BS EN 301:2013

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Adhesives, phenolic and aminoplastic, for load-bearing timber structures — Classification and performance requirements

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National foreword

This British Standard is the UK implementation of EN 301:2013. It supersedes BS EN 301:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/52, Adhesives.

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.

ISBN 978 0 580 76778 4

ICS 83.180

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 October 2013.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 301

October 2013

ICS 83.180

Supersedes EN 301:2006

English Version

Adhesives, phenolic and aminoplastic, for load-bearing timber structures - Classification and performance requirements

Adhésifs de nature phénolique et aminoplaste, pour structures portantes en bois - Classification et exigences de performance

Klebstoffe, Phenoplaste und Aminoplaste, für tragende Holzbauteile - Klassifizierung und Leistungsanforderungen

This European Standard was approved by CEN on 19 July 2013.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 301:2013: E

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Foreword

This document (EN 301:2013) has been prepared by Technical Committee CEN/TC 193 “Adhesives”, the secretariat of which is held by AENOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2014, and conflicting national standards shall be withdrawn at the latest by April 2014.

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 301:2006.

Compared to EN 301:2006 the following changes have been made:

a) three subclasses for adhesives have been added: for general purpose, for finger jointing and for gap filling purpose;

b) further classification of adhesives according to temperature resistance and for mixed and separate application of adhesive and hardener specified;

c) application of Type II adhesives limited to service class 1;

d) provisions for small modifications of already approved adhesives;

e) requirements for thick glue line in the range of 0,3 mm to 2,0 mm;

f) provisions for delamination tests of hardwood added;

g) pH value for performance of fibre damage test reduced;

h) additional tests for static loads and for separate application of finger joint adhesives.

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

Introduction

This document is one of a series of standards dealing with phenolic and aminoplastic adhesives for use with timber structures, and is published in support of product standards for load-bearing timber structures in connection with EN 1995-1-1 *Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings*. The series consists of one standard for classification and performance requirements (EN 301), five test methods (EN 302, Parts 1 to 4 and EN 15416-2) used to assess the performance of adhesives after specified heat and humidity treatments, and three test methods (EN 302, Parts 5 to 7) to characterise the working properties of the adhesive.

SAFETY STATEMENT — Persons using this document should be familiar with the normal laboratory practice, if applicable. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any regulatory conditions.

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1 Scope

This European Standard establishes a classification for phenolic and aminoplastic polycondensation adhesives according to their suitability for use for load-bearing timber structures in defined climatic exposure conditions, and specifies performance requirements for such adhesives for the factory manufacture or factory-like manufacturing conditions of load-bearing timber structures only.

This European Standard only specifies the performance of an adhesive for use in an environment corresponding to the defined conditions.

The performance requirements of this European Standard apply to the adhesive only, not to the timber structure. This European Standard does not cover the performance of adhesives for on-site gluing (except for factory-like conditions) nor the production of wood-based panels, except solid wood panels, or modified and stabilised wood with considerably reduced swelling and shrinkage properties, e.g. such as acetylated wood, heat treated wood and polymer impregnated wood.

This European Standard is primarily intended for the use of adhesive manufacturers and for the use in timber structures bonded with adhesives, to assess or control the quality of adhesives. The requirements apply to the type testing of the adhesives. Production control activities are outside the scope of this European Standard.

Adhesives meeting the requirements of this European Standard are adequate for use in a load-bearing timber structure, provided that the bonding process has been carried out according to an appropriate product standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

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

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

EN 923, *Adhesives - Terms and definitions*

EN 1245, *Adhesives - Determination of pH*

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

EN 12092, *Adhesives - Determination of viscosity*

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 14080, *Timber structures - Glued laminated timber and glued solid timber - Requirements*

EN 15416-2:2007, *Adhesives for load bearing timber structures other than phenolic and aminoplastic - Test methods - Part 2: Static load test of multiple bondline specimens in compression shear*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 923 and the following apply.

3.1
aminoplastic resin
thermosetting synthetic resin derived from a condensation reaction of the –NH groups or $–NH_2$ groups of amines or amides with aldehydes

3.2
phenolic resin
thermosetting synthetic resin derived from a condensation reaction of a phenol with an aldehyde

3.3
polycondensation adhesive
adhesive mixture made from a resin formed by a polymerisation reaction involving the elimination of water, usually with a hardener

Note 1 to entry: Such adhesives usually also contain extenders and/or fillers.

3.4
service class 1
climatic conditions characterised by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 65 % for a few weeks per year

Note 1 to entry: In service class 1, which comprises typical indoor conditions, the average moisture content in most softwoods will not exceed 12 %.

[SOURCE: EN 1995-1-1:2004, 2.3.1.3]

3.5
service class 2
climatic conditions characterised by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 85 % for a few weeks per year

Note 1 to entry: In service class 2, to which most covered exterior conditions belong, the average moisture content in most softwoods will not exceed 20 %.

[SOURCE: EN 1995-1-1:2004, 2.3.1.3]

3.6
service class 3
climatic conditions leading to higher moisture contents than in service class 2

Note 1 to entry: Exterior conditions typically belong to service class 3.

[SOURCE: EN 1995-1-1:2004, 2.3.1.3, modified – Note 1 to entry has been added.]

3.7
glue line
adhesive layer between the wood members

3.8
thick glue line
glue line of nominal thickness in the range of 0,3 mm to 2,0 mm at the time of bonding

Note 1 to entry: Thick glue lines are achieved by using spacers, grooves or similar devices with a thickness of 0,3 mm to 2,0 mm when two plain members are glued together.

3.9
close contact glue line
glue line of thickness maximum 0,1 mm

Note 1 to entry: Close contact glue line is achieved by pressing together two plane wood members with a clamping pressure of (0,8 ± 0,1) N/mm^2 without grooves, spacers or similar devices.

4 Classification

Adhesives (general purpose, finger jointing or gap filling) for structural purposes shall produce joints of such strength and durability that the integrity of the bond is maintained in the assigned service class throughout the expected life of the structure.

Two types of adhesive, I and II, are classified according to their suitability for use in different climatic conditions:

— **Type I** to be used in service classes 1, 2 and 3 (EN 1995-1-1);

— **Type II** to be used in service class 1 only.

NOTE The application of the adhesive types in the different service classes can be restricted by national regulations applicable at the end use site of the bonded timber structure.

These two types of adhesive are further divided into three subclasses according to the end use:

— **General-purpose adhesive (GP)** to be used for glue lines between laminations, for finger joints in laminations and structural timber, and for large finger joints;

— **Finger jointing adhesive (FJ)** to be used for finger jointing of laminations and structural timber only;

— **Gap filling adhesive (GF)** to be used for fibre parallel gluing, e.g. glue lines between glulam components of block-glued glulam and for large finger joints. Gap filling adhesives can in addition be classified as application type **GP** usable for glue lines between laminations and for finger jointing of laminations and structural timber.

Table 1 specifies the thirteen adhesive classes for which this European Standard applies and their designations. The designations consist of:

— type: **I** or **II**;

— application: **GP, FJ** or **GF**;

— maximum test temperature in degrees Celsius: **70** or **90** for type **I**, or maximum use temperature in degrees Celsius: **50** for type **II**;

— use: **M** for mixed application, and **S** for separate application of adhesive and hardener.

Each application area and use shall be part of the designation.

EXAMPLE EN 301 **I 70 GP 0,6M** and EN 301 **I 70 FJ 0,1S** if classified as general purpose adhesive for mixed application and classified as finger joint adhesive for separate application.

Table 1 — Adhesive classes

Adhesive type Designation	**Application**	**Max. test temp.**[c] °C	**Max. glue line thickness** mm **Test**	**Use**	**Service classes**[a]
	Face lamination and finger jointing for general use	70	1,0	0,6[d]	1,2,3
EN 301 **I 70 GP 0,6M**	General purpose	70	1,0	0,3	1,2,3
EN 301 **I 70 GP 0,3S**	General purpose				
	Special	90	2,0	1,5	1, 2, 3
EN 301 **I 90 GF 1,5M**	Gap filling[d]	90	1,0	0,6[d]	1, 2, 3
EN 301 **I 90 GP 0,6M**	General purpose	90	1,0	0,3	1, 2, 3
EN 301 **I 90 GP 0,3S**	General purpose				
EN 301 **I 90 FJ 0,1M**	Finger joint	90	0,3	0,1	1, 2, 3
EN 301 **I 90 FJ 0,1S**	Finger joint	90	0,3	0,1	1, 2, 3
EN 301 **I 70 FJ 0,1M**	Finger joint	70	0,3	0,1	1, 2, 3
EN 301 **I 70 FJ 0,1S**	Finger joint	70	0,3	0,1	1, 2, 3
EN 301 **II 50 GP 0,6M**	General purpose	[b]	1,0	0,6[d]	1
EN 301 **II 50 GP 0,3S**	General purpose	[b]	1,0	0,3	1
EN 301 **II 50 FJ 0,1M**	Finger joint	[b]	0,3	0,1	1
EN 301 **II 50 FJ 0,1S**	Finger joint	[b]	0,3	0,1	1

[a] The application of the adhesive types in the different service classes can be restricted by national regulations applicable at the end use site of the bonded timber structures.

[b] Maximum temperature in use is 50 °C, does not need to be tested.

[c] Tested according to EN 15416–2.

[d] Only mixed application.

Table 2 specifies the tests, which shall be performed for each class. In case an adhesive serves for several applications as specified in Table 2, the necessary tests given for each application need to be fulfilled.

Table 2 — Necessary tests for adhesive subclasses

Application	**Glue line thickness in test** mm	EN 302–1	EN 302–2	EN 302–3	EN 302–4	EN 15416–2
General purpose **(GP)**	0,1[g]	X	X[c]	X[c]		X[a]
	0,5			X	X	
	1,0	X				
Finger joint **(FJ)**	0,1[g]	X[b]	X[b,c,f]	X[c]		X[a]
	0,3	X[b]				
Gap filling **(GF)**	0,1[g]	X	X			X[e]
	0,5			X	X	
	1,0	X				
	2,0	X	X	X[d]		

[a] For type I adhesive at 70 °C or 90 °C. The test is not required for adhesive type II. When tested at 90 °C, the adhesive will also automatically pass 70 °C. Phenolic resin (PRF) adhesives do not need to be tested.

[b] For separate application of adhesive and hardener for finger jointing, to be tested with nominal ratio ± 30 % mass fraction of hardener. Before approval of the adhesive an additional type testing in a production line shall be performed, see 5.7. A wider span is allowable.

[c] For separate application of adhesive and hardener for face lamination or finger jointing additional test with separate spread of adhesive and hardener is required.

[d] Using beech wood, see EN 15425:2008, 5.4.

[e] GF adhesives are only to be tested at 90 °C.

[f] Only with min. assembly time.

[g] As defined in 3.9, close contact.

5 Requirements

5.1 General

Adhesives complying with this European Standard shall meet the performance requirements specified in 5.2 to 5.7 when tested in accordance with the following test methods:

a) The tensile shear test (see 5.2 and EN 302-1) using bonded test pieces made from beech (*Fagus sylvatica* L.).

b) The delamination test (see 5.3 and EN 302-2) on bonded test pieces made from Norway spruce (*Picea abies* L.). The test with Norway spruce also covers the approval of silver fir (*Abies alba*) and Scots pine (*Pinus sylvestris*). If the adhesive is to be used on wood from other conifers species like larch (*Larix decidua*), Douglas fir (*Pseudotsuga menziesii*) and pines with coloured heartwood (other than Scots pine (*Pinus sylvestris*)), from hardwood species and/or preservative treated wood, also prepare four laminated members using representative samples from using wood with mean density.

c) The fibre damage test (see 5.4 and EN 302-3) on bonded test pieces made from Norway spruce (*Picea abies* L.). For gap filling adhesives (GF), the test pieces are made from beech (*Fagus sylvatica* L). See 5.4.

d) The shrinkage stress test (see 5.5 and EN 302-4) on bonded test pieces made from Norway spruce (*Picea abies* L.)

e) The static load test (see 5.6 and EN 15416-2) on bonded test pieces made from beech (*Fagus sylvatica* L).

f) The type testing of separate application finger joint adhesive (see 5.7) to be tested on finger jointed wood with minimum dimension of 40 mm x 170 mm.

All these tests are to be carried out with ready for use glue mixes, i.e. adhesive and hardener mixed just before application. The adhesive shall be applied according to the manufacturer's instructions.

In the case of separate application of adhesive and hardener, the delamination test (EN 302-2) and the fibre damage test (EN 302-3) shall in addition be performed with separate spread of adhesive and hardener.

For small modifications of already approved adhesives, the only additional tests required are those specified in Table 3. The tests shall be as specified in Table 2.

Table 3 — Additional tests for small modifications of approved adhesives

Test method	**Glue line thickness** mm	**Sample production**	**Modification of approved adhesive**		
			Adding of max. 5 % water for bonding finger joints	**Adding of max. 2,5 % colour for bonding finger joints or laminations**	**Change in hardener dosage of max. ± 5 % hardener**
EN 302–1	0,1 1,0	Mixed	X	X X[c]	X X
EN 302–2	0,1	Mixed/separate[a]	X		X
EN 302–3	0,5	Mixed/separate[b]			X

[a] According to application area.

[b] For separate application use 0,1 mm thick glue line.

[c] Only 0,3 mm thick glue line for Finger jointing adhesives (**FJ**).

5.2 Tensile shear test

Mean tensile shear strengths (N/mm^2), measured in accordance with EN 302-1, of close contact glue lines and thick glue lines in beech test pieces treated as specified in EN 302-1 shall be not less than those given in Table 4.

Table 4 — Minimum mean tensile shear failing strengths for close contact and gap joints on beech test pieces (in N/mm^2)

Treatment	Close contact glue line		Thick glue line 0,3 mm		Thick glue line 1,0 mm		Thick glue line 2,0 mm
Serial no	Type I	Type II	Type I	Type II	Type I	Type II	Type I
A1	10,0	10,0	9,5	9,5	8,0	8,0	6,0
A2	6,0	6,0	5,5	5,5	4,0	4,0	3,0
A3	8,0	8,0	7,6	7,6	6,4	6,4	4,8
A4	6,0	—[a]	5,5	—[a]	4,0	—[a]	3,0
A5	8,0	—[a]	7,6	—[a]	6,4	—[a]	4,8
[a] Not required.							

5.3 Delamination test

The resistance to delamination of bonded laminated specimens determined by the test method in EN 302-2 shall be as given in Table 5.

Table 5 — Requirements for resistance to delamination in %

Conditioning treatment	Adhesive type	Maximum delamination in any specimen %
High temperature treatment	I	5,0
Low temperature treatment	II	10,0

These values are also valid for 2 mm thick glue lines.

In the case of specific hardwood species[1)], the following provisions apply:

— the test shall be performed with the lamination and glulam cross-section and sawing patterns of the laminations conforming to the maximum sizes and the laminations sawing patterns used in the respective product;

— the maximum delamination shall be less than or equal to 8 % for adhesive type I. The maximum delamination shall be less than or equal to 12 % for adhesive type II.

5.4 Fibre damage test

The requirement established for the acid fibre damage test (below) shall only apply if either

a) the adhesive mixture, or

b) one of the adhesive components when applied separately

shows a pH value lower than 3,0 (lower than 2,0 when formic acid is the hardener) as determined by EN 1245.

1) Oak (Quercus robur, Quercus petrea, Quercus alba) with a mean density of less than 830 kg/m^3. Other wood species can be added when sufficient experience is available.

If an adhesive is intended to be used with different application resin – hardener – ratios, the test according to EN 302-3 only needs to be performed with the resin-hardener-ratio resulting in the lowest pH-value.

The mean tensile transverse strength of the untreated control pieces made from Norway spruce determined by the method in EN 302-3 shall be not less than 2 N/mm^2. The mean tensile transverse strength of untreated control pieces made from beech (gap filling adhesive) shall be not less than 5 N/mm^2.

The mean tensile transverse strength of the test joints after exposure to the cyclic treatment specified in EN 302-3 shall be not less than 80 % of the average value obtained for the control pieces.

5.5 Shrinkage test

The mean compressive shear strength after the shrinkage test, as determined by the method in EN 302-4, shall be not less than 1,5 N/mm^2.

This test is not required for finger jointing adhesive (**FJ**).

5.6 Static load test

The mean creep deformation of the glue lines in each of the test samples, as determined by the method in EN 15416-2:2007, shall not exceed 0,05 mm after the test.

When tested in accordance with EN 15416-2, not more than one of the six samples are allowed to fail during the test period.

For adhesives in the **I90** classes with maximum temperature of 90 °C in Table 1, the test climate no 1 in EN 15416-2:2007, 6.2 shall be 90 °C.

5.7 Type testing of separate application finger joint adhesive

After the laboratory testing has been fulfilled, the adhesive shall be controlled for curing in a full-scale production unit. The test procedure for ensuring a sufficient curing of the glue line in the finger joint shall be as given below:

1) Prepare 40 test pieces for bending test in accordance with EN 408, 20 finger-jointed specimens produced with the minimum resin-hardener- ratio and 20 finger jointed specimens produced with the maximum resin-hardener-ratio. The strength of the finger joints tested shall be equal to or greater than the characteristic bending strength of the unjointed timber.

2) Prepare 10 test pieces with the nominal ratio of adhesive and hardener for delamination test as described in Annex A (one cycle consisting of 6 h immersed in boiling water and dried for 18 h at 60 °C to a moisture content of u < 19 %.) The average delamination of the finger joints shall be less than 10 % and single values shall be lower than 15 %.

6 Working properties of the adhesive

6.1 General

The working properties to be determined are given in the relevant product standards.

6.2 Physical properties of adhesive prepared for use

6.2.1 Dynamic viscosity of the adhesive as prepared for use is determined by EN 12092.

6.2.2 pH of the adhesive mix and/or of the adhesive and the hardener is determined by EN 1245.

6.3 Use of the adhesive

In some member states, it may be required to determine:

a) adhesive spread and instructions on whether or not the adhesive has to be spread on both surfaces to be bonded, and if the components are applied separately or not;

b) maximum assembly time under referenced conditions, according to EN 302-5 [1], expressed in minutes;

c) working life under referenced conditions according to EN 302-7 [3], expressed in hours;

d) minimum pressing time under referenced conditions according to EN 302-6 [2], expressed in hours;

e) minimum, maximum and recommended temperatures for spreading and curing;

f) minimum pressure value.

Annex A
(normative)

Delamination test for finger joints with separate spread of adhesive and hardener

A.1 Production of the specimens

The finger joints shall be produced in accordance with EN 14080.

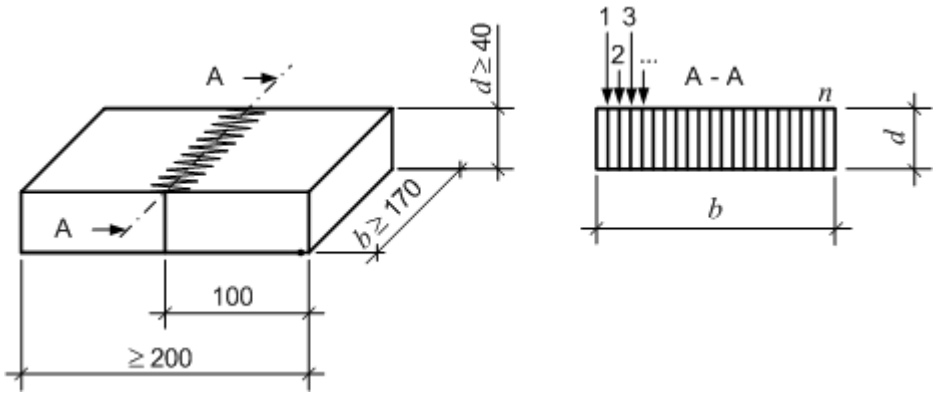
The finger length shall be less than 25 mm.

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/m^3.

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 7 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 millimetres), is part of the specimens and that the joint becomes visible at the end grain of the cross cut (see Figure A.1).

Dimensions in millimetres



a) Dimensions b) Numbering of finger tips

Key

1, 2, 3 number of finger tip

Figure A.1 — Specimens for delamination tests with finger joints in laminations

A.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 $l$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 in a drying duct at a temperature of (60 ± 3) °C to a moisture content of u < 19 %, but at least for 18 h.

Bibliography

[1] EN 302-5, *Adhesives for load-bearing structures - Test methods - Part 5: Determination of maximum assembly time under referenced conditions*

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

[3] EN 302-7, *Adhesives for load-bearing timber structures - Test methods - Part 7: Determination of the working life under referenced conditions*

[4] EN 391, *Glued laminated timber - Delamination test of glue lines*

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