BS EN 15416-1:2017

BSI Standards Publication

Adhesives for load bearing timber structures other than phenolic and aminoplastic — Test methods

Part 1: Long-term tension load test perpendicular to the bond line at varying climate conditions with specimens perpendicular to the glue line (Glass house test)

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National foreword

This British Standard is the UK implementation of EN 15416-1:2017.

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.

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Date	Text affected

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English Version

Adhesives for load bearing timber structures other than phenolic and aminoplastic - Test methods - Part 1: Long-term tension load test perpendicular to the bond line at varying climate conditions with specimens perpendicular to the glue line (Glass house test)

Adhésifs pour structures portantes en bois de type autre que phénolique et aminoplaste - Méthodes d"essais - Partie 1 : Essai de charge soutenue à long terme dans des conditions climatiques cycliques avec des éprouvettes chargées perpendiculairement au joint de colle (essai de la serre)

Klebstoffe für tragende Holzbauteile ausgenommen Phenolharzklebstoffe und Aminoplaste - Prüfverfahren - Teil 1: Langzeit-Zugprüfung senkrecht zur Klebfuge bei verschiedenen Klimabedingungen mit Prüfkörpern senkrecht zur Klebstofffuge (Glashaus-Prüfung)

This European Standard was approved by CEN on 30 October 2016.

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European foreword

This document (EN 15416-1:2017) 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of an identical text or by endorsement, at the latest by July 2017, and conflicting national standards shall be withdrawn at the latest by July 2017.

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

This document is intended to harmonize the provisions in EN 14080:2013, B.2, EN 15497:2014 and EN 16254:2013+A1:2016, Annex B and EN 16351. It differs with respect to the following:

a) consistent specification of the test method for the determination of the long-term performance at varying climate conditions in one standard;

b) reference to EN 16254 for EPI adhesives added in the scope;

c) Figure 1 and Figure 2 for connection device added;

d) alternative cutting scheme of the components of the test sticks presented in Figure 4.

This document is one of a series dealing with adhesives for use with timber structures, and is published in support of product standards for bonded load-bearing timber structures.

The series consists of three classification and performance requirements for adhesives for load-bearing timber structures, phenolic and aminoplastic adhesives (EN 301), one component polyurethane adhesives (EN 15425) and emulsion polymerized isocyanate adhesives (EN 16254), together with 12 test methods (EN 302 Parts 1 to 8 and EN 15416 Parts 1 and 3 to 5).

These European Standards have the following titles:

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

EN 15425, *Adhesives — One component polyurethane (PUR) for load-bearing timber structures - Classification and performance requirements*

EN 16254, *Adhesives — Emulsion polymerized isocyanate (EPI) for load-bearing timber structures — Classification and performance requirements*

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

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

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

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

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

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

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

EN 302-8, *Adhesives for load-bearing timber structures — Test methods — Part 8: Static load test of multiple bond line specimens in compression shea*r

EN 15416-1, A*dhesives for load bearing timber structures other than phenolic and aminoplastic — Test methods — Part 1: Long-term tension load test perpendicular to the bond line at varying climate conditions with specimens perpendicular to the glue line (Glass house test)*

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 15416-4, *Adhesives for load bearing timber structures other than phenolic and aminoplastic — Test methods — Part 4: Determination of open assembly time under referenced conditions*

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

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Introduction

Safety statement

Persons using this European Standard should be familiar with the normal laboratory practice, if applicable. This European Standard cannot 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.

Environmental statement

It is understood that some of the material permitted in this European Standard may have negative environmental impact. As technological advantages lead to better alternatives for these materials, they will be eliminated from this European Standard to the extent possible.

At the end of the test, it is recommended that the user of this European Standard take care to carry out an appropriate disposal of the wastes, according to local regulation.

1 Scope

This European Standard specifies a method of determining the ability of adhesive bonds to resist long-term sustained load applied vertical to the glue lines. It is applicable to adhesives used in load-bearing timber structures.

It is suitable for the following applications:

a) for assessing the compliance of adhesives according to EN 15425 and EN 16254;

b) for assessing the suitability and quality of adhesives for load-bearing timber structures;

c) for assessing the effect on the bond strength resulting from long-term sustained load at cyclic climate conditions.

This method is intended primarily to obtain performance data for the classification of adhesives for load bearing timber structures according to their suitability for use in defined climatic environments.

This method is not intended to provide data for structural design, and does not necessarily represent the performance of the bonded member in service.

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

3 Principle

Bonded test pieces are subjected to long-term sustained load applied vertical to the glue lines at cyclic climate conditions. The test climate is at natural outdoor conditions in Europe between latitude 45° and 60°. The loaded samples are protected with light penetrable covering (“Glass house”).

4 Apparatus

4.1 House for weather exposure

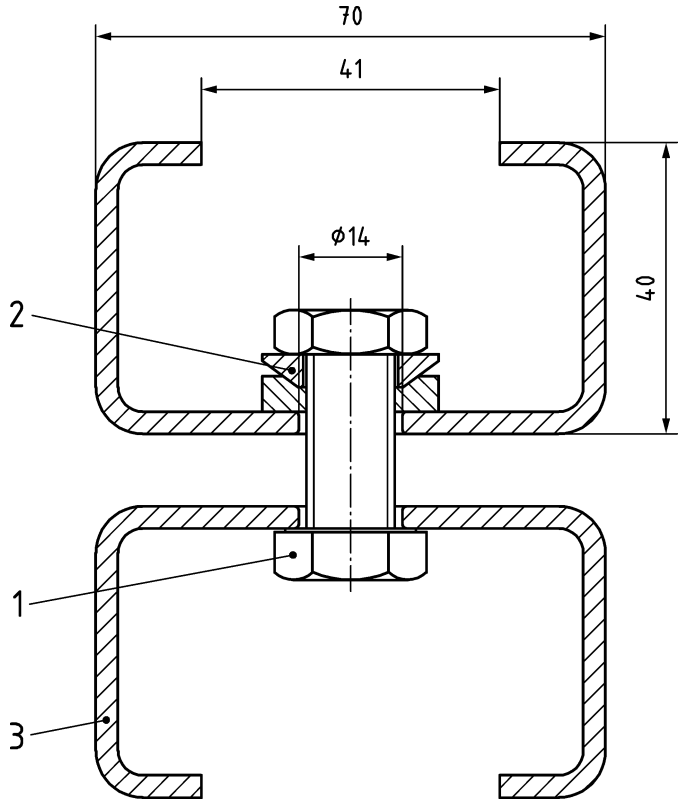
The weather exposure shall take place in a natural ventilated house covered with a light penetrating material where the air can circulate through openings along the floor and the roof.

4.2 Test jig

The 10 samples, making a test set for each of the 3 duration of load times, shall be placed in a suitable test jig and loaded with a transverse tensile load according to 5.5.1. The test jigs shall enable a smooth loading of the test pieces. The individual samples shall be free to rotate to secure that the load will be applied 90° to the glue lines.

NOTE Test jigs with a hanging dead load for the load application in combination with a vertical loading of the individual specimens using a principle as visualized in Figure 1 and Figure 2, has shown to be a suitable method.

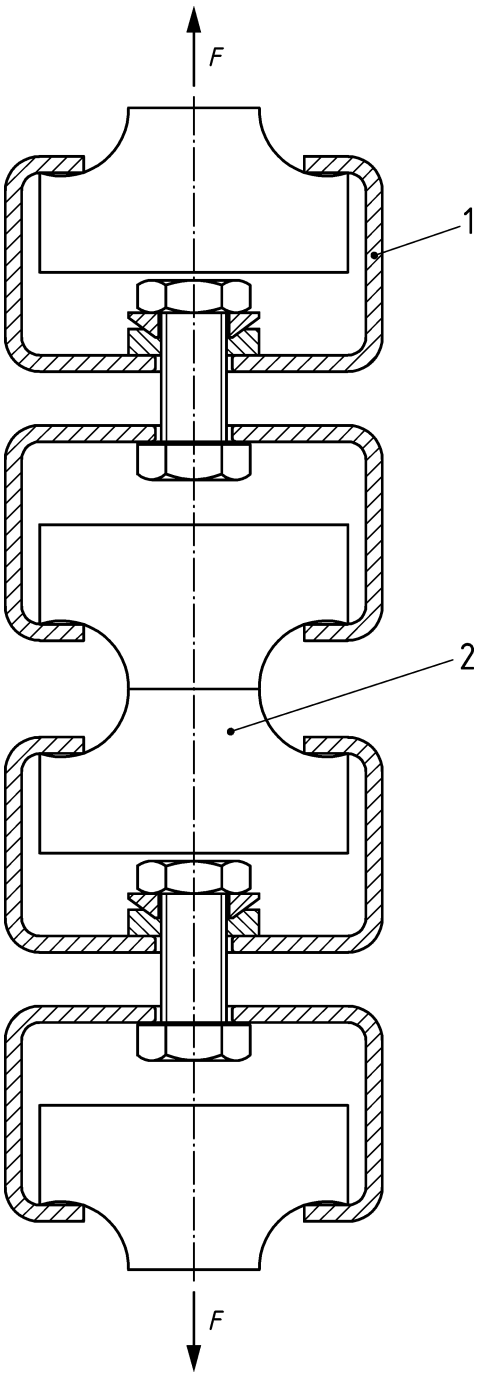
Dimensions in millimetres



Key

1 screw M12x30
2 spherical washers, conical seats (DIN 6319)
3 connection device 70 mm × 40 mm; length 50 mm

Figure 1 — Example of connection device between two specimens



Key

1 connection device
2 loaded test piece
F load

Figure 2 — Specimen mounted in the connection device

4.3 Testing machine

The test machine shall be identical with the equipment described in EN 302-3.

5 Method

5.1 General

The specimens shall be produced following EN 302-3, but with specimens made from untreated beech wood (*Fagus sylvatica* L.) with close contact and 0,5 mm thick glue line for application areas "Special purpose" and "General purpose", and a close contact glue line for application area "Finger joints".

5.2 Selection of timber

The beech wood boards from which the specimens are cut shall be free from knots, straight grained and shall have a density of (700 ± 50) kg/m^3 at 12 % moisture content. The timber prior to specimen manufacture shall be conditioned in a climate chamber at storage conditions of (20 ± 2) °C and (65 ± 5) % relative humidity (hereafter climate [20/65]). The moisture content shall be (12 ± 1) %.

Each beech wood board shall have a width of at least 150 mm, a length of at least 750 mm and a thickness of at least 35 mm, and shall be used to manufacture one test stick as shown in Figure 3, a) and b). The annual ring orientation of both components glued together shall be roughly co-linear and with an angle of the growth rings in the range of 30° and 60°.

5.3 Production of the test sticks

In total, 5 sticks with a cross section of 50 mm × 60 mm (after bonding and final preparation) and a length of at least 700 mm, enabling the cutting of 8 test specimens and 2 spare specimens from each stick of the specimen type described in EN 302-3, shall be manufactured for each glue line thickness.

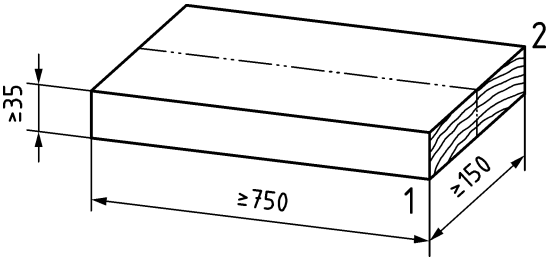
Alternatively, longer sticks can be pre-assembled into sub-sections of at least 300 mm prior to bonding, providing sufficient matched samples for cutting the required number of specimens.

Not more than 8 h before the bonding, the boards are planned to their final thickness. For test pieces with a 0,5 mm thick glue line, each stick is prepared in an appropriate manner to ensure that the correct glue line thickness is achieved and to ensure that there is no loss of adhesive during the bonding of the test sticks.

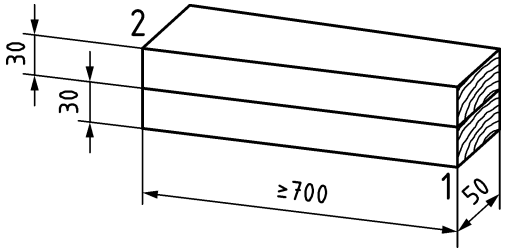
The manufacture and build-up of the test sticks shall in principle follow the scheme shown in Figure 3, a) and b). The adhesive shall be used in accordance with the recommendations of the adhesive manufacturer.

An alternative way is to use radial/semi radial cut boards with the correct annual ring angle (30° to 60°), split it and make test sticks with the annual rings roughly co-linear as shown in Figure 4, a) and b).

Dimensions in millimetres



a) Dimensions before cutting and planning



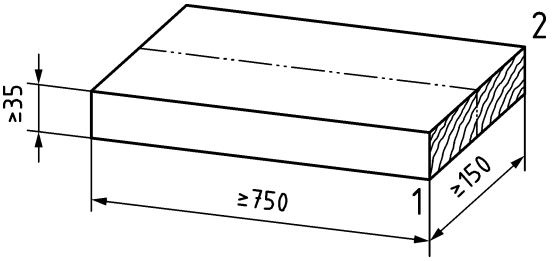
b) Final dimensions after bonding and planning

Key

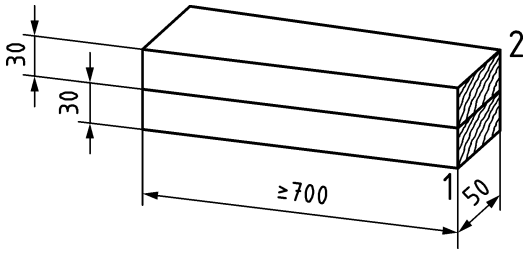
1 and 2 position of corners during specimen preparation

Figure 3 — Cutting scheme of the components of the test sticks

Dimensions in millimetres



a) Dimensions before cutting and planning



b) Final dimensions after bonding and planning

Key

1 and 2 position of corners during specimen preparation

Figure 4 — Alternative cutting scheme of the components of the test sticks

5.4 Cutting of the test pieces and build-up of the test batches

Cutting to single test specimens shall be done at the earliest 7 days after the bonding. The 10 specimens for each group of test pieces are made up of two specimens from each stick/group of sub-sections. Figure 5 gives an overview of the 10 specimens derived from each stick/group of subsections for the determination of the tensile strength perpendicular to the glue line.

NOTE For details of cutting, see EN 302–3:2013, Clause 5 and Figure 2.

Dimensions in millimetres

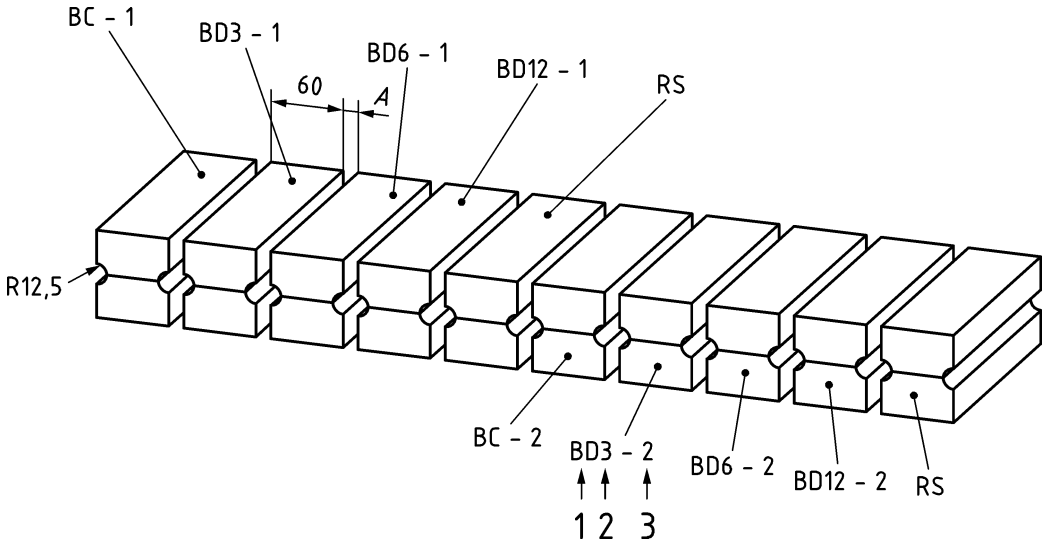


Figure 5 — Cutting scheme for test stick and numbering of specimens

5.5 Test procedures

5.5.1 General

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 14 days of conditioning in climate [20/65] subsequent to gluing;

b) long-term testing of 3 batches (BD3, BD6 and BD12), each consisting of 10 specimens. Each batch shall be subjected to a different duration of load time being 3 months (BD3), 6 months (BD6) and 12 months (BD12). 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 unloaded, reconditioned in climate [20/65] and then tested for residual tensile strength perpendicular to the glue line in ramp loading.

The applied load shall be (1 250 ± 10) N, leading to a constant nominal stress level of 1,0 N/mm^2 for the duration of load tests. The load is related to a net cross section of 25 mm × 50 mm.

Check at least once a week for collapsed test pieces. If a failure occurred, the remaining test pieces have to be reloaded as soon as possible. In case of failures, prevent damage on the remaining specimens by the use of appropriate devices.

5.5.2 Climate for duration of load tests

The climate for the duration of load tests shall be at natural outdoor conditions in Europe between latitude 45° and 60° with the samples and the test jigs being protected with light penetrable covering.

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) °C with (90 ± 5) % relative humidity, and (35 ± 2) °C with (40 ± 5) % relative humidity.

5.5.3 Tensile test procedure

5.5.3.1 Control batch

The specimens are tested after 14 days of conditioning in climate [20/65] subsequent to gluing. The ramp loading is performed with a constant speed of loading of 3 mm/min.

5.5.3.2 Long-term loaded test batches

After unloading, the specimens tested for residual strength after long-term loading (BD3, BD6 and BD12) shall be conditioned at least for 3 weeks in climate [20/65] before ramp loading. The ramp loading is performed with a constant speed of loading of 3 mm/min.

6 Expression of results

Calculate the transverse tensile strength for every tested test piece according to the following formula:

$$f_{t,90,max} = \frac{F_{max}}{A} \quad (1)$$

where

$f_{t,90,max}$ is the transverse tensile strength in Newtons per square millimetre (N/mm^2);

F_{max} is the load at failure in Newtons (N);

A is the area in square millimetres, (1 250 mm^2).

Express the results for each series, BC, BD3, BD6 and BD12, as the average transverse testing strength (arithmetic mean).

The failure types A, B and C shall be described as follows:

— A: solid wood failure;

— B: failure along the glue line, with a fine cover of fibres visible in the failure zone;

— C: failure in or along the glue line, without a fine cover of fibres visible in the failure zone.

For each sample, failure type A, B and C shall be estimated and rounded off to the nearest 10 %, summing up to a total of 100 % (for example 70 % failure type A, 20 % failure type B and 10 % failure type C).

7 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 months, 6 months and 12 months of duration of load shall not be less than 5 N/mm^2.

In each batch, BD3, BD6 or BD12, only one specimen may fail within each of the respective load duration periods. In this case, the mean value of the residual strength of the respective batch shall be calculated from the remaining 9 specimens.

8 Test report

The test report shall include, at least, the following:

a) date of reporting;

b) statement that the test was carried out in accordance with this European Standard;

c) manufacturer's name and the chemical nature and origin of the sample of adhesive tested;

d) density of wood at 12 % moisture content in kilograms per cubic metre (kg/m^3);

e) application and bonding conditions used for the laminations including date of gluing and test piece preparation;

f) glue line thickness in finished laminations;

g) start and end date of the period of duration of load for each long-term exposed test series;

h) records of existing climate for each long-term exposed test series;

i) date of test piece preparation and testing;

j) tensile strength for each individual test piece, and average transverse tensile strength expressed in Newtons per square millimetre (N/mm^2) and rounded to the nearest 0,1 N/mm^2 for both control and climatically cycled test pieces. Every single test piece shall be recorded;

k) type of failure (type A, B and C) for each test piece, and the average of the estimated proportions of each failure type, rounded to the nearest 10 %;

l) any other factors that may have affected the results.

Bibliography

[1] EN 923:2015, *Adhesives — Terms and definitions*

[2] EN 15425, *Adhesives - One component polyurethane (PUR) for load-bearing timber structures — Classification and performance requirements*

[3] EN 16254, *Adhesives — Emulsion polymerized isocyanate (EPI) for load-bearing timber structures — Classification and performance requirements*

[4] DIN 6319, *Spherical washers, conical seats*

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