\frac{h}{600}\right)^{0,1} \\ 0{,}90\end{cases} \tag{F.1}$$

If the overall height or depth of the glued solid timber is less than 150 mm the bending strength parallel to the grain $f_{m,gs,k}$ determined by testing shall be multiplied by k_h (see Formula (F.2)):

$$k_h = \max\begin{cases}\left(\frac{h}{150}\right)^{0,15} \\ 0{,}77\end{cases} \tag{F.2}$$

For glued laminated timber and glued solid timber the characteristic values shall be derived in accordance with the methods given in EN 14358.

F.4 Compliance criteria

For glued laminated timber and glued solid timber the characteristic values shall be greater than or equal to the declared value.

For glulam with large finger joints each test result shall be greater than or equal to the declared value.

F.5 Report

A test report in accordance with EN 408 shall be given.

For glued laminated timber and glued solid timber $f_{m,g,mean}$, $E_{0,g,mean}$, $\rho_{g,k}$ and the related coefficients of variation shall be given additionally.

Any preservative treatment shall be documented.

Annex G
(normative)

Measurement of moisture content

G.1 General

Moisture meters shall enable to measure the moisture content of timber with an accuracy of ± 2 % moisture content.

The accuracy of a moisture meter according to EN 13183-2 or -3 shall be checked by comparison with results from measurements with the oven dry method according to EN 13183-1.

G.2 Measurement of moisture content of boards during production

The moisture content of each board shall be measured.

The accuracy of the moisture meter shall be checked for each combination of species and preservative treatment (if relevant) with timber pieces having representative cross-sections and with moisture contents covering the likely range of moisture contents during production, but at least a range of 8 % moisture content difference.

If the measurement is done by an electrical resistance moisture meter the electrodes have to be driven into one face of the board at a distance of 0,3 m from either end of the board so that the tips of the electrodes penetrate into a depth of 0,3 times the thickness of the board. Lower penetration depths are allowed if correlation with moisture content is checked within the Factory Production Control.

If the measurement is done by an in-line capacitive moisture meter the mean value of the measured data is to be used.

G.3 Mean moisture content of glued laminated timber and glulam components for the production of glulam with large finger joints and block glued glulam

The mean moisture content shall be measured with an electrical resistance moisture meter. Measurements shall be done at a point not nearer than 1 m from either end or in the centre of the piece if it is less than 2 m long using insulated electrodes having a maximum penetration length of 40 mm.

The mean moisture content shall be estimated from at least three measurements, done at the top, the middle and the bottom.

G.4 Moisture content of glued solid timber

The moisture content shall be measured with an electrical resistance moisture meter at a distance of 1 m from either end in a depth of 0,3 times the thickness of the beam or 40 mm.

Annex H
(normative)

Equipment

H.1 General

Equipment should be available to:

a) monitor continuously the temperature and relative humidity of the air (e.g. thermo hygrograph) in storage, production and curing areas;

b) measure the temperature of the timber;

c) moisten the air, if necessary;

d) measure the moisture content of the timber and for checking moisture meters for measurements according to Annex G;

e) weigh and mix resin and hardener in the required proportions (if relevant);

f) uniformly apply the required quantity of adhesive;

g) achieve the required glue line pressure, temperature and relative humidity of the air during curing of the adhesive;

h) control the cramping pressure;

i) measure glue line thickness.

H.2 Additionally for the production of glued laminated timber and glued solid timber

Equipment should be available to:

a) machine strength grading or for enabling visual strength grading when these operations are carried out by the manufacturer;

b) produce finger joints in the laminations with sufficient and reliable strength when these operations are carried out by the manufacturer;

c) test the strength of finger joints in the laminations;

d) test the integrity of the glue lines (see Annex C or D).

H.3 Additionally for the production of glulam with large finger joints

A robust finger joint cutter should be available capable of cutting fingers for large finger joints.

H.4 Additionally for the production of block glued glulam

Equipment should be available to:

a) cut sample cylindrical specimens (if relevant);

b) test the integrity of the glue lines (see Annex C or D).

Annex I
(normative)

Minimum production requirements

I.1 Personnel

The personnel shall have proven skill in the production of the glued laminated products.

The personnel shall have proven skills and training to meet the requirements of 6.3.

I.2 Production and storage facilities

I.2.1 General

The production and storage facilities shall be suitable for all phases of the production of the glued laminated products, taking into consideration the requirements given in this standard.

I.2.2 Facilities for drying and storage of timber

Drying facilities of sufficient capacity shall be available when the drying is carried out by the manufacturer of the glued laminated products.

Storage facilities of sufficient capacity shall be available to maintain the required moisture content of the timber.

Storage facilities of sufficient capacity shall be available to achieve the required temperature of the timber for the respective operation.

I.2.3 Facilities for processing and storage of adhesives

Unless resin and hardener are pumped directly from storage tanks and mixed automatically during application, there shall be a separate area for the preparation of the adhesive (mixing of resin and hardener). There shall also be suitable resin and hardener storage facilities and an area for cleaning the adhesive equipment.

I.2.4 Facilities for production and curing

The air temperature and relative humidity in the facilities for production and curing shall ensure that the required temperature at the glue line is reliably achieved and that no inadmissible changes in moisture content of the member occurs until the glued laminated products are fully cured.

The air temperature in the production facilities shall be at least 15 ^{o}C. The instructions of the adhesive manufacturer shall be regarded. During curing of the glue lines under pressure and during post-curing the air temperature shall be at least 18 ^{o}C. If the glue line is directly heated, e.g. using radio frequency equipment, the air temperature shall be at least 15 ^{o}C.

During the production of the glued laminated products the relative humidity in a conventional production process shall be between 40 % and 75 %. During curing the relative humidity shall be at least 30 %.

I.3 Equipment

The equipment shall be suitable for all phases of the production, taking into consideration the requirements given in this standard. The equipment given in Annex H shall be available.

I.4 Finger joints in laminations

I.4.1 Wane and edge damages

The planed glued laminated timber or glued solid timber shall not have wane or edge damage within the finger joint area.

I.4.2 Finger joint geometry

The geometry of the fingers shall permit the joint to be self-interlocking after pressing.

The finger length l_j, the pitch p, the tip width b_t, the reduction factor $v = b_t/p$ and the finger angle α shall fulfil Formulae (I.1) and (I.2), respectively:

$$l_j \geq 4\, p\, (1 - 2\, v) \tag{I.1}$$

$$\alpha \leq 7{,}1\ ^\circ \tag{I.2}$$

The reduction factor v shall be $v \leq 0{,}18$ and the finger length l_j shall be $l_j > 10$ mm.

Recommended geometries are given in Table I.1.

Table I.1 — Recommended geometries

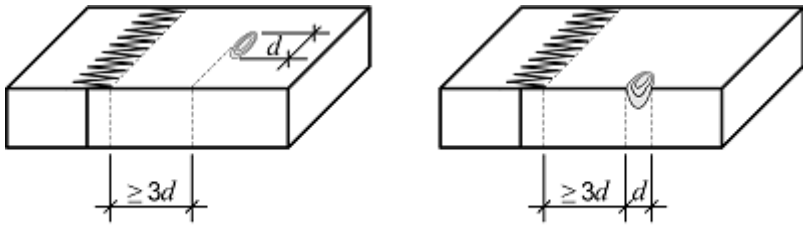
Finger length l_j (mm)	Pitch p (mm)	Tip width b_t (mm)	Reduction factor v
15	3,8	0,42	0,11
20	5,0	0,5	0,10
20	6,2	1,0	0,16
30	6,2	0,6	0,10

I.4.3 Knots and local grain deviation

Knots with a diameter smaller than 6 mm may be disregarded.

There shall be no knots or pronounced grain disturbance within the joint itself.

Outside the joint the distance between the edge of a knot and the base of a finger joint shall be not less than three times the knot diameter *d* (see Figure I.1), unless an approved grading procedure is used and it is documented by testing that an adequate strength of the finger joints is achieved with a smaller minimum distance.



Key: d knot diameter

Figure I.1 — Minimum distance from the base of the finger joint and a knot

When timber pieces are cross cut to remove a knot, the grain at the cross-cut shall be approximately parallel to the axis of the board. The distance between the edge of a knot and the cross cut shall be at least 1,5 d. The grain deviation needs not to be checked if the distance is 3 d.

I.4.4 Moisture content at bonding

The moisture content of each board shall be measured according to G.2.

At assembly, the moisture content in every untreated boards shall be between 6 % and 15 % or between 11 % and 18 % for preservative treated boards. Additionally, the instructions of the adhesive manufacturer shall be followed.

The moisture content of two boards to be jointed shall not differ more than 5 % moisture content.

I.4.5 Bonding surface and application of the adhesive

I.4.5.1 General

At the time of bonding the bonding surfaces shall be clean.

The adhesive shall be used in accordance with the instructions of the adhesive manufacturer.

The adhesive shall be applied to both timber ends unless different provisions are given in the subsequent subsections.

The application method shall ensure that all finger surfaces in the assembled joint are covered with the adhesive.

I.4.5.2 Manual application

If the adhesive is applied manually, it may be applied to only one of the timber ends. It shall be checked visually that adhesive is applied to all finger flanks. This general requirement may be considered satisfied, if adhesive is squeezed out of all four surfaces of the joint when the pressure is applied.

I.4.5.3 Application by machine

The suitability of the adhesive for a separate application of resin and hardener shall be verified in accordance with 5.5.3.2.2.

If the adhesive is applied by comb or roller, the adhesive shall be applied to both timber ends over a length of at least ¾ of the finger length.

If resin and hardener are applied separately by comb or roller the production equipment shall have a device (e.g. a balance or a flow rate meter) to control and document the effective ratio of resin and hardener used. The application of resin and hardener shall be done by two independent application devices, e.g. by two

combs with one nozzle or one comb with two nozzles per finger flank. The application device shall ensure that resin and hardener are applied evenly over at least 75 % of the finger length.

Adhesives may be applied contact-free to only one timber end if it is documented that the adhesive application results in that the principal requirements, i.e. that all finger surfaces in the assembled joint are covered with adhesive, is fulfilled in a reliable way. The fulfilment of the principal requirements shall be continuously controlled and documented.

I.4.6 Time between cutting and bonding

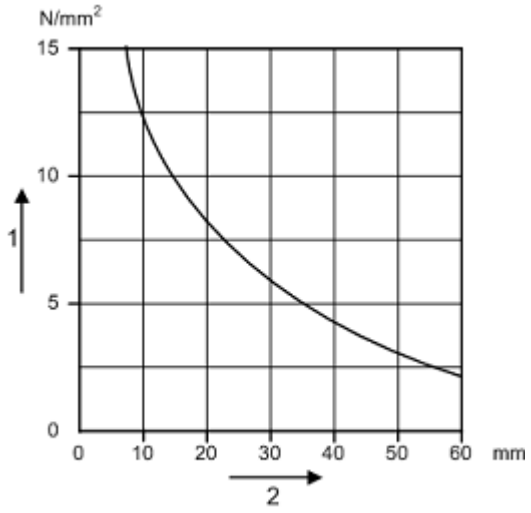
Finger joints in laminations shall be bonded within 6 h after cutting the finger joint profile.

I.4.7 Pressure

The relative tip gap $e = l_t / l_j$ should be 0,01 ≤ e ≤ 0,08 after pressing.

If the pressure is applied in a cyclic finger joint press, the full pressure shall be applied to the finger joint for at least 1 s for laminations for the production of glued laminated timber. Recommended cramping pressure for jointing timber having a temperature of approximately 20 °C can be taken from Figure I.2.

For the production of glued solid timber the full pressure shall be applied to the finger joint for at least 2 s.



Key

1 full pressure

2 finger length

Figure I.2 — Recommended values for full pressure

I.4.8 Curing

The temperature of the timber at the glue line during curing shall not be less than 18 °C. The not fully cured jointed laminations shall be moved in a way that the curing process is not affected by deformation or vibration.

The jointed laminations may be further processed, if it can be ensured that the curing process is not affected. The provisions of the technical data sheet of the adhesive shall apply.

Before production of curved members the finger joints shall be fully cured.

I.5 Bonding of laminations

I.5.1 Permissible finished lamination sizes and radius of curvature

The permissible finished lamination thickness shall be taken from Table I.2.

The finished width of the laminations for glued solid timber shall not exceed 280 mm.

The finished overall depth of glued solid timber shall not exceed 280 mm.

NOTE For glued laminated products produced with Emulsion polymer isocyanate adhesives, see also 5.5.3.4.

Table I.2 — Recommended finished thickness t for laminations in mm

	Service class (SC) according to EN 1995-1-1	
	SC 1 or 2	**SC 3**
Glued laminated timber	$6 \leq t \leq 45$	$6 \leq t \leq 35$[a]
Glued solid timber	$45 < t \leq 85$	-
[a] For glulam which is not a component for block glued glulam and which has a cross-sectional area up to 60.000 mm^2 this value may be raised by an agreement between customer and producer.		

For curved glued laminated timber the permissible finished thickness t of the laminations is also governed by the radius r of curvature of the lamination with the smallest radius of the glued laminated timber and the declared characteristic bending strength of the end joints. The finished thickness t shall comply with Formula (I.3):

$$t \leq \frac{r}{250}\left(1+\frac{f_{\mathrm{m,j,dc,k}}}{150}\right) \tag{I.3}$$

where

t is the finished lamination thickness (in mm);

r is the radius of the lamination with the smallest radius of the member (in mm);

$f_{\mathrm{m,j,dc,k}}$ is the declared characteristic bending strength of the finger joints (in N/mm^2).

I.5.2 Laminations made of two boards side by side

Where a lamination for glued laminated timber consists of two boards side by side and the edges are not bonded, the edge-joints in adjacent laminations shall be staggered laterally by at least the lamination thickness, see Figure 4.

Such glued laminated timber shall only be used in service class 1 or 2.

I.5.3 Grooves in laminations

In order to reduce cupping and cracking, laminations for the production of glued laminated timber may be grooved.

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

Grooves in adjacent laminations may be staggered.

I.5.4 Orientation of laminations in the cross section

The laminations shall have the pith to the same side and the outermost laminations at either edge shall have the pith facing outwards, see Figure I.3 a), with the following exception:

For glued laminated timber to be used in service class 1 or 2, the outermost laminations at either edge may have the pith side facing in the same direction, see Figure I.3 b).

a) **b)**

Figure I.3 — Orientation of the laminations in the cross section

I.5.5 Moisture content at bonding

Provisions of I.4.4 shall apply.

I.5.6 Planing of laminations

The maximum deviation from the average thickness shall be less than or equal to the values given in Table I.3.

Table I.3 — Maximum deviation from the average thickness of laminations in mm

	Maximum deviation from the average thickness in mm	
Type of adhesives used to bond the laminations	**Over the cross sectional width b[a]**	**Within a lamination length of 1 m**
Phenoplastic and aminoplastic adhesive mixed before application	$\min\begin{cases}0{,}0015\ b\\0{,}3\end{cases}$	± 0,2 mm
Phenoplastic and aminoplastic adhesive (separate application of resin and hardener)		± 0,1 mm
Moisture curing one component polyurethane adhesive and Emulsion polymer isocyanate adhesive tested with a glue line thickness of 0,5 mm	$\min\begin{cases}0{,}0015\,b\\0{,}15\end{cases}$	± 0,1 mm
Emulsion polymer isocyanate adhesive tested with a glue line thickness of 0,3 mm	$\min\begin{cases}0{,}001\,b\\0{,}10\end{cases}$	± 0,1 mm
[a] b = width of lamination.		

I.5.7 Bonding surface and adhesive application

The application of the adhesive shall ensure a uniform application of the required quantity and a reliable mixing of the components of the adhesive.

At the time of adhesive application the bonding surfaces shall be clean.

The adhesive shall be used in accordance with the instructions of the adhesive manufacturer.

I.5.8 Glue line thickness

For phenolic and aminoplastic adhesives mixed before use the glue line thickness shall not exceed the maximum glue line thickness declared by the adhesive manufacturer or 0,6 mm, whichever is the smaller. For the separate application of resin and hardener the maximum glue line thickness shall be less than or equal to 0,3 mm.

For moisture curing one-component polyurethane adhesives and emulsion polymer isocyanate adhesives tested with a glue line thickness of 0,5 mm the maximum glue line thickness shall be less than or equal to 0,3 mm.

For emulsion polymer isocyanate adhesives tested with a glue line thickness of 0,3 mm the maximum glue line thickness shall be less than or equal to 0,2 mm.

The glue line thickness shall be checked with a magnifying glass with which the glue line thickness can be determined with an accuracy of 10 %.

Single local deviations, e.g. as a result of chatter marks due to planing, may be disregarded.

I.5.9 Cramping

The cramping pressure shall be chosen depending on the cross section of the laminations, the species, the adhesive and the kind of processing. The pressure values of the data sheet of the adhesive manufacturer shall be regarded.

Recommended values for the cramping pressure may be taken from Table I.4. For curved glued laminated products these values should be increased by 0,2 N/mm^2.

Table I.4 — Recommended values for cramping pressure

Lamination thickness *t* (mm)	***t* ≤ 35**	**35 < *t* ≤ 45**	**45 < *t* ≤ 85**
Cramping pressure (N/mm^2)	0,6 to 0,8	0,8 for grooved laminations 1,0 for laminations without grooves	0,8 to 1,0

Pressure shall be maintained during cramping. Tightening-up shall be carried out as necessary, and in all cases immediately after initial cramping.

I.5.10 Curing

The temperature of the timber at the glue line during curing under pressure and during the required post-curing time shall not be less than 18 °C.

Glulam and glued solid timber shall be moved in a way that the post-curing process is not affected by deformation or vibration.

I.6 Glulam with large finger joints

I.6.1 Moisture content at bonding

The mean moisture content of the glulam components shall be less than 15 %. The difference of the mean moisture contents of the components to be glued shall be less than 2 %. Additionally the instructions of the adhesive manufacturer shall be followed.

I.6.2 Finger joint geometry

The provisions of I.4.2 apply with the following amendments:

The finger length shall be at least 45 mm.

The cross sectional width of the components shall be at least five times the pitch.

NOTE A common profile has a nominal finger length l_{lfj} *of* 50 mm, a pitch p of 12 mm and a tip width b_{t} of 2 mm.

I.6.3 Machining of the fingers

The machining of the fingers in both components shall be done with the same set up of cutters.

The machining of the fingers shall be carried out not more than 24 h before bonding. With species that are difficult to bond, e.g. have a high resin content, or where the laminations have been treated with preservatives, cutting shall be carried out not more than 6 h before bonding. These time limits may be extended up to 72 h (24 h for species that are difficult to bond) if moisture induced deformation of the fingers is prevented by appropriate means, e.g. airtight coverings and securing the finger profiles by counterpieces.

The total area with damaged fingers shall be less than 5 % of each cross section of the glulam components to be jointed.

I.6.4 Bonding surface and adhesive application

At the time of adhesive application the bonding surfaces shall be clean.

The adhesive shall be used in accordance with the instructions of the adhesive manufacturer.

The adhesive shall be applied evenly and in the required quantity to the full length of the fingers of both components to be jointed so that continuous adhesive squeeze out is achieved along all glue lines at the beginning of cramping.

I.6.5 Cramping

The cramping equipment shall ensure the required pressure over the whole area of the large finger joint.

The cramping pressure shall be that specified by the adhesive manufacturer. It shall be not less than 0,3 N/mm^2 unless it can be reduced by suitable arrangements such as the use of plate vibrators when moving together the fingers of the joint.

The pressure shall be so that no splitting results from cramping.

The cramping pressure shall be maintained for a minimum period of 1 min after visible adhesive squeeze out has ceased.

It may be necessary to apply a pressure perpendicular to the finger plane to counteract splitting of the components and to ensure a sufficient lateral pressure on the outmost fingers.

I.6.6 Glue line thickness

The thickness of the glue line between the glulam components shall be checked with a magnifying glass capable of determining glue line thicknesses to an accuracy of 10 % and shall be in accordance with the instruction of the adhesive manufacturer but not more 0,5 mm. Measurements at knots may be disregarded.

The relative tip gap $e = l_t/l_{lfj}$ (see Figure 3), shall be $0{,}02 \leq e \leq 0{,}10$ over the full joint depth after pressing.

I.6.7 Curing

Provisions of I.5.10 shall apply with the following amendments.

The uncured glued laminated timber with large finger joints shall be moved in a way that no differential movement takes place in the joint.

Curing of the glued laminated timber with large finger joints and further processing shall take place in accordance with the instructions of the adhesive manufacturer.

I.7 Block glued glulam

I.7.1 Moisture content at bonding

The mean moisture content of the glulam components shall be less than 15 %. The difference of the mean moisture contents of the components to be glued shall be less than 3 %. Additionally the instructions of the adhesive manufacturer shall be followed.

I.7.2 Bonding surface and adhesive application

The components to be glued shall have been machined and clean. Machining shall be carried out not earlier than 24 h prior to bonding unless the species and the storage conditions are such that no unacceptable changes in the surface occur. With species that are difficult to bond, e.g. have a high resin content or where the laminations have been treated with preservatives, machining shall be carried out not more than 6 h before bonding. The adhesive shall be used in accordance with the instructions of the adhesive manufacturer.

I.7.3 Cramping

The glulam components to be bonded shall not be subjected to bending stresses during cramping.

I.7.4 Glue line thickness

For the production of block glued glulam a gap-filling adhesive shall be used.

The glue line thickness between the glulam components checked with a magnifying glass capable to determining glue line thicknesses with an accuracy of 10 % and shall be in accordance with the instruction of the adhesive manufacturer but not more than 1,5 mm. The glue line thickness shall be checked at the periphery.

I.7.5 Curing

The glulam components to be glued shall be fixed during adhesive application and curing. The glue line pressure and time shall be in compliance with the adhesive manufacturer instruction so that the whole contact area to be glued is reliably bonded and the permissible glue line thickness shall not be exceeded.

Provisions of I.5.10 shall apply.

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M/112 "Structural timber products and ancillaries" given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard, shown in this annex meet the requirements of the Mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the glued laminated product covered by this annex for its intended uses indicated herein; reference shall be made to the information accompanying the CE marking.

This annex establishes the conditions for the CE marking of the glued laminated products, intended for the uses indicated in Table ZA.1 and shows the relevant clauses applicable.

This annex has the same scope as the relevant part in Clause 1 of this standard related to the aspect covered by the mandate and is defined by Table ZA.1.

Table ZA.1 — Scope and relevant clauses

Construction products:	Structural glued laminated products[a], which are: a) glued laminated timber (glulam); b) glued solid timber; c) glulam with large finger joints; d) block glued glulam.		
Intended uses:	In buildings and bridges		
Essential characteristics	**Requirement clauses in this or other European Standards**	**Levels and/or classes**	**Notes**
Mechanical resistance of glued laminated products covering **Modulus of elasticity, Bending strength, Compressive strength, Tensile strength and Shear strength**[b] as:			
Properties of timber	5.1.2	-	Declared as strength class or manufacturer specific strength class
Strength of finger joints	5.1.4.2 or 5.1.5.2 or 5.1.6.2 or 5.2.4.2 or 5.2.5.2	-	
Geometrical data	5.11	-	Declared as dimensions
Additional for glulam with large finger joints: Bending strength of large finger joints	5.3	-	Declared as bending strength of large finger joints

Table ZA.1 *(continued)*

Construction products:	Structural glued laminated products[a], which are: a) glued laminated timber (glulam); b) glued solid timber; c) glulam with large finger joints; d) block glued glulam.		
Intended uses:	In buildings and bridges		
Essential characteristics	**Requirement clauses in this or other European Standards**	**Levels and/or classes**	**Notes**
Bonding strength as:			
Strength of finger joints	5.1.4.2 or 5.1.5.2 or 5.1.6.2 or 5.2.4.2 or 5.2.5.2	-	Declared as strength class or manufacturer specific strength class
Glue lines between laminations in glued laminated timber and glued solid timber	5.5.5	-	Tested according to 5.5.5 and declared as "A", "B", "C" or "S"
Glue lines between glulam components	5.5.7	-	Declared as strength class or manufacturer specific strength class
Large finger joints	5.3	-	Declared as bending strength of large finger joints
Resistance to fire[c]	5.7	R xxx[d]	Strength class or manufacturer specific strength class and geometrical data (i.e. cross section sizes)
Reaction to fire[e]	5.8	A1 to F	D-s2, d0 according to Table 11 or Tested and classified acc. to EN 13501-1
Release of formaldehyde	5.9	-	Class E1 or E2
Release of other dangerous substances[e]	5.10	-	The declared values shall be as relevant.
Durability of bonding strength			
Species	5.5.2	-	Declared as species
Adhesives[b]	5.5.3	-	Declared as adhesive families, adhesive types and subclasses
Durability of other characteristics (i.e. resistance to biological organisms)			
Laminations without preservative treatment	5.6.1	-	Declared as durability class(es) according to EN 350-2
Laminations with preservative treatment	5.6.2	-	Declared according to EN 15228: 2009, Clause 6

[a] For glued laminated products made from coniferous species listed in 5.5.2 and poplar, which are not treated to improve the fire performances.

[b] The declared information enables the designer to calculate the mechanical resistance for the specific end use situation.

[c] The declared information enables the designer to calculate the resistance to fire according to EN 13501-2 for the specific end-use situation.

[d] In accordance with commission decision 2000/367/EC of 3rd May 2000 (OJEC L 133 of 2000-06-06).

[e] The performance of these characteristics may be affected by the preservative treatment of timber against biological attack.

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the

performance of their products with regard to this characteristic and the option "No performance determined" (NPD) in the information accompanying the CE marking (see ZA.3) may be used.

ZA.2 Procedures for the attestation of conformity of glued laminated products

ZA.2.1 System of attestation of conformity

The system of attestation of conformity of glued laminated timber, glulam with large finger joints, block glued glulam and glued solid timber in accordance with the Decision of the Commission 97/176/EC of 1997-02-17 (*see OJEU L73 of 1997-03-14*), as amended by 2001/596/EC of 2001-01-08 (*see OJEU L209 of 2001-08-02*) and given in Annex III of the mandate for “Structural timber products and ancillaries”, are shown in Table ZA.2 for the indicated intended uses.

Table ZA.2 — Attestation of conformity systems

Products	**Intended use(s)**	**Level(s) or classe(s) of reaction to fire**	**Attestation of conformity system(s)**
Products of this column can be treated against fire, biological attack or not treated. Structural glued laminated products and other glued timber products	Buildings and bridges	-	1 (1)
(1) System 1: see Annex III, point 2(1) to Directive 89/107/EEC			

NOTE Glued laminated products treated with fire retardants are not covered in this standard.

The attestation of conformity of the glued laminated products in Table ZA.1 shall be according to the evaluation of conformity procedures indicated in Table ZA.3 resulting from application of the clauses of this European Standard indicated therein.

Table ZA.3 — Assignment of evaluation of conformity tasks for glued laminated products under system 1

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks under the responsibility of the manufacturer	Factory production control (FPC)	Parameters related to essential characteristics of Table ZA.1 relevant for the intended uses which are declared	6.1, 6.3
	Further testing of samples taken at factory according to the prescribed test plan	Essential characteristics of Table ZA.1 relevant for the intended uses which are declared	6.1, 6.3.2.6
	Initial type testing	Essential characteristics of Table ZA.1 relevant for the intended uses which are declared with the exception of reaction to fire and bonding strength (including durability of bonding strength)	6.1, 6.2
Tasks under the responsibility of the product certification body	Initial type testing	Reaction to fire, bonding strength (including durability of bonding strength)	6.1, 6.2
	Initial inspection of factory and of FPC	Parameters related to all essential characteristics of Table ZA.1, relevant for the intended uses which are declared.	6.1, 6.4
	Continuous surveillance, assessment and approval of FPC	Parameters related to the following essential characteristics of Table ZA.1, relevant for the intended uses which are declared: — Reaction to fire: — Mechanical resistance covering modulus of elasticity, bending strength, tensile strength, compressive strength, shear strength; — Bonding strength (including durability of bonding strength); — Release of formaldehyde.	6.1, 6.5

ZA.2.2 EC certificate of conformity

When compliance with the conditions of this annex is achieved, the notified certification body shall draw up the EC Certificate of conformity which entitles the manufacturer to affix the CE marking. The EC Certificate of conformity shall include:

— name, address and identification number of the notified body;

— name and address of the manufacturer, or his authorised representative established in the EEA, and place of production;

NOTE The manufacturer may also be the person responsible for placing the product onto the EEA market, if he takes responsibility for CE marking.

— description of the product (type, identification,...);

— provisions to which the product conforms (i.e. Annex ZA of this EN);

— particular conditions applicable to the use of the product (e.g. provisions for use under certain conditions);

— the number of the certificate;

— conditions of validity of the certificate, where applicable;

— name of, and position held by, the person empowered to sign the certificate.

The above mentioned EC declaration of conformity or the EC certificate of conformity shall be presented in the language or languages accepted in the Member State in which the product is to be used.

ZA.3 CE marking and labelling

ZA.3.1 General

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE-marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the product and on the accompanying documents.

ZA.3.2 CE marking on the product

As for the CE marking affixed on each glued laminated product (i.e. glued laminated timber (glulam), glued solid timber, glulam with large finger joints or block glued glulam), the following information shall accompany the CE-marking symbol:

a) identification number of the notified certification body;

b) name or identifying mark of the manufacturer, (see NOTE in ZA.2.2);

c) the last two digits of the year in which the marking was affixed;

d) number of the EC certificate of conformity of the product;

e) reference to this European Standard and the year of its publication;

f) description of the product:

f.1) generic name:

i) glued laminated timber (glulam); or

ii) glued solid timber; or

iii) glulam with large finger joints; or

iv) block glued glulam.

f.2) species, not necessary for spruce: (*Picea abies)*;

f.3) indication “PT”, if the timber was preservative treated;

g) information on the relevant essential characteristics listed in Table ZA.1:

g.1) modulus of elasticity, bending strength, compressive strength, tensile strength, shear strength and bonding strength, covered as the product's mechanical resistance, as given in Table ZA.1, and declared as:

— strength class or profile for any type of glued laminated products according to Table ZA.1 and, additionally for glulam with large finger joints, also characteristic bending strength of large finger joints;

NOTE 1 This is usually done by reference to a strength class according to Table 3 or 4 or to manufacturer specific strength class.

NOTE 2 For the designation of manufacturer specific strength classes, glulam with asymmetrical layup, resawn and brick-bonded glulam see also 5.1.3.

— bonding strength test method declared as "A", "B", "C", if tested by delamination method A, B or C or by "S", if tested by block shear test;

— adhesive families, according to 5.5.3.1;

— adhesive types according to prEN 301 or EN 15425;

It is allowed to declare only the adhesive types without the subclasses if a full declaration is given within the accompanying papers.

The "No performance determined" (NPD) option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State(s) of destination.

Figures ZA.1 to ZA.4 give examples of a CE marking to be affixed on glued laminated products.

CE 4321	*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234	*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Glued laminated timber	*Number of EN with the year of its publication* *Description of the product*
GL 24h PUR-Type I-B	*Performance of some of the mandated characteristics*

Figure ZA.1 — Example of the CE marking affixed on the glued laminated timber made of spruce and being untreated

CE 4321	*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234	*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Glued solid timber	*Number of EN with the year of its publication* *Description of the product*
C 24 EPI-Type I-B	*Performance of some of the mandated characteristics*

Figure ZA.2 — Example of the CE marking affixed on the glued solid timber made of spruce and being untreated

CE 4321	*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234	*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Glued laminated timber with large finger joint	*Number of EN with the year of its publication* *Description of the product*
GL 24h $f_{m,lfj,k}$ = 20,4 MPa PRF-Type I-B	*Performance of some of the mandated characteristics*

Figure ZA.3 — Example of the CE marking affixed on the glued laminated timber with large finger joints made of spruce and being untreated

CE 4321	*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234	*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Block glued glulam	*Number of EN with the year of its publication* *Description of the product*
GL 28c MUF-Type I-B	*Performance of some of the mandated characteristics*

Figure ZA.4 — Example of the CE marking affixed on the block glued glulam made of spruce and being untreated

ZA.3.3 CE marking in the accompanying documents

The following information shall accompany the CE marking symbol in the commercial documents, accompanying the glued laminated product:

Information a) to f.3), given in ZA.3.2.

g.1) Information according to ZA.3.2, g.1) with the following amendment: the adhesive types and subclasses according to prEN 301:2011, Table 1 shall be declared;

g.2) Resistance to fire indirectly declared by reference to a strength class or profile and, additionally for glulam with large finger joints, to the characteristic bending strength of large finger joints;

NOTE By this method Resistance to fire of glued laminated products is indirectly declared so that it can be calculated later under a fire engineering design for specific end-use situation taking into account additional parameters, e.g. charring rates, given in the respective fire design code.

g.3) Reaction to fire: class (including smoke and droplets) as class according to EN 13501-1, either referring to Table 11 (CWFT), as class D-s2, d0, or based on results of the relevant tests, specified in the standards, referred therein;

g.4) release of formaldehyde: class E1 or E2;

g.5) release of other dangerous substances: see 5.10, where applicable;

g.6) durability (i.e. resistance to biological organisms) of the timber used for the product:

g.6.1) without preservative treatment, as natural durability: declared as durability class according to EN 350-2 or;

g.6.2) after preservative treatment, declared, in accordance with EN 15228:2009, Clause 6.

The “No performance determined” (NPD) option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State(s) of destination.

Figures ZA.5 to ZA.8 give examples of CE marking to be given in the commercial documents, accompanying the glued laminated product.

CE 4321		*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234		*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Glued laminated timber Intended to be used in buildings and bridges		*Number of EN with the year of its publication* *Description of the product* *Intended use of the product as laid down in the European Standard applied*
Mechanical resistance and resistance to fire as		*Performance of the mandated characteristics*
– geometrical data (mm)	160 x 800	
– strength class	GL 24h	
Bonding strength as		
– strength class	GL 24h	
– bonding strength test	B	
Reaction to fire	D-s2, d0	
Release of formaldehyde	E1	*Other dangerous substances need only to be declared if there is at least one additional regulated dangerous substance which obliges the manufacturer to declare. In this case, the substance has to be mentioned.*
Durability of bonding strength		
– species	*Picea abies*	
– adhesive	MUF, Type IGP70S	
Durability of other characteristics as		
- natural durability class(es) against wood destroying fungi	Durability class 5	

Figure ZA.5 — Example of CE marking given in the commercial documents, accompanying glued laminated timber

CE 4321		*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234		*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Glued solid timber Intended to be used in buildings and bridges		*Number of EN with the year of its publication* *Description of the product* *Intended use of the product as laid down in the European Standard applied*
Mechanical resistance and resistance to fire as		*Performance of the mandated characteristics*
– geometrical data (mm)	160 x 240	
– strength class	C 24	
Bonding strength as		
– strength class	C 24	
– bonding strength test	B	
Reaction to fire	D-s2, d0	
Release of formaldehyde	E1	*Other dangerous substances need only to be declared if there is at least one additional regulated dangerous substance which obliges the manufacturer to declare. In this case, the substance has to be mentioned.*
Durability of bonding strength		
– species	*Picea abies*	
– adhesive	MUF, Type IGP70S	
Durability of other characteristics as		
- natural durability class(es) against wood destroying fungi	Durability class 5	

Figure ZA.6 — Example of CE marking given in the commercial documents, accompanying glued solid timber

CE 4321		*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 4321-CPD-00234		*Name or identifying mark of the manufac-turer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Glued laminated timber with large finger joints Intended to be used in buildings and bridges		*Number of EN with the year of its publication* *Description of the product* *Intended use of the product as laid down in the European Standard applied*
Mechanical resistance and resistance to fire as		*Performance of the mandated characteristics*
– geometrical data (mm)	120 x 900 x 22000	
– strength class	GL 24h	
– bending strength of large finger joints	$f_{m,lfj,k}$ =20,4 MPa	
Bonding strength as		
– strength class	GL 24h	
– bending strength of large finger joints	$f_{m,lfj,k}$ =20,4 MPa	
– bonding strength test	B	
Reaction to fire	D-s2, d0	
Release of formaldehyde	E1	*Other dangerous substances need only to be declared if there is at least one additional regulated dangerous substance which obliges the manufacturer to declare. In this case, the substance has to be mentioned.*
Durability of bonding strength		
– species	*Picea abies*	
– adhesive for bonds between laminations	MUF, Type IGP70S	
– adhesive for finger joints	MUF, Type IFJ90S	
– adhesive for large finger joints	PRF, Type IGP90M	
Durability of other characteristics as		
- natural durability class(es) against wood destroying fungi	Durability class 5	

Figure ZA.7 — Example of CE marking given in the commercial documents, accompanying glued laminated timber with large finger joints

CE 4321	*CE-marking symbol given in Directive 93/68/EEC* *Identification number of the notified certification body*
AnyCo Ltd **13** 04321-CPD-00234	*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed* *Number of the EC certificate of conformity*
EN 14080:2013 Block glued glulam Intended to be used in buildings and bridges	*Number of EN with the year of its publication* *Description of the product* *Intended use of the product as laid down in the European Standard applied*
Mechanical resistance and resistance to fire as	*Performance of the mandated characteristics*
– geometrical data (mm)	400 x 400 x 16000
– strength class	GL 28c
Bonding strength as	
– strength class	GL 28c
– bonding strength test	B
Reaction to fire	D-s2, d0
Release of formaldehyde	E1
Durability of bonding strength	
– species	*Picea abies*
– adhesive for bonds between laminations	MUF, Type IGP70S
– adhesive for finger joints	MUF, Type I
– adhesive for block glue line	PRF, Type IGP90M
Durability of other characteristics as	
- natural durability class(es) against wood destroying fungi	Durability class 5

Other dangerous substances need only to be declared if there is at least one additional regulated dangerous substance which obliges the manufacturer to declare. In this case, the substance has to be mentioned.

Figure ZA.8 — Example of CE marking given in the commercial documents, accompanying block glued glulam

Bibliography

[1] EN 386, *Glued laminated timber — Performance requirements and minimum production requirements*

[2] EN 1912, *Structural Timber — Strength classes — Assignment of visual grades and species*

[3] EN 13501-2, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services*

[4] EN 13556, *Round and sawn timber — Nomenclature of timbers used in Europe*

[5] EN 14081-4, *Timber structures — Strength graded structural timber with rectangular cross section — Part 4: Machine grading — Grading machine settings for machine controlled systems*

[6] prEN 15497, *Structural finger jointed solid timber — Performance requirements and minimum production requirements*

[7] prEN 16351, *Timber structures — Cross laminated timber — Requirements*

[8] EN ISO 9000, *Quality management systems — Fundamentals and vocabulary (ISO 9000)*

[9] ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

[10] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products

National Annex NA
(Informative)

Guidance on the implementation of BS EN 14080:2013 in the UK

NA.1 Introduction

This National Annex is purely informative. Any user wishing to claim compliance with BS EN 14080:2013 must adhere strictly to the requirements of the standard.

This National Annex gives advice on general UK practice regarding hardwood glulam for structural design purposes, and its relation to BS EN 14080:2013. It gives recommendations on other standards, both current and withdrawn, that may be relevant to users, and advises on a minimum quality sorting process that avoids the inclusion of lower grade material. Clause NA.2 discusses the differences between BS EN 14080:2005 and BS EN 14080:2013.

Attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval. This was because of the inclusion of a prescriptive list of species from which glulam is to be made in order to conform to the revised standard. This was coupled with the committee's concerns surrounding the specific exclusion of hardwoods from its scope, which is contrary to the longstanding experience of their satisfactory design and use in the UK, together with their inclusion in BS EN 14080:2005.

NA.2 Differences between BS EN 14080:2005 and BS EN 14080:2013

The list of species in Clause 5.5.2 of the standard is a narrowing of scope in comparison with BS EN 14080:2005, used in conjunction with EN 386, and in comparison with ISO 12578, whose scope has no such restrictions concerning species of hardwood – *See NOTE 1*. BS EN 14080:2005 did not exclude the use of hardwoods, and general UK practice has been to use them.

The upper limits of thickness permitted for laminations that are used in the manufacturing of a softwood glulam product known as glued solid timber (GST) have also changed. For this, the upper lamination thickness limits have been almost doubled – in BS EN 14080:2013 the thickness is 85 mm compared with BS EN 14080:2005, where it is given as 45 mm. This modifies longstanding UK practice for conventional horizontal or vertically glued laminated timber, as stated in BS EN 386:2001 and in British Standard codes dating back to BS CP112:1967.

The UK committee is of the opinion that thick laminations implemented in conjunction with laminating stock derived from low wood quality timber is an area for concern. Such wood may be associated with the lower visual strength class GS of BS EN 14081-1. This could lead to service issues arising from excessive distortion or splitting in certain environments, especially those in which there are fluctuations in moisture content. Such modest but significant fluctuations may occur in Service class 2 and even occasionally in Service class 1.

NOTE 1 ISO 12578:2008 states that: "Although most glued laminated timber is made from coniferous species, ISO 12578:2008 also applies to broad-leaf species if the tests specified in ISO 12578:2008 show that a satisfactory glue bond can be achieved." (Broad-leaf species is an alternative term for hardwoods).

NA.3 Horizontally glued laminated hardwood

PD 6693-1 Clause 7 gives recommendations for the design of horizontally glued laminated hardwood members, in conjunction with Clause 3.3 of BS EN 1995-1-1:2004+A1:2008. This indicates how the

physical and mechanical properties of horizontally glued laminated hardwood members having four or more laminations and produced in accordance with BS EN 386:2001 are derived using modification factors for engineering design calculations. The characteristic strengths, stiffnesses and densities for the glulam are taken as the products of a series of tabulated modification factors combined with strength class data obtained from BS EN 338. Grade strength values are required which depend upon the species and its classification. For glue laminating, the UK committee recommends that these should be based upon T1 Grade for temperate hardwoods in accordance with BS 4978 or HS grade for tropical hardwoods in accordance with BS 5756.

Table NA.1 is taken from PD 6693-1:2012 and gives examples of commonly available hardwoods that are suitable for glue laminating.

Table NA.1 – Examples of hardwoods suitable for glue laminating

Common name	Botanical identification
Kapur	*Dryobalanops aromatica, Dryobalanops oblongifolia*
American white oak	*Quercus alba*
Keruing	*Dipterocarpus spp.*
Opepe	*Nauclea diderrichii*
American red oak	*Quercus rubra*
Iroko	*Milicia excelsa, Milicia regia*
Jarrah	*Eucalyptus marginata*
American white ash	*Fraxinus americana*
Beech	*Fagus sylvatica*
European ash	*Fraxinus excelsior*
European oak	*Quercus spp.*
Sweet chestnut	*Castanea sativa*

NOTE 2 BS EN 13556 indicates the common and botanical names for timbers.

NOTE 3 Strength class assignments for visual grades and species are provided in BS EN 1912 and this indicates whether T1 Grade or HS Grade is appropriate.

NOTE 4 In common with BS EN 386:2001 these recommendations are restricted to glued laminated timber whose individual laminations have a finished thickness not in excess of 45 mm.

NOTE 5 Alternative hardwoods may also be satisfactory provided it is shown that an adequate glue bond is achieved. The UK committee therefore recommends that users should establish that the species can be reliably and permanently bonded for the lifetime of the structure. The proposed adhesive should be within the scope of BS EN 301 and as this standard indicates, testing should be conducted with the adhesive brand, hardwood species and lamination thickness intended for the actual project concerned. Very dense tropical timbers such as Greenheart have in the past been subjected to similar tests but have been found to be unsuitable for glue laminating.

NOTE 6 To follow the calculation procedure recommended in BS PD 6693-1 for alternative species, it is also necessary to derive the characteristic physical and mechanical properties for the hardwood species or species group, based on tests in accordance with BS EN 408.

NA.4 Glued Solid Timber

For glued solid timber (GST), a visual strength grade listed in BS EN 1912 should be applied for quality selection of the individual laminations, such that in conjunction with the relevant species, also listed in the standard, the requirements of strength Class C24, as a minimum, are met.

NOTE 7 When machine strength grading is used to select the laminations for GST, this recommendation for visual strength grading as an over-ride check for wood quality applies additionally.

NOTE 8 In general UK practice there is no experience of testing or performance in service for British grown coniferous species used to manufacture glued solid timber (GST).

References

BS PD 6693-1, Recommendations for the design of timber structures to Eurocode 5: Design of timber structures. General. Common rules and rules for buildings.

BS EN 301, Adhesives, phenolic and aminoplastic, for load-bearing timber structures. Classification and performance requirements.

BS EN 338, Structural timber. Strength classes.

BS EN 386:2001, Glued laminated timber. Performance requirements and minimum production requirements.

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

BS EN 1912, Structural Timber. Strength classes. Assignment of visual grades and species.

BS 4978, Visual strength grading of softwood. Specification.

BS 5756, Visual strength grading of hardwood. Specification.

BS EN 13556, Round and sawn timber. Nomenclature of timbers used in Europe.

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

ISO 12578 ISO 12578:2008, Timber structures – Glued laminated timber – Component performance and production requirements.

In the above, for dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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