EUROPEAN ASSESSMENT DOCUMENT

EAD 130320-00-0304

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GLUED LAMINATED TIMBER MADE OF SOLID HARDWOOD

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

The EAD covers glued laminated timber made of solid European oak (*Quercus robur, Quercus petraea*), American white oak (*Quercus alba*), European beech (*Fagus sylvatica*), European ash (*Fraxinus excelsior*), Sweet chestnut (*Castanea sativa*), European birch (*Betula spec*.), Light red Meranti *(Shorea spp.)*, Dark Red Meranti *(Shorea spp.)*, Keruing (*Dipterocarpus alatus Roxb.),* Kempas *(Koompassia malaccensis),* Kapur *(Dryobalanops spp.),* Balau (*Shorea Laevis Ridl.)*, Eucalyptus (*Eucalyptus diversicolor, Eucalyptus marginata und Eucalyptus globulus*), Iroko (*Milicia spp.*) wood graded according to EN 14081-1[1].
Regarding geometry and beam-lay-up the glued laminated timber complies to EN 14080 (see Figure 1). The laminations made from solid hardwood may be finger jointed according to EN 14080. Adhesives of type I with the letter "w" in the designation according to EN 301 or EN 15425 are used to produce glued laminated timber made of solid hardwood.

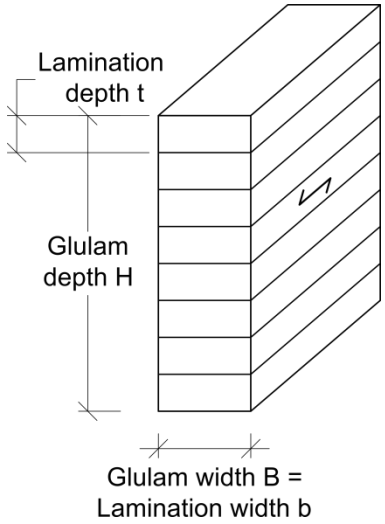

Figure 1 Geometry and beam-lay-up the glued laminated timber made of solid hardwood

The product is not fully covered by the following harmonised European standard (hEN): EN 14080. The EAD on hand covers glued laminated timber made of solid hardwood. Hence the assessment methods given in EN 14080, which covers softwood only, do not fully apply.

The EAD covers glued laminated timber made of solid hardwood

- with maximum dimensions of the laminations used in the resistance to delamination test according to 2.2.18;

- that is manufactured considering the special instructions for the respective hardwood species of the adhesive manufacturer regarding open and closed assembly times as well as for pressing times;
- that is manufactured considering additional provisions for the surface treatment before gluing given by the adhesive manufacturer (e.g. sanding instead of planing, reduced times between surface treatment and gluing, pre-treatment with a primer etc.);

- that has a relative bond shear strength rel $f_{v,b,05} \geq 0.90$ and a 10%-quantile of wood fiber percentage $WFP_{10} \geq 0.50$ at dry conditions according to Annex A, Part I;
- that has a relative bond shear strength rel $f_{v,b,05} \geq 0.90$ and a 10%-quantile of wood fiber percentage $WFP_{10} \geq 0.40$ at wet conditions according to Annex A, Part II;
- that has no wane or edge damage within the finger joint area;

1 *All undated references to standards or to EADs in this Chapter are to be understood as references to the dated versions listed in clause 4.*

- with a geometry of the fingers that permits the joint to be self-interlocking after pressing;
- with a geometry of the finger joints recommended in EN 14080, Table I.1 or with a finger length lj, pitch p , tip width b_t, whereas the reduction factor v = b_t / p and the finger angle α fulfil Formulae (1.1) and (1.2), respectively:

$$l_j \geq 4 \cdot p\,(1 - 2 \cdot \nu) \quad (1.1)$$

$$\alpha \leq 7.1° \quad (1.2)$$

The reduction factor ν is $\nu \leq 0{,}18$ and the finger length l_j is greater than 10mm.

- with no knots or pronounced grain disturbance within the finger joint itself;
- with a distance between the edge of a knot and the base of a finger joint not less than three times the knot diameter *d* (see EN 14080, Figure I.1) outside the finger joint, or with a distance between the edge of a knot and the base of the finger joint not less than 1.5 times the knot diameter in case the grain at the cross-cut is approximately parallel to the axis of the board. Knots with a diameter smaller than 6 mm may be disregarded;
- with finished lamination sizes according to Table I.2 of EN 14080 and radius of curvature according to equation (1.3) (c.f. EN 14080, Annex I.5.1):

$$t \leq \frac{r}{250}\left(1+\frac{f_{m,j,dc,k}}{150}\right) \quad (1.3)$$

where

t	finished lamination thickness (in mm);
r	radius of the lamination with the smallest radius of the member (in mm);
$f_{m,j,dc,k}$	characteristic bending strength of the finger joints (in N/mm²).

- with laminations which have the pith to the same side and where the outermost laminations at either edge have the pith facing outwards (see figure I.3 a)) of EN 14080). However, products which have the pith side at the outermost laminations facing in the same direction are also covered by this EAD if they are intended to be used in service classes 1 or 2 only (c.f. EN 14080; Annex I.5.4);
- with a maximum deviation from the average lamination thickness according to Table I.3 of EN 14080.

This EAD covers products with a glue line thickness (c.f. EN 14080, Annex I.5.8)

- which does, for phenolic and aminoplastic adhesives, not exceed the maximum glue line thickness as indicated by the adhesive manufacturer or 0,6 mm, whichever is the smaller;
- which is, for phenolic and aminoplastic adhesives and in case of a separate application of resin and hardener, less than or equal to 0,3mm;
- which is, for moisture curing one-component polyurethane adhesives tested with a glue line thickness of 0,5 mm, less than or equal to 0,3 mm.

The glued laminated timber made of solid hardwood can consist of laminations made of two boards side by side according to Annex I.5.2 of EN 14080. It also can have grooves in laminations according to Annex I.5.3 of EN 14080.

The EAD does not cover glued laminated timber made of

- hardwood treated with flame retardants
- recycled hardwood.

Generally, in outdoor conditions glulam made of sufficient durable hardwood is used to avoid using preservative treatments against biological attack for health and environmental reasons. Inside glulam made of hardwood is used to minimize the cross-section of beams due to the higher strength compared to glulam made of softwood and for aesthetic reasons. In that case a preservative treatment against biological attack is not necessary to ensure a sufficient durability of the glulam. A treatment against biological attack might influence the strength and stiffness properties of the glued laminated timber. Thus, also hardwood preservative treated against biological attack is not covered by the assessment methods as provided for in this EAD.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

Glued laminated timber made of solid hardwood is used in load-bearing timber structures in service classes 1 to 3 according to EN 1995-1-1.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the Glued laminated timber made of solid hardwood for the intended use of 50 years when installed in the works provided that the Glued laminated timber made of solid hardwood is subject to appropriate installation. These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific terms used in this EAD (if necessary in addition to the definitions in CPR, Art 2)

Timber source

It is the geographical area of growth of the trees from which the timber is sawn.

[2] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1 shows how the performance of Glued laminated timber made of solid hardwood is assessed in relation to the essential characteristics.

Table 2.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Bending strength of the glued laminated timber – with flatwise bending of the laminations	2.2.1	Level $f_{m,g,flat,k}$ in N/mm²
2	Bending strength of the glued laminated timber – with edgewise bending of the laminations	2.2.2	Level $f_{m,g,edge,k}$ in N/mm²
3	Tensile strength parallel to the grain of the glued laminated timber	2.2.3	Level $f_{t,0,g,k}$ in N/mm²
4	Tensile strength perpendicular to the grain of the glued laminated timber	2.2.4	Level $f_{t,90,g,k}$ in N/mm²
5	Compression strength parallel to the grain of the glued laminated timber	2.2.5	Level $f_{c,0,g,k}$ in N/mm²
6	Compression strength perpendicular to the grain of the glued laminated timber	2.2.6	Level $f_{,90,g,k}$ in N/mm²
7	Shear strength of the glued laminated timber	2.2.7	Level $f_{v,g,k}$ in N/mm²
8	Rolling shear strength of the glued laminated timber	2.2.8	Level $f_{r,g,k}$ in N/mm²
9	Modulus of elasticity parallel to the grain of the glued laminated timber	2.2.9	Level $E_{0,g,mean}$ in N/mm² $E_{0,g,05}$ in N/mm²
10	Modulus of elasticity perpendicular to the grain of the glued laminated timber	2.2.10	Level $E_{90,g,mean}$ in N/mm² $E_{90,g,05}$ in N/mm²
11	Shear modulus of the glued laminated timber	2.2.11	Level $G_{g,mean}$ in N/mm² $G_{g,05}$ in N/mm²
12	Rolling shear modulus of the glued laminated timber	2.2.12	Level $G_{r,g,mean}$ in N/mm² $G_{r,g,05}$ in N/mm²

No	Essential characteristic	Assessment method	Type of expression of product performance
13	Density of the glued laminated timber	2.2.13	Level $\rho_{g,k}$ in kg/m³
14	PH-value	2.2.14	Level pH-value
15	Dimensional stability	2.2.15	Description
Basic Works Requirement 2: Safety in case of fire			
16	Reaction to fire	2.2.16.1	Class
17	Charring rate	2.2.16.2	Level β_0 and β_n in mm/min
Basic Works Requirement 3: Hygiene, health and the environment			
18	Content, emission and/or release of dangerous substances	2.2.17	Description
19	Formaldehyde emission	2.2.17.1	Class
Durability aspects			
20	Durability of bonding strength of the glued laminated timber/ Durability of bonding strength of finger joints of the lamination	2.2.18	Description
21	Mechanical durability of the glued laminated timber	2.2.19	Level k_{mod}, k_{def}
22	Durability against biological attack	2.2.20	Description

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance

The density and moisture content shall be determined for all specimens in the tests from clause 2.2.1 to 2.2.14.

For all tests – except for edgewise bending tests of laminations according to Table 2.2, lines 3 and 4 – the timber for the specimens used in the lamination tests and for the specimens used in the tests of the glued laminated timber shall be sampled as a representative mixture from all relevant timber sources.

2.2.1 Bending strength of the glued laminated timber - Flatwise bending of the laminations

2.2.1.1 Properties of laminations without finger joints

The characteristic value of the tensile strength parallel to the grain $f_{t,0,l,k,}$ and the mean value of the modulus of elasticity $E_{t,0,l,mean}$ shall be determined acc. to lines 1 and 2 in Table 2.2. The characteristic value shall be calculated acc. to EN 384 and EN 14358.
If the wood species (in combination with source and grading rule) is assigned to a D-class acc. to EN 338 no further tests for the laminations without finger joints have to be performed.

In case no D-class assignment exists, the edgewise bending strength $f_{m,l,edge,k}$ and the mean modulus of elasticity parallel to the grain $E_{t,0,l,mean}$ of the lamination shall be determined according to the provisions in Table 2.2, lines 3 and 4. The characteristic values shall be calculated according to EN 384 and EN 14358.

Table 2.2 Specification of the determination of lamination properties

Tests of the lamination[3]	**Test method**	**Timber source of the specimen**	**Specimen type**	**Minimum Number**
Tensile strength $f_{t,0,l,k}$	EN 14080, Annex E.5	See clause 2.2	Medium cross-section*	100 representative mixture of all sources
Modulus of elasticity $E_{t,0,l,mean}$	EN 408			
Edgewise bending strength $f_{m,l,edge,k}$	EN 408	According to EN 384, clause 5.1	Typical cross-sections considering EN 384, clause 5.1	40 specimens per source
Modulus of elasticity $E_{t,0,l,mean}$	EN 408			
* Medium cross-section: minimum 2/3 of the maximum depth and width				

2.2.1.2 Strength of laminations with finger joints

The characteristic values of the tensile strength parallel to the grain $f_{t,0,j,k}$ and the flatwise bending strength $f_{m,j,k,flat}$ shall be determined according to the provisions in Table 2.3. The characteristic values shall be determined according to EN 14358.

Table 2.3 Specification of the determination of finger-jointed lamination strength

Tests of the lamination[2]	**Test method**	**Specimen type**	**Minimum Number**
Tensile strength parallel to the grain $f_{t,0,j,k}$	EN 14080, Annex E	Medium cross-section*	100
Flatwise bending strength $f_{m,j,k,flat}$		Medium cross-section*	100
* Medium cross-section: minimum 2/3 of the maximum depth and width			

3 For all tests: the density and the moisture content of all specimens shall be determined

2.2.1.3 Bending strength of the glued laminated timber - Flatwise bending strength of the laminations - determined from properties of laminations and finger joints

To avoid great testing effort and as a simplified method the characteristic value of the bending strength of the glued laminated timber - Flatwise bending strength of the laminations - $f_{m,g,flat,k}$ shall be determined from the strength and stiffness properties of the laminations using formulae (2.1):

$$f_{m,g,flat,k} = a_1 + a_2 f_{t,0,l,k}^{e_1} + a_3 \left(f_{t,0,j,k} - f_{t,0,l,k} + a_4 \right)^{e_2} \quad (2.1)$$

Where

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

$f_{t,0,j,k}$ is the characteristic tensile strength of the finger jointed laminations

The model parameters a_1, a_2, a_3, a_4, e_1, e_2 in equation (2.1) are determined by means of a material model based on Finite-Element calculations and Monte-Carlo-simulations of the stochastic lamination properties $f_{t,0,l}$ and $f_{t,0,j}$. The basic principles of the method are given in Annex C. The concept and corner stones of the calculation scheme should be provided for in the Evaluation Report.

The tests according to Table 2.4 shall be carried out to verify this approach. The specimens shall be tested in bending according to EN 408 whereby the orientation of laminations and finger joints is given in Figure 2.1. The finger joints are randomly distributed as in usual industrial production, but shall conform with following requirement:

At least every third tested specimen should exhibit at least one finger joint in the outer lamination at the tension edge of the cross-section within the zone of constant bending moment.

Table 2.4 Specification of the determination of the bending strength of the glued laminated timber - Flatwise bending strength of the laminations -

Tests of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Bending strength $f_{m,g,flat,k}$	EN 14080, Annex F	Smallest cross-sectional height	7
		H = 600 mm or largest cross-sectional height (whatever is smaller)	7

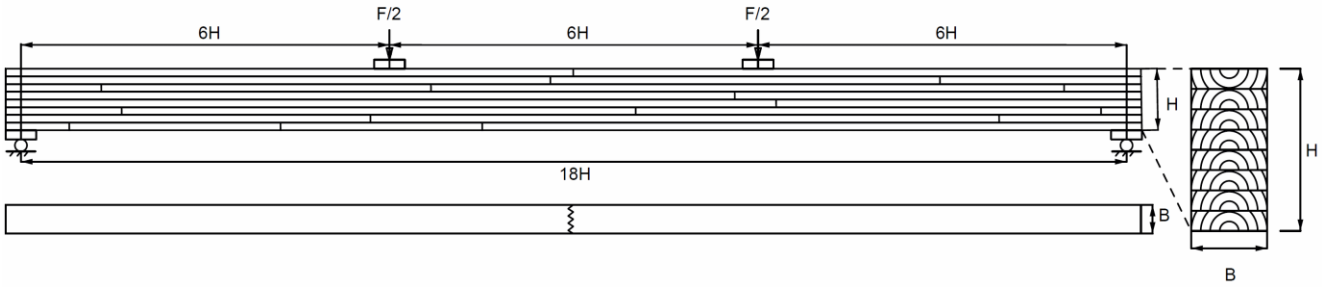

Figure 2.1 Test setup for the determination of the bending strength of the glued laminated timber in principle - Flatwise bending strength of the laminations -

2.2.1.4 Bending strength of the glued laminated timber - Flatwise bending strength of the laminations - determined from full scale tests with glued laminated timber

Alternatively the characteristic value of the bending strength of the glued laminated timber - Flatwise bending strength of the laminations - shall be determined from tests according to Table 2.5. The size effect shall be characterized on the basis of the test results.

The specimens shall be tested in bending according to EN 408 whereby the orientation of laminations and finger joints is given in Figure 2.1. The finger joints are randomly distributed as in usual industrial production, but shall conform with following requirement:

At least every third tested specimen should exhibit at least one finger joint in the outer lamination at the tension edge of the cross-section within the zone of constant bending moment.

Table 2.5 Specification of the determination of the flatwise bending strength of the glued laminated timber - Flatwise bending strength of the laminations -

Tests of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Flatwise bending strength $f_{m,g,flat,k}$	EN 14080, Annex F	Smallest cross-sectional height	15
		Intermediate cross-sectional height*	10
		H = 600 mm or largest cross-sectional height (whatever is smaller)	15
* Intermediate cross-sectional height: i.e. approximately 50 % of the largest cross-sectional height			

2.2.2 Bending strength of the glued laminated timber - Edgewise bending of the laminations

2.2.2.1 Strength of laminations with finger joints

The characteristic value of the edgewise bending strength $f_{m,j,edge,k}$ of laminations with finger joints shall be determined according to the provisions in Table 2.6. The characteristic values shall be calculated according to EN 14358.

Table 2.6 Specification of the determination of edgewise bending strength of the lamination with finger joints

Test of the lamination[2]	**Test and assessment method**	**Specimen type**	**Minimum Number**
Edgewise bending strength $f_{m,j,edge,k}$	EN 14080, Annex E with edgewise bending of the lamination	Medium cross-section*	50
* Medium cross-section: minimum 2/3 of the maximum depth and width			

2.2.2.2 Bending strength of the glued laminated timber - Edgewise bending of the laminations - determined from lamination strength

As simplified method the characteristic value of the bending strength of glued laminated timber - Edgewise bending of laminations - $f_{m,g,edge,k}$ shall be taken as the minimum value of edgewise bending strength $f_{m,l,edge,k}$ and of edgewise finger joint bending strength $f_{m,j,edge,k}$ according to clause 2.2.1.1 and 2.2.2.1 multiplied with a system factor k_{sys}. Equation (2.2) applies.

$$f_{m,g,edge,k} = \min (f_{m,l,edge,k}; f_{m,j,edge,k}) \cdot k_{sys} \quad (2.2)$$

Where

k_{sys} is the system factor acc. to EN 1995-1-1, clause 6.6 (4), Figure 6.12 depending on the number of laminations.

2.2.2.3 Bending strength of the glued laminated timber - Edgewise bending of the laminations - determined from full scale tests with glued laminated timber

Alternatively the characteristic value of the bending strength of the glued laminated timber with edgewise bending of the laminations may be determined from tests according to Table 2.7. The characteristic values shall be calculated according to EN 14358. If there is a system effect it shall be characterized on the basis of the test results.
The specimens shall be tested according to EN 408 whereby the orientation of laminations and (randomly distributed) finger joints is given in Figure 2.2.

Table 2.7 Specification of the determination of edgewise bending strength of the glued laminated timber - Edgewise bending of the laminations -

Test of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Bending strength of the glued laminated timber - Edgewise bending of the laminations $f_{m,g,edge,k}$	EN 408	Smallest cross-sectional width	7
		H = 600 mm or largest cross-sectional width (whatever is smaller)	7

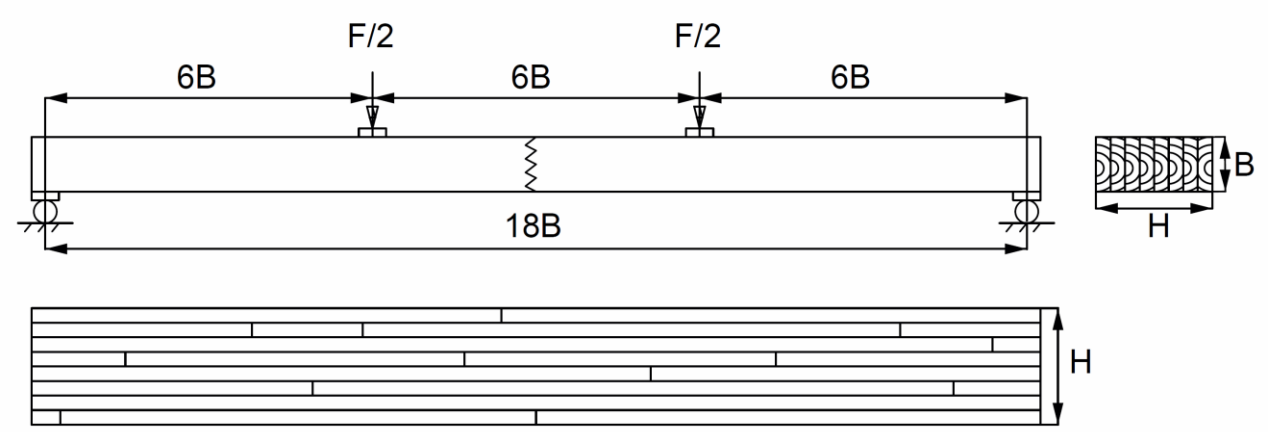

Figure 2.2 Test setup for the determination of the bending strength of the glued laminated timber in principle - Edgewise bending strength of the laminations -

2.2.3 Tensile strength parallel to the grain of the glued laminated timber

2.2.3.1 Tensile strength of the glued laminated timber determined from lamination tensile strength

As simplified method the characteristic value of the tensile strength parallel to the grain of the glued laminated timber $f_{t,0,g,k}$ shall be taken as the minimum value of the characteristic tensile strength parallel to the grain of the finger-jointed or not finger jointed laminations determined according to clause 2.2.1.1. and 2.2.1.2. Equation (2.3) applies.

$$f_{t,0,g,k} = \min (f_{t,0,l,k}; f_{t,0,j,k}) \quad (2.3)$$

Where

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

2.2.3.2 Tensile strength of the glued laminated timber determined by tests

Alternatively the characteristic value of the tensile strength parallel to the grain of the glued laminated timber may be determined from tests according to Table 2.8. The characteristic values shall be determined according to EN 14358.

Table 2.8 Specification of the determination of tensile strength parallel to the grain of the glued laminated timber

Test of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Tensile Strength $f_{t,0,g,k}$	EN 408	Typical cross-section	15

2.2.4 Tensile strength perpendicular to the grain of the glued laminated timber

2.2.4.1 Assessment according to EN 384

As simplified method the characteristic value of the tensile strength perpendicular to the grain of the glued laminated timber $f_{t,90,g,k}$ is 0,6 N/mm² (taken from EN 384, Table 2).

2.2.4.2 Determination from full scale tests with glued laminated timber

Alternatively the characteristic value of the tensile strength perpendicular to the grain of the glued laminated timber may be determined from tests according to Table 2.9. The tests shall be carried out with glulam beams made of laminations with the largest lamination depth. The characteristic value shall be calculated according to EN 14358.

Table 2.9 Specification of the determination of tensile strength perpendicular to the grain of the glued laminated timber

Test of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Tensile strength perpendicular to the grain $f_{t,90,g,k}$	EN 408	Specimen acc. to EN 408, clause 16	15

2.2.5 Compression strength parallel to the grain of the glued laminated timber

2.2.5.1 Assessment according to EN 384

As simplified method the characteristic value of the compression strength parallel to the grain of the glued laminated timber $f_{c,0,g,k}$ shall be determined from $f_{m,l,k}$ (determined acc. to clause 2.2.1.1, Table 2.2) according to EN 384, Table 2 for a reference moisture content of u = 12 %. This applies if the glued laminated timber is only used in service class 1. In case the glued laminated timber shall be used in service classes 2 or 3 the characteristic value taken from Table 2 shall be decreased by the factor 0,8 (see EN 384, clause 5.4.2).

2.2.5.2 Determination from full scale tests with glued laminated timber

Alternatively the characteristic value of the compression strength parallel to the grain of the glued laminated timber $f_{c,0,g,k}$ may be determined from tests according to Table 2.10. The characteristic value shall be calculated according to EN 14358. The determined characteristic value for specimen with equilibrium moisture content at normal climate conditions acc. to EN 408 of about 12 % applies if the glued laminated timber is only used in service class 1.
In case the glued laminated timber shall be used in service classes 2 or 3 the characteristic value shall be decreased by the factor 0,8 (see EN 384, clause 5.4.2). Optionally the test may be carried out with specimen with 18 % ± 2 % moisture content.
If there is a system effect it shall be characterized on the basis of the test results.

Table 2.10 Specification of the determination of the compression strength parallel to the grain of the glued laminated timber

Test of the glued laminated timber[2]	**Test method**	**Specimen type**	**Moisture content of the specimen**	**Minimum Number**
Compression strength parallel to the grain $f_{c,0,g,k}$	EN 408	Smallest cross-section	Equilibrium moisture content at normal climate conditions acc. to EN 408 about 12 %	15
			Optional: 18 ± 2 %	
		H = 600 mm or largest cross-sectional height (whatever is smaller)	Equilibrium moisture content at normal climate conditions acc. to EN 408 about 12 %	15
			Optional: 18 ± 2 %	

2.2.6 Compression strength perpendicular to the grain of the glued laminated timber

2.2.6.1 Determination according to EN 384

As simplified method the characteristic value of the compression strength perpendicular to the grain of the glued laminated timber $f_{c,90,g,k}$ shall be determined according to EN 384, Table 2 for a reference moisture content of u = 12 % using the characteristic density determined according to clause 2.2.13.
This applies if the glued laminated timber is only used in service class 1. In case the glued laminated timber shall be used in service classes 2 or 3 the characteristic value taken from Table 2 shall be decreased by the factor 0,8.

2.2.6.2 Determination from full scale tests with glued laminated timber

Alternatively the characteristic value of the compression strength perpendicular to the grain of the glued laminated timber $f_{c,90,g,k}$ may be determined from tests according to Table 2.11. The characteristic value shall be calculated according to EN 14358. The determined characteristic value for specimen with equilibrium moisture content at normal climate conditions acc. to EN 408 of about 12 % applies if the glued laminated timber is only used in service class 1.
In case the glued laminated timber shall be used in service classes 2 or 3 the characteristic value shall be decreased by the factor 0.8. Optionally the test may be carried out with specimen with 18 ± 2 % moisture content.

Table 2.11 Specification of the determination of the compression strength perpendicular to the grain of the glued laminated timber

Test of the glued laminated timber[2]	Test method	Specimen type	Moisture content of the specimen	Minimum Number
Compression strength perpen-dicular to the grain $f_{c,90,g,k}$	EN 408	Specimen acc. to EN 408, clause 16	Equilibrium moisture content at normal climate conditions acc. to EN 408 about 12 %	15
			Optional: 18 ± 2 %	

2.2.7 Shear strength of the glued laminated timber

The characteristic value of the shear strength of the glued laminated timber $f_{v,g,k}$ shall be determined from tests according to Table 2.12. The characteristic value shall be calculated according to EN 14358.

If it is not intended to utilize a size effect and if the largest cross-section has been tested the characteristic value of the shear strength of the largest cross-sectional height can be used for all sizes.

If it is intended to utilize a size effect or if the tested cross-sectional height is smaller than the largest cross-sectional height, additional tests with the smallest cross-section shall be carried out. The size effect for interpolation or extrapolation is calculated from the test results of the two cross-sectional sizes.

Table 2.12 Specification of the determination of the shear strength of the glued laminated timber

Test of the glued laminated timber[2]	Test method	Specimen type	Minimum Number
Shear strength $f_{v,g,k}$	ASTM 3737	Smallest cross-section (optional)	10
		H = 600 mm or largest cross-sectional height (whatever is smaller)	10

2.2.8 Rolling shear strength of the glued laminated timber

2.2.8.1 Determination from full scale tests with glued laminated timber

The characteristic value of the rolling shear strength of the glued laminated timber $f_{r,g,k}$ shall be determined from tests according to Table 2.13. The base characteristic value shall be calculated according to EN 14358.

Table 2.13 Specification of the determination of the rolling shear strength of the glued laminated timber

Test of the glued laminated timber[2]	Test method	Specimen type	Minimum Number
Rolling shear strength $f_{r,g,k}$	EN 16351, Annex F.3.3	Acc. to EN 16351, Annex F.3.3[4]	10

4 Test specimen made from cross laminated timber described in EN 16351 shall be used.

2.2.8.2 Assessment according to EN 14080

As simplified method the characteristic value of the rolling shear strength of the glued laminated timber may be taken as $f_{r,g,k}$ = 1,2 N/mm² according to EN 14080, Table 4).

2.2.9 Modulus of elasticity parallel to the grain of the glued laminated timber

The mean and characteristic value of the modulus of elasticity parallel to the grain of the glued laminated timber $E_{0,g}$ shall be determined from tests according to Table 2.14.

Table 2.14 Specification of the determination of the modulus of elasticity parallel to the grain of the glued laminated timber

Test of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Modulus of Elasticity parallel to the grain $E_{0,g}$	EN 408, determination of the local modulus of Elasticity parallel to the grain	Smallest cross-section	7 (15[5])
		H = 600 mm or largest cross-sectional height (whatever is smaller)	7 (15[4])

Note: These tests are usually carried out in conjunction with the tests acc. to Table 2.4 or Table 2.5

2.2.10 Modulus of elasticity perpendicular to the grain of the glued laminated timber

2.2.10.1 Determination according to EN 384

As simplified method the modulus of elasticity perpendicular to the grain of the glued laminated timber $E_{90,g}$ shall be determined using the test results according to Table 2.2. The mean value of the modulus of elasticity perpendicular to the grain shall be determined according to EN 384, clause 5.5.2.2.2.

2.2.10.2 Determination from full scale tests with glued laminated timber

Alternatively the mean and characteristic value of the modulus of elasticity perpendicular to the grain of the glued laminated timber may be determined from tests according to Table 2.15. The characteristic value shall be calculated according to EN 14358.

Table 2.15 Specification of the determination of the modulus of elasticity perpendicular to the grain of the glued laminated timber

Test of the glued laminated timber[2]	**Test method**	**Specimen type**	**Minimum Number**
Modulus of elasticity perpendicular to the grain $E_{90,g}$	EN 408	Specimen acc. to EN 408, clause 17	15

Note: These tests are usually carried out in conjunction with the tests acc. to Table 2.11.

5 If the bending strength has been determined from full scale tests the specimen number acc. to clause 2.2.1.4 may be used.

2.2.11 Shear modulus of the glued laminated timber

2.2.11.1 Determination according to EN 384

As simplified method the shear modulus G_g shall be determined on the basis of the mean value of the modulus of elasticity parallel to the grain $E_{0,g,mean}$. The mean and characteristic value of the shear modulus shall be determined according to EN 384, Table 2.

2.2.11.2 Determination from full scale tests with glued laminated timber

Alternatively the mean and characteristic value of the shear modulus of the glued laminated timber may be determined from tests according to Table 2.16. The characteristic value shall be calculated according to EN 14358.

Table 2.16 Specification of the determination of the shear modulus of the glued laminated timber

Test of the glued laminated timber[2]	Test method	Specimen type	Minimum Number
Shear modulus G_g	ASTM 3737 (main test method) or EN 408	Smallest cross-section	10
		H = 600 mm or largest cross-sectional height (whatever is smaller)	10

2.2.12 Rolling shear modulus of the glued laminated timber

2.2.12.1 Determination from full scale tests with glued laminated timber

The mean and characteristic value of the rolling shear modulus of the glued laminated timber shall be determined from full scale tests with glued laminated timber according to Table 2.17. The characteristic value shall be calculated according to EN 14358.

Table 2.17 Specification of the determination of the rolling shear modulus of the glued laminated timber

Test of the glued laminated timber[2]	Test method	Specimen type	Minimum Number
Rolling shear modulus $G_{r,g}$	EN 16351, Annex F.3.3	Acc. to EN 16351, Annex F.3.3[6]	10

2.2.12.2 Assessment according to EN 14080

As simplified method the mean and characteristic value of the rolling shear modulus of the glued laminated timber may be taken as $G_{r,g,mean}$ = 65 N/mm² and $G_{r,g,05}$ = 54 N/mm² according to EN 14080, Table 4).

2.2.13 Density of the glued laminated timber

The characteristic value of the density $\rho_{g,k}$ shall be determined from the density values determined in the tests according to clause 2.2.1.3 or 2.2.1.4 using EN 384, clause 5.5.2.2.3.

6 Test specimen made from cross laminated timber described in EN 16351 shall be used.

2.2.14 PH-value of the hardwood

The pH-value shall be assessed according to Annex B. The arithmetic mean of the individual pH-values of one hardwood species determined according to Annex B shall be given in the ETA as pH-value for the hardwood species used.

2.2.15 Dimensional stability

The dimensional stability of the glued laminated timber made of solid hardwood shall be assessed according to EN 14080, clause 5.11. Differently to EN 14080, Table 14 the dimensional changes in EN 336, clause 4.2 for hardwood shall be considered.

2.2.16 Safety in case of fire

2.2.16.1 Reaction to fire

The glued laminated timber made of solid hardwood shall be tested, using the test method(s) relevant for the corresponding reaction to fire class according to EN 13501-1. The glued laminated timber made of solid hardwood shall be classified according to Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1.

If tests according to EN 13823 are required, the provisions of EN 14080, clause 5.8 regarding the mounting and fixing conditions of test specimens shall apply.

2.2.16.2 Charring rate

The charring rates of the glued laminated timber made of solid hardwood β_0 and β_n shall be taken from EN 1995-1-2, table 3.1.

2.2.17 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer[7] after identifying the release scenarios taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The identified intended release scenarios for this product and intended use with respect to dangerous substances are:

IA 1: Product with direct contact to indoor air.

IA 2: Product with indirect contact to indoor air (e.g covered products) but possible impact on indoor air.

IA 3: Product with no contact to and no impact on indoor air.

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7 The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **not** obliged:

- to provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- to provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS.

Any information provided by the manufacturer regarding the chemical composition of the products may not be distributed to EOTA or to TABs.

2.2.17.1 SVOC and VOC

For the intended use covered by the release scenario IA1 and/or IA2 semi-volatile organic compounds (SVOC) and volatile organic compounds (VOC) shall be determined in accordance with EN 16516. The respective loading factor [m^2/m^3] used for emission testing can be taken from the following table:

Table 2.18 Loading factor L, depending on the product type (in accordance with EN 16516)

Intended use	Loading factor [m^2/m^3]
Walls	1.0
Floor, ceiling	0.4
Small surfaces, e.g. door, window, heating system	0.05
Very small surfaces, e.g. sealants	0.007

The preparation of the test specimen is performed by using a representative sample of the product installed in accordance with the manufacturer's product installation instructions or in absence of such instructions the usual practice of the product installation. The size of the test specimen has to be chosen in consideration of the test chamber size and the intended loading factor (see above).

Once the test specimen has been produced, as described above, it should immediately be placed in the emission test chamber. This time is considered the starting time of the emission test.

The test results have to be reported for the relevant parameters (e.g. chamber size, temperature and relative humidity, air exchange rate, loading factor, size of test specimen, conditioning, production date, arrival date, test period, test result) after 3 and/or 28 days testing.

The product performance shall be expressed in [µg/m^3 or mg/m^3] and stated in the ETA.

2.2.17.2 Formaldehyde emission

If a formaldehyde-containing adhesive for bonding the glued laminated timber made of solid hardwood is used, the release of formaldehyde has to be determined according to EN 14080, Annex A.

The release of formaldehyde is stated as class E1 or E2.

2.2.18 Durability of bonding strength of the glued laminated timber/ Durability of bonding strength of finger joints of the lamination

The suitability of the adhesive for gluing the respective hardwood species shall be assessed in accordance with EN 301 and EN 15425. As requested in these standards the resistance to delamination test according to EN 302-2 shall be carried out with the respective hardwood species. Deviating from EN 302-2 depth and width laminations dimension may be reduced. If the lamination dimensions are reduced the reduced dimensions shall be given as maximum dimension for the laminations of the glued laminated timber in the ETA.

The durability of the bonding strength of the glued laminated timber for use in service class 1 only shall be determined by tests according to Table 2.19. The restriction to service class 1 shall be stated in the ETA.

Table 2.19 Specification of the determination of the bonding strength of the glued laminated timber

Tests of the glued laminated timber[2]	Test method	Specimen type	Minimum Number	Provisions to be fulfilled
Shear strength -dry conditions-	Block shear tests acc. to Annex A, method “dry”	Smallest cross-section	7	Annex A, dry conditions
		Largest cross-section	7	
Delamination	EN 14080, Annex C, method A	Smallest cross-section	7	EN 301, clause 5.3 provisions for hardwood
		Largest cross-section with largest lamination depth	7	

The durability of the bonding strength of the glued laminated timber for use in service class 1 and service classes 2 or 3 shall be determined by tests according to Table 2.20.

Table 2.20 Specification of the determination of the bonding strength of the glued laminated timber

Tests of the glued laminated timber[2]	Test method	Specimen type	Minimum Number	Provisions to be fulfilled
Shear strength -dry conditions-	Block shear tests acc. to Annex A, method “dry”	Smallest cross-section	7	Annex A, dry conditions
		Largest cross-section	7	
Shear strength -wet conditions-	Block shear tests acc. to Annex A, method “wet”	Smallest cross-section	7	Annex A, wet conditions
		Largest cross-section	7	
Delamination	EN 14080, Annex C, method A	Smallest cross-section	7	EN 301, clause 5.3 provisions for hardwood
		Largest cross-section with largest lamination depth	7	

2.2.19 Mechanical durability of the glued laminated timber

The modification factor for duration of load and moisture content k_{mod} and the factor for the evaluation of creep deformation taking into account the relevant service class k_{def} shall be taken from EN 1995-1-1 for solid wood.

2.2.20 Durability against biological attack

The natural durability against biological attack shall be assessed according to EN 14080, clause 5.6.1.

3 ASSESSMENT AND DETERMINATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and determination of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 97/176/EC as amended by Commission Decision 2001/596/EC.

The system is 1.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and determination of constancy of performance are laid down in Table 3.1.

Table 3.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
Mechanical resistance, stiffness and density					
1	Strength, stiffness and density properties of the laminations	EN 14081-1, 6.3	EN 14081-1, 6.3	Each piece of structural solid timber	EN 14081-1, 6.3
2	Species, Adhesives	See control plan	Check whether the species and adhesives arewithin the conditions given in 1.1	-	For each delivery
3	Moisture content of timber to be jointed	EN 14080, Annex G	EN 14080, Annex I.4.4	2 taken at random	weekly
4	Temperature of the timber	EN 14080, Annex I.4.8 and I.5.10	EN 14080, Annex I.4.8 and I.5.10	-	Continuously during production
5	Glue line thickness	EN 14080, Annex I.5.8	EN 14080, Annex I.5.8	-	daily
6	Cramping pressure for glued finger joints in laminations and for face-gluing	See control plan	Ensure that the cramping pressure is adapted to the raw density of the timber species	-	daily
7	Bending strength of laminations with finger joints	EN 14080, Annex E	See control plan	2 samples taken at random for each strength class or characteristic bending strength, species and adhesive	2 per shift, wood species and production line

No	Subject/type of control		Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
8	Bending strength of laminations without finger joints		EN 14080, Annex E	See control plan	2 samples taken at random for each strength class or characteristic bending strength, species	2 per shift, wood species and production line
9	Geometrical data		EN 14080, 5.11.1	EN 14080, 5.11.1	2 taken at random	2 per shift
10	Bonding strength	Shear strength -dry conditions-	Annex B, Part I –dry conditions-	See clause 3.4.1	one full cross sectional specimen for each 20 m^3 of production	1 per shift
		Shear strength -wet conditions-	Annex B, Part II –wet conditions-	See clause 3.4.1		
		Delamination	EN 14080, Annex C, method B	EN 301, clause 5.3 provisions for hardwood		
		Glue line thickness	EN 14080, Annex I.5.8	EN 14080, Annex I.5.8		
11	Dimensional stability		EN 14080, clause 5.11	EN 336, clause 4.2	2 taken at random	2 per shift
Safety in case of fire						
12	Reaction to fire		Check that all relevant indirect parameters (e.g.: • minimum thickness, • apparent minimum density, • wood species • type of adhesive and its coverage) as determined within the reaction to fire tests are fulfilled	See control plan	1	Per shift
Content, emission and/or release of dangerous substances						
13	Formaldehyde emission		EN 14080, 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 assessment of the performance are used.

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body of the product in the procedure of assessment and determination of constancy of performance for the glued laminated timber made of solid hardwood are laid down in Table 3.2.

Table 3.2 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	Ascertain that the factory production control with the staff and equipment is suitable to ensure a continuous and orderly manufacturing of the product considering particularly the following inspections and in accordance with EN 14080, Annex I clauses I.1 to I.3, I.4.4 to I.4.8, I.5.5 to I.6.1 and I.6.3 to I.7.5: – Suitable premises – Suitable technical equipment – Qualified personnel – Suitability of the factory production control established by the manufacturer – Full implementation of the control plan	Verification of the complete FPC, to be implemented by the manufacturer as defined in the control plan	-	-	When starting the production process or when starting a new production line
Continuous surveillance, assessment and evaluation of factory production control					
2	Ascertain that the system of factory production control and the specified automated manufacturing process are maintained according to EN 14080, Annex I clauses I.1 to I.3, I.4.4 to I.4.8, I.5.5 to I.6.1 and I.6.3 to I.7.5 and as defined in the control plan	Verification of the controls carried out by the manufac-turer on the raw materials, on the manu-facturing process and on the product as indicated in Table 3.1 and as defined in the control plan	-	-	Twice a year

3.4 Special methods of control and testing used for the assessment and determination of constancy of performance

3.4.1 Relative bond shear strength test

The relative bond shear strength test shall be carried out according to Annex A. Differently, the bond shear strength $f_{v,b}$ and the wood fiber percentage WFP shall be determined as follows.
The mean value of the bond shear strength $f_{v,b,mean}$ and of the wood shear strength $f_{v,w,mean}$ shall be calculated.
The mean value of wood fiber percentage WFP_{mean} shall be calculated.
The relative mean bond shear strength defined as

$$rel\ f_{v,b,mean} = f_{v,b,mean} / f_{v,w,mean} \quad (3.1)$$

shall be calculated.

The results shall fulfill the following requirements for testing at dry conditions acc. to Annex A, Part I:

- $rel\ f_{v,b,mean} \geq 0,90$ and
- $WFP_{mean} \geq 0,80$.

The test results shall fulfill the following requirements for testing at wet conditions acc. to Annex A, Part II:

- $rel\ f_{v,b,mean} \geq 0,90$ and
- $WFP_{mean} \geq 0,70$.

4 REFERENCE DOCUMENTS

EN 301:2017	Adhesives, phenolic and aminoplastic, for load-bearing timber structures – Classification and performance requirements
EN 302-2:2017	Adhesives for load-bearing timber structures – Test methods – Part 2: Determination of resistance to delamination
EN 338:2016	Structural timber – Strength classes
EN 384:2016+A1:2018	Structural timber – Determination of characteristic values of mechanical properties and density
EN 408:2010+A1:2012	Timber structures – Structural timber and glued laminated timber – Determination of some physical and mechanical properties
EN 1995-1-1: 2004+AC: 2006+A1:2008+A2:2014	Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings
EN 1995-1-2:2004+ AC:2009	Eurocode 5: Design of timber structures – Part 1-2: General – Structural fire design
EN 13501-1:2018	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests
EN 14080:2013	Timber structures – Glued laminated timber and glued solid timber – Requirements
EN 14081-1:2016-06	Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements
EN 14358:2016	Timber structures – Calculation of characteristic 5-percentile values and acceptance criteria for a sample
EN 15425:2017	Adhesives – One component polyurethane for load bearing timber structures – Classification and performance requirements
EN 16351:2015	Timber structures – Cross laminated timber – Requirements
ASTM 3737:2012	Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)

ANNEX A RELATIVE BOND SHEAR STRENGTH TEST

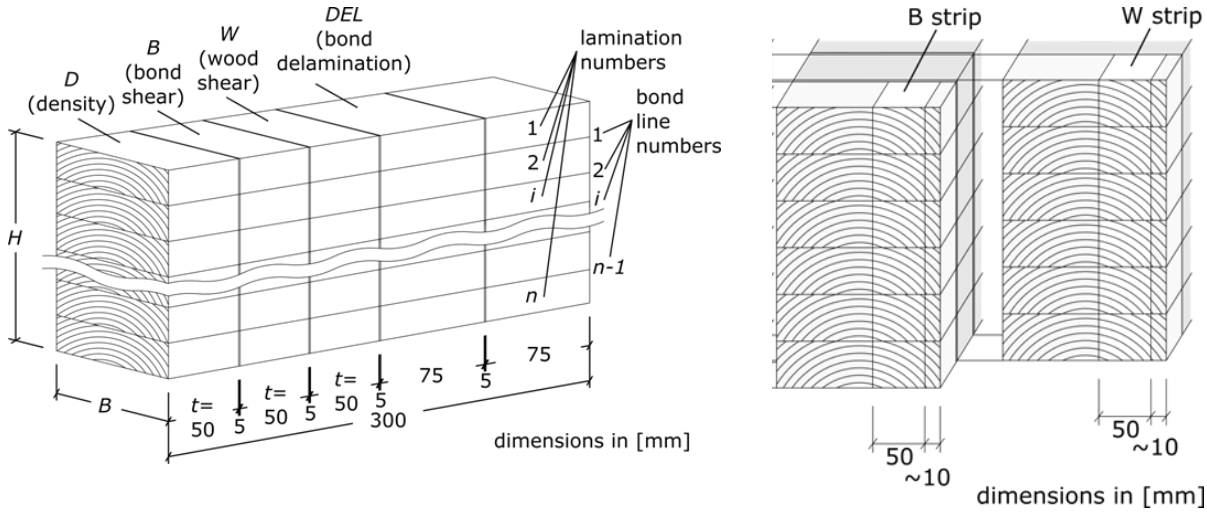
Part I Relative bond shear strength at dry conditions

The relative bond shear strength rel $f_{v,b}$ shall be tested as follows:

- Slabs with a length of 50 mm cut from a complete glulam cross-section acc. to Figure A.1 a) For relative bond shear strength the two slabs W (wood shear) and B (bond shear) are used.
- The slabs are divided with respect to width direction into severals sticks, whereby the first 10 mm at the side face are discarded (see Figure A.1 b)).
- Block shear tests acc. to EN 14080, Annex D shall be performed for all glue lines, whereby the "bond shear" specimens are loaded in the same manner as prescribed in EN 14080, but the "wood shear" specimens are loaded with the shear plane at mid-height of the laminiations. The two different loading principles are sketched in Figure A.2.
- The bond shear strength $f_{v,b}$ of each bond-line (in case of "bond shear" specimen) and the wood shear strength of each lamination $f_{v,w}$ (in case of "wood shear" specimen) shall be determined acc. to EN 14080, Annex D.
- In case of the "bond shear" specimen also the wood fiber percentage WFP for every bond line shall be determined.
- The 5%-quantile of bond shear strength $f_{v,b,05}$ and of the wood shear strength $f_{v,w,05}$ shall be calculated acc. to EN 14358.
- The 10%-quantile of the wood fiber percentage WFP_{10} shall be calculated acc. to EN 14358.
- The relative 5%-quantile bond shear strength defined as

$$\text{rel } f_{v,b,05} = f_{v,b,05} / f_{v,w,05} \quad \text{(A.1)}$$

shall be calculated.



a) b)

Figure A.1 Cut plan for the relative bond shear strength method

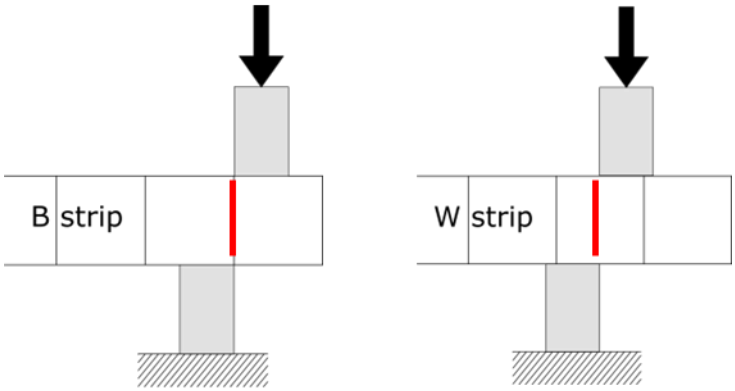


Figure A.2 Test configuration for relative bond shear strength method

Part II Relative bond shear strength at wet conditions

The slabs shall be cut from the glulam specimen in the same manner as given in part I.

The sticks shall be cut from the slabs in the same manner as given in part I.

The sticks shall be treated by following wetting / drying cycles (conforms to EN 14374, Annex B):

- Conditioning in boiling water for at least 4 hours
- Drying in a ventilated drying chamber for at least 16 hours at a temperature of minimally 60°C
- Conditioning in boiling water for at least 4 hours
- Conditioning in water (at room temperature) for at least 2 hours

The sticks shall be tested in wet condition in the same manner as given in part I.

The evaluation of relative bond shear strength rel $f_{v,b,05}$ and of the the wood fiber percentage WFP_{10} shall be performed in the same manner as given in part I.

ANNEX B DETERMINATION OF THE PH-VALUE OF THE HARDWOOD

B.1 Sampling and sample preparation of the hardwood

Preparation of the hardwood

A representative average sample of about 50 g (at least 20 g) per piece shall be obtained from individual samples taken from various positions on the original hardwood sample. The hardwood should have a dry matter content of > 90% and should be dried gently, where applicable. A suitable drill shall be used to obtain the required amount of borings or bore dust.

The use of the cone and quartering method is recommended. This technique involves pouring of the sample material into a conical heap, mixing well and dividing the material up into four equal parts, e.g. using a doctor blade. A new conical heap is then formed from two opposite quarters, with the other two quarters being discarded. The same procedure is repeated analogously for each remaining heap until the required sample amount is obtained.

The material shall be comminuted to a grain size of ≤ 1 mm using a laboratory mill; where applicable, the sieve fraction ≤ 1 mm shall then be separated using the sieve set. Finer material can be fractionated directly, i.e. without grinding.

It shall be ensured that no heating of the material occurs in any of the steps.

Preparation of the extractant

Distilled water shall be poured into a suitable vessel, e.g. an Erlenmeyer flask with a magnetic stir bar or a boiling flask with annealed boiling stones, heated on a hotplate until it starts to boil and kept at a boil for approximately 10 minutes for removing the carbon dioxide. After a short cooling period, the water should be kept in a closed vessel (e.g. a sqeeze bottle). The distilled water can alternatively be autoclaved at 121 °C for 20 minutes for removing the carbon dioxide.

The extractant must be cooled to room temperature before being used.

Preparation of the aqueous extract from the solid

A 2 g sample of the material for analysis prepared as described above (sieve fraction ≤ 1 mm, dry matter content > 90%) shall be placed in a beaker, 50 ml of the extractant shall be added and the contents shall be thoroughly mixed. The suspension must have a dry matter content of 3.5% to 4%; otherwise an accordingly larger amount of the analysis material shall be added to the beaker for the given dry matter content.

The suspension shall be set aside for 15 minutes and shaken occasionally. Then, the suspension shall be either filtered through a liquid filter such as a pleated filter or decanted if the solid has precipitated completely out of the suspension.

B.2 Procedure

Determination of the dry matter content

For determination of the dry matter content at least two samples of approximately 1 g each of the sample material prepared as described above shall be placed in previously weighed vessels on an analytical balance with an accuracy of 0.1 mg and dried in a drying cabinet at a temperature of 103 °C ± 2 K until the mass remains constant (mass difference of less than 0.1% for two measurements taken 2 h apart). The dry weight shall then be determined and the dry matter content calculated in accordance with the following formula:

$$t = \frac{(m_{tr} + m_G) - m_G}{(m_f + m_G) - m_G} \times 100\ [\%]$$

where t = dry mass content [%]
m_G = mass of vessel [g]
m_{tr} = dry weight of sample [g]
m_f = wet weight of sample [g]

The arithmetic mean of the individual values shall be specified with one decimal place accuracy.

Determination of the pH-value

Calibration and pH determination shall be carried out in accordance with the instructions for use provided with the instrument.

The electrode shall first be calibrated with at least two standard solutions covering the expected pH range, e.g. for the basic range with pH 7 and pH 10 or for the acidic range with pH 7 and pH 4. Calibration shall preferably be carried out in 50 ml beakers.

Following calibration, the electrode shall be rinsed with distilled water and stored in distilled water between measurements.

Unless otherwise specified, the pH measurement shall be carried out twice on each of at least two samples. For each of the liquid samples prepared as described above an amount of 20 to 25 ml shall be poured into a 50 ml beaker. The electrode shall be dipped into the test solution.

The value shall be read off when the reading has stabilised, after about one minute at the earliest. The electrode shall then be taken out of the solution and rinsed with distilled water. The measurement shall then be carried out on the next sample.

The arithmetic mean of the individual values shall be specified with one decimal place accuracy.

B.3 Test report

The test report shall at least include:

- a unique description of the sample material (Botanical name of the Species, geographic origin, species population)
- the dry matter content
- the pH-value
- the name of the tester
- the date of the test.

ANNEX C BASIC PRINCIPLES OF THE STRENGTH MODEL FOR GLULAM MADE FROM HARDWOODS

In order to simulate the bending strength of glued laminated timber based on the properties of the laminations and finger-joints an apt calculation model may be used. The model may be based on following basic principles:

- A two-dimensional Finite Element (FE) model of the glulam beam is used.
- Individual global mechanical properties are assigned to each lamination, representing the experimentally observed statistical distributions of single boards.
- Each lamination is divided lengthwise into zones with different strength and stiffness properties (typical length: about 100 mm).
- Each lamination incorporates special zones to model the finger joints (if needed for the glulam)
- The properties of each lamination zone (i.e. tension / compression strength, E-Modulus parallel to fiber) are generated based on the auto-correlation and cross-correlation coefficients between the different properties.
  The properties of each finger joint (tensions strength) are assigned stochastically according to the empirically determined distribution of finger joint strength.
- Orthotropic material behavior is assumed. Apt damage laws for tension and compression are used.
- A solution algorithm apt for non-linear behavior is used (e.g. Newton Raphson Method).
- Monte-Carlo simulations are performed with the FE model: For every stochastically assigned set of material parameters one FE calculation is performed and one bending strength is determined. By repetition with different stochastically determined sets of lamination/finger joint properties the resulting distribution of glulam bending strength values is calculated.
- From the calculated distribution of bending strength values the characteristic bending strength is derived.
- The distribution of calculated bending strength values can be compared to the results of the validation tests (i.e. bending tests with glulam beams of different cross-section height) and the free model parameters (e.g. parameters of the assumed damage laws) can be calibrated.