BS EN 302-4:2013

BSI Standards Publication

Adhesives for load-bearing timber structures — Test methods

Part 4: Determination of the effects of wood shrinkage on the shear strength

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National foreword

This British Standard is the UK implementation of EN 302-4:2013. It supersedes BS EN 302-4:2004, which is withdrawn.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.

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English Version

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

Adhésifs pour structures portantes en bois - Méthodes d'essai - Partie 4: Détermination de l'influence du retrait du bois sur la résistance au cisaillement

Klebstoffe für tragende Holzbauteile - Prüfverfahren - Teil 4: Bestimmung des Einflusses von Holzschwindung auf die Scherfestigkeit

This European Standard was approved by CEN on 5 February 2013.

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Contents

Page

Foreword

This document (EN 302-4:2013) 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of an identical text or by endorsement, at the latest by September 2013 and conflicting national standards shall be withdrawn at the latest by September 2013.

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

This document supersedes EN 302-4:2004.

The following modifications have been made:

— The wood density requirement for Norwegian spruce has been altered;

— A recommended time period is given for the dry storage treatment.

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 dealing with adhesives for use with timber structures, and is published in support of EN 1995, *Eurocode 5: Design of 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 polymerised isocyanate adhesives (prEN 16254), and all together eleven test methods (EN 302 Parts 1 to 7 and EN 15416 Parts 2 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 for load bearing timber structures — Classification and performance requirements*

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

EN 302, *Adhesives for load-bearing timber structures — Test methods*

— *Part 1: Determination of longitudinal tensile shear strength*

— *Part 2: Determination of resistance to delamination*

— *Part 3: Determination of the effect of acid damage to wood fibres by temperature and humidity cycling on the transverse tensile strength*

— *Part 4: Determination of the effects of wood shrinkage on the shear strength*

— *Part 5: Determination of maximum assembly time under referenced conditions*

— *Part 6: Determination of the minimum pressing time under referenced conditions*

— *Part 7: Determination of the working life under referenced conditions*

EN 15416, *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*

— *Part 3: Creep deformation test at cyclic climate conditions with specimens loaded in bending shear*

— *Part 4: Determination of open assembly time for one component polyurethane adhesives*

— *Part 5: Determination of conventional pressing time*

Safety statement

Persons using this document should be familiar with the normal laboratory practice, if applicable. This document 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 standard can have a negative environmental impact. As technological advantages lead to better alternatives for these materials, they will be eliminated from this standard to the greatest extent possible.

At the end of the test, it is recommended that the user of the standard take care to carry out an appropriate disposal of the wastes, according to local regulations.

1 Scope

This European Standard specifies a method for determining the influence of shear strength in crosswise gluing by wood shrinkage under drying conditions.

It is suitable for the following applications:

a) for assessing the compliance of adhesives with EN 301, EN 15425 and prEN 16254;

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

c) for determining if the adhesive is capable of withstanding stresses due to wood shrinkage without unacceptable loss of strength.

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 test is carried out on Norway spruce (*Picea abies* L.).

This method is not intended for use to provide numerical design data 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 13183-1, *Moisture content of a piece of sawn timber — Part 1: Determination by oven dry method*

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 6344-2, *Coated abrasives — Grain size analysis — Part 2: Determination of grain size distribution of macrogrits P12 to P220*

3 Principle

A crosswise double joint with 0,5 mm thick glue line is submitted to a dry storage treatment and then strained to failure by a compressive shear force.

4 Apparatus

4.1 Testing machine, which shall be either:

a) capable of maintaining a constant rate of loading of (20 ± 5) kN/min; or

b) capable of maintaining a constant crosshead speed as described in ISO 5893.

4.2 Climatic cabinets, which shall be capable of maintaining the bonded assemblies under the following conditions:

a) (40 ± 2) °C and a relative humidity of (30 ± 2) % and an air speed of (0,7 ± 0,15) m/s measured in the centre of an empty cabinet;

b) (20 ± 2) °C and a relative humidity of (65 ± 5) %;

c) (20 ± 2) °C and a relative humidity of (75 to 80) %.

5 Method

5.1 General

5.1.1 Selection of timber

Use Norway spruce (*Picea abies* L.) having a density of (450 ± 25) kg/m³ measured at 12 % moisture content as determined by oven drying (according to EN 13183-1).

5.1.2 Preparation of cover pieces

From three boards with a length of at least 1 200 mm, prepare three pairs of solid Norway spruce cover pieces that are knot-free, straight grained with growth rings that are approximately tangential to the face and have a radius of 60 mm to 140 mm. The cover pieces shall be

a) 400 mm in length,

b) 140 mm in width, and

c) (20 ± 0,5) mm in thickness

after conditioning, measurement of moisture content (oven dry method according to EN 13183-1) and final preparation. Each matching pair of cover pieces is intended for the production of a specimen.

5.1.3 Preparation of core pieces

Prepare three laminated spruce core pieces that are knot-free, straight-grained and with annual rings at an angle of 35° to 55° relative to the surface (see Figure 1). The dimensions of the core pieces shall be

a) 400 mm in length,

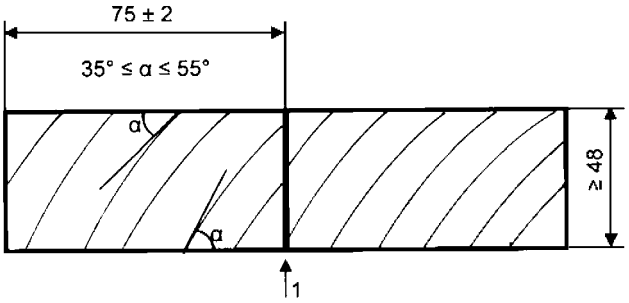
b) 140 mm in width, and

c) (40,0 ± 0,5) mm in thickness

after conditioning, measurement of moisture content (oven dry method according to EN 13183-1) and final preparation.

These laminated core pieces shall be produced of two boards with a width of (75 ± 2) mm, and a thickness of at least 48 mm. The two boards shall be bonded together longitudinally with a phenol-resorcinol-formaldehyde adhesive which passed EN 301 (used according to the adhesive manufacturer's instructions), with an annual ring orientation as indicated in Figure 1.

Dimensions in millimetres



Key

1 phenolic-resorcinol-formaldehyde (PRF) adhesive glue line

α angle of annual line orientation to the surfaces

Figure 1 — Cross-section of the laminated Norway spruce core piece before planing and cutting to the required dimensions of 140 mm wide by (40,0 ± 0,5) mm thick

5.1.4 Conditioning

Condition the core and cover pieces such that the average moisture content of all three pieces used in an assembly is (17,5 ± 0,5) %. Individual core and cover pieces may have a moisture content of (17 ± 1) %, as determined by the oven-dry method, according to EN 13183-1.

NOTE Storage at (20 ± 2) °C and 75 % to 80 % relative humidity would be expected to give rise to a moisture content in the wood of between 16 % and 18 %.

Not more than 8 h before bonding, either lightly plane or lightly sand, using a grade P100 abrasive paper as defined in ISO 6344-2, each surface to be bonded. Remove any dust carefully.

Do not touch or soil the prepared surface.

5.2 Preparation of the bonded assemblies

Before bonding the specimens together, take a sample from each of the core and cover pieces for the wood moisture content determination, using the oven-dry method, according to EN 13183-1.

Calculate and record each specimen's mean moisture content using the following formula:

$$U_m = \frac{U_1 + U_2 + 2U_3}{4}$$

where

U_m is the specimen's mean moisture content in percent;

U_1 is the moisture content of the first cover piece in percent;

U_2 is the moisture content of the second cover piece in percent;

U_3 is the moisture content of the core piece in percent.

Prepare the bonded assemblies as shown in Figure 2 with the curvature of the growth rings of the cover pieces away from the surfaces to be bonded (Figure 2 c)), and the grain of the cover pieces at right angles to the grain of the core piece (Figures 2 a) and 2 b)). Fix two (0,5 ± 0,01) mm thick aluminium spacer frames

(Figure 3), one spacer on the core piece and one spacer on the cover piece to limit the bond area to (100 ± 0,1) mm x (100 ± 0,1) mm and the nominal bond line thickness to 0,5 mm.

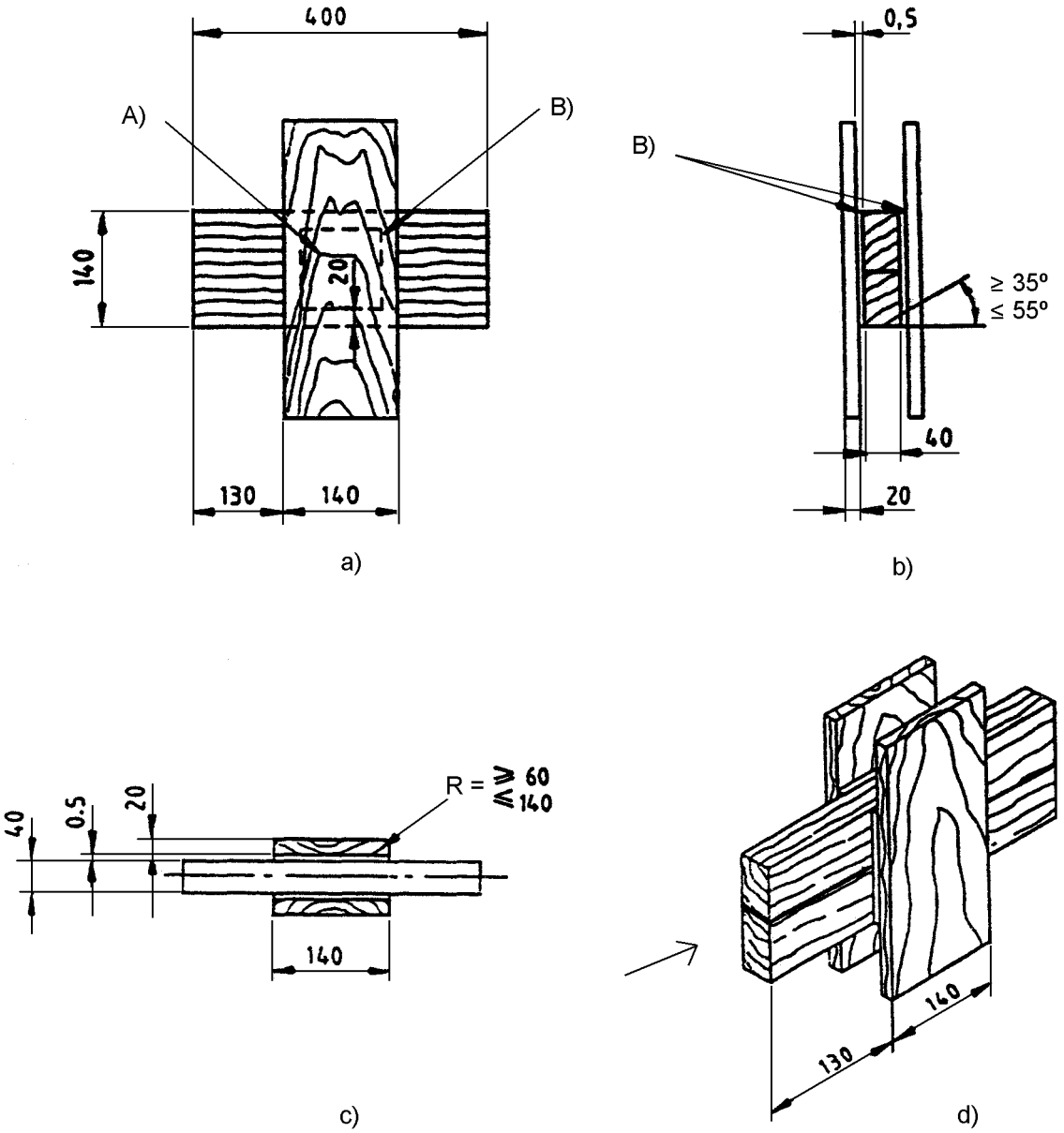
If no other instructions are provided by the adhesive manufacturer, apply the adhesive on the surface of the core piece to be bonded as well as on the surface of the cover piece to be bonded, to ensure good surface wetting.

To aid in the removal of the leftover, hardened adhesive after bonding, it is recommended to use tape strips on the lateral sides of the core and cover pieces before bonding.

Bonding shall take place at standard climate ((20 ± 2) °C and a relative humidity of (65 ± 5) %). Apply a load of (7,7 ± 0,1) kN and maintain for 24 h. This load corresponds to a pressure of approximately 0,8 N/mm² applied to the surface of the frame (9 600 mm²).

Remove the clamps and carefully remove any leftover hardened adhesive from the surfaces of the assembled specimen. Weigh and record each specimen's weight to the nearest gram, which is now considered the initial weight of the specimen. Store the assemblies for 7 days at standard climate [20/65].

Dimensions in millimetres



Key

A bond plane (100 ± 0,1) mm x (100 ± 0,1) mm

B aluminium frames

R radius of annual growth rings

→ the direction of the air stream in the drying cabinet

Figure 2 — Crosswise bonded assemblies

Dimensions in millimetres

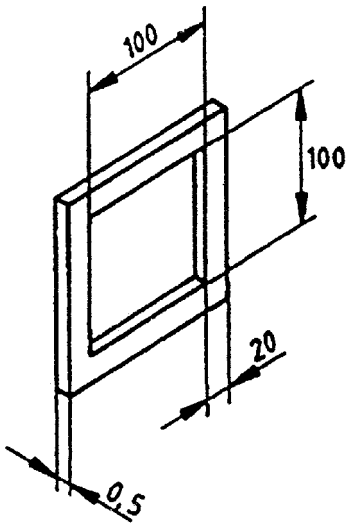


Figure 3 — Aluminium spacer frame

5.3 Number of bonded assemblies

Prepare three bonded assemblies for each adhesive to be tested.

5.4 Dry storage treatment

After the specified clamping and storage time (5.2), place the bonded assemblies in a climate of (40 ± 2) ºC, (30 ± 2) % relative humidity and an air speed of (0,7 ± 0,15) m/s until each specimen attains a moisture content reduction of nine percentage points. The specimen's targeted final weight shall be calculated before the drying storage treatment begins. The final moisture content shall be calculated in terms of weight, and shall be equivalent to the specimen's targeted final moisture content. The final weight tolerance shall be ± 2 g.

EXAMPLE If the moisture content of the specimen was 17,5 % before drying, the specimen's targeted moisture content after drying is 8,5 %.

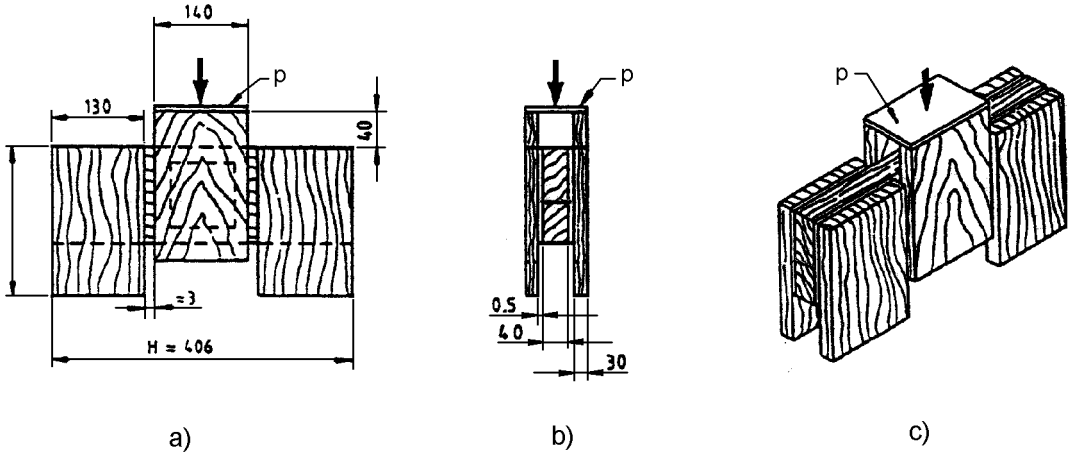
The specimens shall be placed into the climatic chamber so that the glue line orientation is parallel to the airflow direction (as in Figure 2 d)). The weight of the bonded assemblies shall be controlled daily. After every control, the specimens shall have their places rotated in the oven to ensure that all specimens receive the same drying treatment. After a specimen has achieved its final weight and been removed from the climatic cabinet, it shall be replaced by a dummy specimen. Record the number of days to achieve the final weight for each specimen. The recommended drying period is between 6 days and 9 days.

5.5 Preparation of the test piece

After drying the bonded assemblies, trim the two cover pieces and bond four supplementary pieces of Norway spruce wood, about 220 mm long and 30 mm thick, onto the specimens to ensure even loading, leaving a small gap (about 3 mm) to allow free movement on compression (see Figure 4). Take great care not to subject the testing area to stress during all these operations.

It is advisable that the wooden supports be bonded onto the core piece with a polyvinyl acetate (PVAC) adhesive, and that pressure be applied with screws, avoiding the use of nails.

Dimensions in millimetres



Key
p testing plate

Figure 4 — Test piece design

5.6 Climatic storage

After the dry storage treatment (5.4) and the preparation of the specimens (5.5), store all test pieces in the standard climate, (20 ± 2) °C and (65 ± 5) % RH, for two weeks after the last specimen has completed the dry storage treatment (5.4).

Should one of the test specimens fail before the test procedure (5.7) can be carried out, then disregard all three test specimens and repeat the procedure 5.3 to 5.7 on a series of three newly prepared test specimens.

5.7 Test procedure

Insert the test piece in the testing machine (4.1). The testing plate (p) shown in Figure 4 c) shall be aligning (e.g. hinged or ball-and-socket). The plate shall be made to fit smoothly on top of the specimen, so that close contact is ensured. The hinge or similar device is locked into place, so that the testing plate (p) is fixed flush to the specimen's surface. Check optically that no gaps between the wooden supports and supporting surface are present. Apply a compressive force, until the test piece fails, either at:

a) a rate of load increase of (20 ± 5) kN/min; or

b) if the test machine is not capable of applying a constant rate of load increase, a constant rate of displacement by crosshead movement is to be used so that the time to failure is not less than 60 s.

Record the load at failure to the nearest newton.

6 Expression of results

Calculate the shear strength of the test piece according to the following formula:

$$f_v = \frac{F_{c,\max}}{A}$$

where

f_v is the shear strength in newtons per square millimetre;

$F_{c,max}$ is the maximum compression load at failure (N);

A is the area, which is 20 000 mm².

Express the result of the test as the mean of the shear strength in N/mm² of the three test pieces rounded to the nearest 0,1 N/mm².

7 Test report

The following items shall be recorded in the test report.

7.1 The adhesive

The following information about the adhesive shall be included in the test report:

a) chemical nature and origin of the sample;

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

c) number of components and method of preparation and application.

7.2 Preparation of the samples and the testing procedures

The following information about the preparation of the test pieces and the testing procedure shall be included in the test report:

a) wood density expressed in kg/m³ at 12 % moisture content;

b) the bonding procedure (i.e. application of adhesive spread, closed assembly time and pressure time);

c) type of testing machine (a) or b) according to 4.1);

d) period of drying storage treatment for each specimen (as in 5.4).

7.3 Test results

The following information about the test results shall be included in the test report:

a) that the test was carried out in accordance with EN 302-4;

b) initial and final moisture content and initial and final weight of each specimen;

c) value of the shear strength in N/mm² for all three test pieces to the nearest 0,1 N/mm²;

d) mean shear strength in N/mm² rounded to the nearest 0,1 N/mm²;

e) estimate of the proportion of tested surface covered by wood fibres to the closest 10 % expressed as the mean value for all test results;

f) date of the issue of the report;

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

Bibliography

[1] EN 15425, *Adhesives — One component polyurethane for load bearing timber structures — Classification and performance requirements*

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

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