BS EN 15416-3:2017

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 15416-3:2017. It supersedes BS EN 15416-3:2007+A1:2010 which is withdrawn.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.

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English Version

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

Adhésifs pour structures portantes en bois de type autre que phénolique et aminoplaste - Méthodes d'essais - Partie 3 : Essai de déformation par fluage dans des conditions climatiques cycliques avec des éprouvettes chargées en cisaillement par flexion

Klebstoffe für tragende Holzbauteile ausgenommen Phenolharzklebstoffe und Aminoplaste - Prüfverfahren - Teil 3: Prüfung der Kriechverformung unter zyklischen Klimabedingungen an Prüfkörpern bei Biege-Scherbeanspruchung

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

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 15416-3:2017) 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of an identical text or by endorsement, at the latest by July 2017, and conflicting national standards shall be withdrawn at the latest by July 2017.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 supersedes EN 15416-3:2007+A1:2010.

Compared to EN 15416-3:2007+A1:2010, the following main modifications have been made:

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

b) glue line thickness to be used will be taken from EN 15425 or EN 16254;

c) alternative way of making the test pieces is given in 6.2 and 6.3;

d) possibility to use other climatic conditions as given in 7.1, Table 1 has been deleted;

e) loads have been given a tolerance of ± 50 N in 7.1;

f) duration times can be found in EN 15425 or in EN 16254;

g) measurement of the glue line thickness in the test piece has been introduced.

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, *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 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 shear*

— EN 15416-1, *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)*

— 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*

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

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 for determining the creep deformation of bonded specimens loaded in bending shear. 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 to EN 15425 and EN 16254;

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

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

EN 923:2015, *Adhesives — Terms and definitions*

EN 15425:2017, *Adhesives — One component polyurethane (PUR) for load-bearing timber structures — Classification and performance requirements*

EN 16254:2013+A1:2016, *Adhesives — Emulsion polymerized isocyanate (EPI) 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 923:2015 and the following apply.

3.1
relative creep value
$k_{\mathrm{def}}(t)$
time-dependent increase of the deformation of one specimen

Note 1 to entry: By means of the deflection $w(t)$ and the initial deflection $w(0)$, the relative creep value is calculated using Formula (1).

$$k_{\mathrm{def}}(t)=\frac{w(t)}{w(0)} \tag{1}$$

where

$w(t)$ is the deflection at time t;

$w(0)$ is the initial deflection immediately after initial loading, measured 1 min after the loading of the individual specimen;

$k_{\mathrm{def}}(t)$ is the relative creep value.

3.2
ratio of relative creep
$Rc_{\mathrm{i}}(t)$
ratio of the relative creep values $k_{\mathrm{def}}(t)$ of two matched specimens, *tested adhesive, i* and *PRF, i*, at time t

Note 1 to entry: By means of $k_{\mathrm{def}}(t)$, *tested adhesive, i* and $k_{\mathrm{def}}(t)$, *PRF, i* within one pair of matched bending specimens, *i*, the ratio of relative creep is calculated using Formula (2).

$$Rc_{\mathrm{i}}(t) = \frac{k_{\mathrm{def}}(t), tested\,adhesive, i}{k_{\mathrm{def}}(t),\ PRF, i} \tag{2}$$

where

$k_{\mathrm{def}}(t)$, *tested adhesive, i* is the relative creep value of the respective tested adhesive sample *i*;

$k_{\mathrm{def}}(t)$, *PRF, i* is the relative creep value of the respective phenolic-resorcinol (PRF) - sample *i;*

$Rc_{\mathrm{i}}(t)$ is the ratio of relative creep of matched pair of bending specimens *i*.

4 Principle

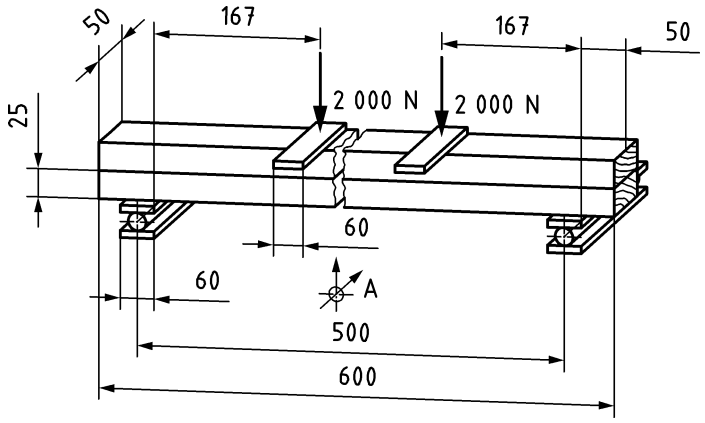
Bending specimens of a constant cross-section are subjected to constant load at cyclically varying climate conditions. Specimens bonded with the adhesive to be tested are compared with specimens bonded with a PRF-adhesive conforming to the requirement of adhesive type GP-I-M as specified in EN 301.

5 Apparatus

5.1 Test jig

A test jig being capable of applying a load of (2 000 ± 50) N in each loading point. The loading principle is shown in Figure 1.

Dimensions in millimetres



Key

A measuring gauge for the measuring of the deflection of the specimen

Figure 1 — Loading principle for the creep deformation test

5.2 Climate chamber

A climate chamber capable of maintaining the two test climates (20 ± 2) °C and (85 ± 5) % RH and (45 ± 2) °C and (40 ± 5) % RH. The climate chamber shall be capable of alternating between the two test climates in 10 h.

5.3 Measuring gauge

A measuring gauge enabling readings of the deflection of the specimens with an accuracy of 0,01 mm, see Figure 1.

6 Preparation of specimens

6.1 General

Five boards of straight grained, defect-free Norway spruce (*Picea abies* L.) of density (450 ± 25) kg/m^3 at 12 % moisture content shall be used to manufacture a total of 5 pairs of matched bending specimens with glue line thickness according to EN 15425:2017, Table 2 or to EN 16254:2013+A1:2016, Table 2.

6.2 Option 1

Each board shall have a width of at least 150 mm, a length of at least 1 260 mm and a thickness of at least 33 mm, and shall be used to manufacture one pair of 2 matched bending specimens according to the scheme shown in Figure 2.

Each of the 2 matched bending specimens consists of 2 boards of equal sizes. Each board shall have a thickness in the bond line area of (25,0 ± 0,1) mm after final preparation, a width of at least 75 mm before the bonding and a length of at least 625 mm before the bonding, with an angle of the growth rings between 30° and 60° (in relation to the surface to be bonded).

Not more than 24 h before the bonding, the boards are planed to their final thickness and one of the two boards of each specimen is prepared at the periphery 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 specimen.

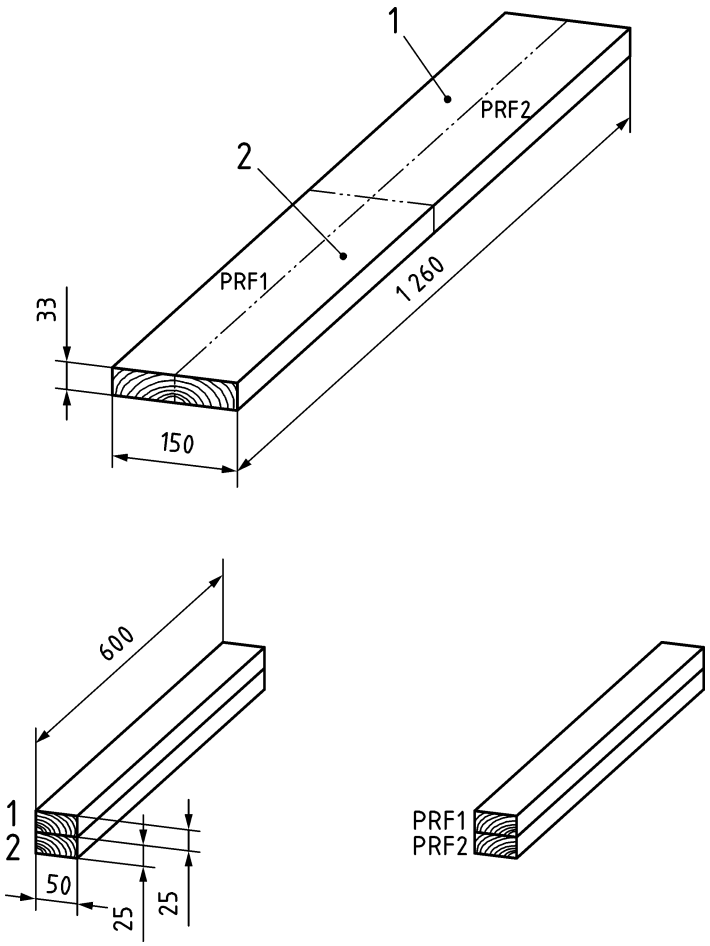
NOTE The use of a 0,2 mm thick cardboard spacer frame with a width of maximum 10 mm bonded on a planed board with the final thickness of (25 ± 0,1) mm, or milling a 60 mm wide groove with a depth of (0,2 ± 0,1) mm into a (25,2 ± 0,1) mm thick, planed board, have shown to be suitable methods for the production of samples with a glue line thickness of (0,3 ± 0,1) mm.

Each specimen is glued from the two boards with an orientation of the growth rings as shown in Figure 2. One specimen of the pair shall be glued with the adhesive tested for assessment and the other specimen of the pair shall be glued with an adhesive of thermosetting phenolic-resorcinol type conforming to the requirements for an adhesive of type GP-I-M as specified in EN 301. The adhesives shall be used in accordance with the recommendations of the adhesive manufacturer.

After pressing and curing for at least seven days in standard climate (20 ± 2) °C and (65 ± 5) % RH, the specimens are planed to final width of (50 ± 0,1) mm and cut to final length of (600 ± 1,0) mm, ensuring that the prepared periphery is cut off completely from the test specimen, so that the specimen has a constant glue line thickness as required. The thickness of the specimens shall not be changed after bonding.

Measure and record the glue line thickness at all 4 loading points on each side of the specimen. The glue line thickness shall be checked with a magnifying glass with which the glue line thickness can be determined with an accuracy of 10 %.

Dimensions in millimetres



Key

1 and 2	wood members used for the adhesive to be tested
PRF1 and PRF2	wood members used for the PRF reference adhesive

Figure 2 — Cutting scheme and build-up of matched pair of bending shear specimens

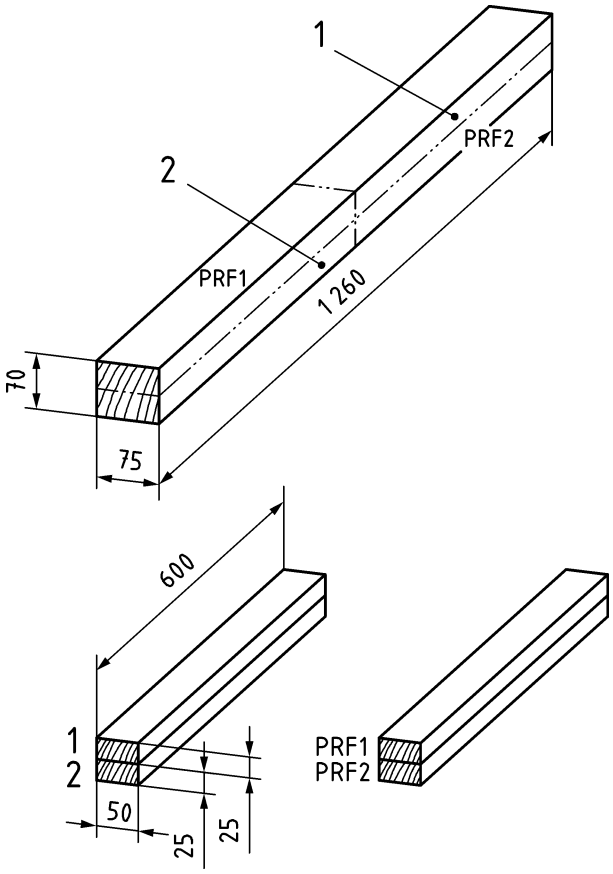
6.3 Option 2

The used board shall have a width of at least 75 mm, a length of at least 1 260 mm and a thickness of at least 70 mm, and shall be used to manufacture one pair of 2 matched bending specimens according to the scheme shown in Figure 3.

The board shall be split in the height into two parts, each with a cross section of at least 33 mm × 75 mm. Each of the 2 matched bending specimens consists of 2 boards of equal sizes. Each board shall have a thickness in the bond line area of (25,0 ± 0,1) mm after final preparation, a width of at least 70 mm and a length of at least 625 mm before the bonding, with an angle of the growth rings between 30° and 60° (in relation to the surface to be bonded).

For the rest of the preparation, the procedure described in option 1 shall be followed.

Dimensions in millimetres



Key

1 and 2	wood members used for the adhesive to be tested
PRF1 and PRF2	wood members used for the PRF reference adhesive

Figure 3 — Cutting scheme and build-up of matched pair of bending shear specimens

7 Test procedure, evaluation and expression of results

7.1 Test procedure

The creep deformation test shall be performed as four point bending tests with the loads applied at a distance of one third of the span of 500 mm from the supports, see Figure 1. Each of the two loads shall be (2 000 ± 50) N. The loading shall be applied symmetrically with respect to mid-span. The loading

procedure shall be smooth and no impact loading shall occur. The bearing lengths at the supports and at the load application points shall be 60 mm and the bearing width shall be at least 50 mm. This loading results in a maximum bending stress level of 16 N/mm^2 and a maximum shear stress level of 1,2 N/mm^2.

The specimens shall be subjected to a cyclic stepped climate as shown in Table 1, alternating repeatedly between a constant climate of (20 ± 2) °C and (85 ± 5) % RH, followed by a climate of (45 ± 2) °C and (40 ± 5) % RH. Each climate step shall last for 1 week; the test shall start with a climate (20 ± 2) °C and (85 ± 5) % RH.

Table 1 — Cyclic stepped climate

Climate step	**Temperature**	**Relative humidity**	**Duration of climate step**
No.	°C	%	h
1	(20 ± 2)	(85 ± 5)	168
2	(45 ± 2)	(40 ± 5)	168

The mid-span deflection of each bending specimen shall be recorded at the bending tension edge in the middle of the width of the test piece.

The employed dial gauges shall enable readings to 0,01 mm. The initial deflection shall be recorded 1 min after the loading of each sample and subsequently at least once every week at the end of each climate step.

The loading shall be sustained for a loading period as described in EN 15425 (PUR adhesives) or EN 16254 (EPI adhesives).

If the specified ratio of relative creep requirement given in EN 15425 or in EN 16254 is fulfilled for the short loading period, the test is completed.

In case the specified ratio of relative creep requirement given in EN 15425 or EN 16254 is not met for the short loading period, the loading shall continue as described in the respective standard.

7.2 Evaluation and expression of results

For each specimen, the initial deflection (measured 1 min after loading) is denoted by $w(0)$, the deflections at times t expressed in 0,01 mm are denoted by $w(t)$. For each specimen and deflection recording the relative creep value $k_{\mathrm{def}}(t)$ shall be calculated according to Formula (3):

$$k_{\mathrm{def}}(t)=\frac{w(t)}{w(0)} \tag{3}$$

To take into consideration changes in deflection due to the cycling of the climate, the final value $k_{\mathrm{def}}(final)$ at the end of the duration time shall be calculated for each specimen as the mean value of the last two readings at the end of each climate condition according to Formula (4):

$$k_{\mathrm{def}}(final)==\frac{k_{\mathrm{def,\ climate\ 1}}(final)+k_{\mathrm{def,\ climate\ 2}}(final)}{2} \tag{4}$$

with

$$k_{\mathrm{def,\ climate\ 1}}(final)=\frac{k_{\mathrm{def,\ climate\ 1}}(last\ week)+k_{\mathrm{def,\ climate\ 1}}(last\ week-2 weeks)}{2} \tag{5}$$

$$k_{\text{def, climate 2}}\left(final\right)=\frac{k_{\text{def, climate 2}}\left(last\ week\right)+k_{\text{def, climate 2}}\left(last\ week-2 weeks\right)}{2} \quad (6)$$

where

climate 1 = (20 ± 2) °C and (85 ± 5) % RH;

climate 2 = (45 ± 2) °C and (40 ± 5) % RH.

Figures should be calculated to an accuracy of 0,01 scale-units and rounded to 0,01.

For each of the five pairs of matched bending specimens, the ratio of relative creep $Rc_{\text{i}}\left(t\right)$ as the ratio of the relative creep value k_{def} (*t*), *tested adhesive, i* of the specimen glued with the tested adhesive vs. the relative creep value k_{def} *(t), PRF, i* of the specimen glued with the PRF adhesive shall be determined according to Formula (7):

$$Rc_{\text{i}}\left(t\right)=\frac{k_{\text{def}}\left(t\right);tested\ adhesive,i}{k_{\text{def}}\left(t\right),PRF,i}\ \ i = 1.....5 \quad (7)$$

The average ratio of relative creep Rc_{mean} of all five matched pairs of bending specimen shall be evaluated at the end of the loading period (time *t*) as described in EN 15425 or EN 16254 according to Formula (8):

$$Rc_{\text{mean}}\left(t\right)=\frac{1}{5}\sum_{1}^{5}Rc_{\text{i}}\left(t\right) \quad (8)$$

8 Test report

The test report shall include the following information:

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

b) period of time during which the test was carried out and the date of the report;

c) chemical nature and origin of the sample of adhesive tested and information that the PRF-adhesive confirms with type GP-l-M according to EN 301;

d) manufacturer's name and batch number or other means of uniquely identifying the sample;

e) details of the preparation and method of application of the adhesive including date of gluing;

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

g) temperature, pressure and duration of pressure used to produce the test specimens;

h) average of glue line thickness measured per specimen;

i) results of the deflection measurements for each individual sample;

j) results for the relative creep values k_{def} (*t*) for each sample;

k) ratio of relative creep Rc_{i} for each pair of matched bending specimens and the mean ratio of relative creep Rc_{mean} at the end of the test period.

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