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Thermal insulation products for building applications — Determination of the pull-through resistance of plate anchors through thermal insulation products

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Thermal insulation products for building applications - Determination of the pull-through resistance of plate anchors through thermal insulation products

Produits isolants thermiques destinés aux applications du bâtiment - Détermination de la résistance au déboutonnage des chevilles à rosace dans les produits isolants thermiques

Wärmedämmstoffe für das Bauwesen - Bestimmung des Durchzugwiderstandes von Tellerdübeln durch Wärmedämmstoffe

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European foreword

This document (EN 16382:2016) has been prepared by Technical Committee CEN/TC 88 “Thermal insulating materials and products”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by April 2017, and conflicting national standards shall be withdrawn at the latest by April 2017.

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NOTE It has not been possible to include a statement on the accuracy of measurement in this edition, but it is intended to include such a statement when this European Standard is next revised.

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1 Scope

This European Standard specifies equipment and procedures for determining the pull-through resistance of plate anchors through thermal insulation products.

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 206, *Concrete — Specification, performance, production and conformity*

EN 823, *Thermal insulating products for building applications — Determination of thickness*

EN 1607, *Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces*

EN 1990:2002, *Eurocode — Basis of structural design*

EN ISO 9229, *Thermal insulation — Vocabulary (ISO 9229)*

ISO 12491:1997, *Statistical methods for quality control of building materials and components*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 9229 apply.

4 Principle

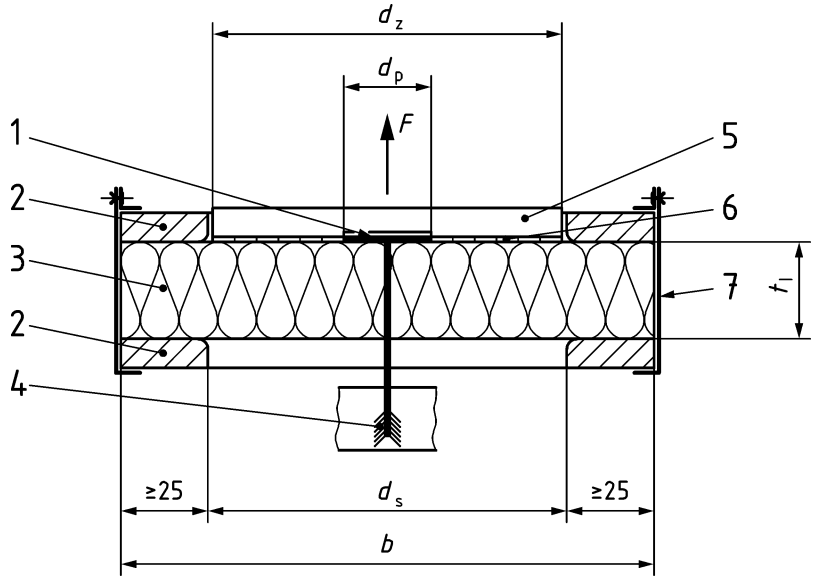
The pull-through resistance of a plate anchor through thermal insulation products is determined by a direct tensile load perpendicular to the surface of the thermal insulation product. The tensile load is applied by means of a tension plate glued to the test area of the thermal insulation product.

5 Apparatus

NOTE In Clause 5, the numbers between brackets refer to Figures 1 to 3.

The plate anchor (1) which is to be tested is pulled through the thermal insulation product (3). The edges of the thermal insulation product are fixed by two square templates with a centric circular opening (2) and clamps (7). The anchor is positioned in the centre of the sample. The circular tension plate (5) is glued (6) onto the thermal insulation product. The anchor is covered previously with a non-adhesive foil. The tension load is introduced to the thermal insulation product by the circular tension plate which fits into the circular opening of the template. The anchorage area of the plate anchor is fixed by a suitable device. The tension load is exerted until failure.

Dimensions in millimetres



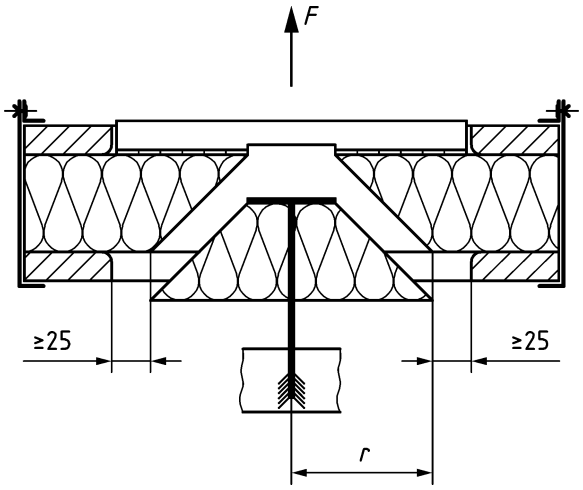
Key

1 plate anchor covered with a suitable non-adhesive foil
2 template
3 thermal insulation product
4 suitable device for fixation the anchorage area of the anchor
5 tension plate
6 glue
7 clamp

b width of the square template
d_p diameter of the anchor plate including additional plates if used
d_s diameter of the circular recess in the template
d_z diameter of the tension plate
F tensile load
t_I thickness of the thermal insulation product

Figure 1 — Principle of the test arrangement

Dimensions in millimetres

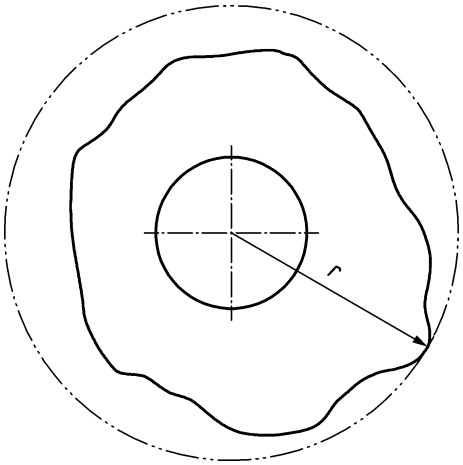


Key

F tensile load

r distance from the centre of the anchor sleeve to the remotest point of the breaking cone

Figure 2 — Schematic presentation of a failure with a breaking cone of the insulation product after pull-through testing



Key

r distance from the centre of the anchor sleeve to the remotest point of the breaking cone

Figure 3 — Determination of the distance *r* by a breaking cone

5.1 Glue

The glue shall be suitable for the thermal insulation product and for the tension plate (e.g. solvent-free epoxy or polyurethane based). The glue shall not influence the mechanical properties of the insulation product.

5.2 Template

The square templates with circular openings shall be rigid. Test results are valid if every distance of the circular recess to the breaking cone is at least 25 mm.

NOTE Suitable materials for the template are e.g. laminated wood plates of at least 20 mm thickness or steel plates of at least 7 mm thickness.

The side length b of the templates shall be at least 50 mm larger than the diameter d_s of the circular recess in the template.

The minimum diameter of the circular recess in the template, d_S, is calculated from the diameter of the anchor plate d_p and the thickness of the tested thermal insulation product, t_I, as follows:

$$d_s \geq d_p + 2 \times t_I + 50 \quad (1)$$

where

d_S is the diameter of the circular recess in the template in mm;

d_p is the diameter of the anchor plate including additional plates if used in mm;

t_I is the thickness of the thermal insulation product in mm.

5.3 Clamping device

At least two clamps (7) at each edge are used to fix the thermal insulation product.

5.4 Tension plate

The circular tension plate (5) introduces the load into the thermal insulation product. The tension plate shall be rigid. It shall be connected to the testing machine by a self-alignment device in the centre. The tension plate shall have a diameter of $d_Z = d_S - 10$ mm.

NOTE Suitable materials for the tension plate are e.g. laminated wood plates of at least 20 mm thickness or steel plates of at least 7 mm thickness.

5.5 Tensile testing machine

The tensile testing machine needs to be appropriate for the range of force and the displacement involved and capable of having a constant crosshead speed adjusted to (20 ± 1) mm/min. It shall be capable of measuring the force with an error limit of a maximum of 1 % (see EN 1607).

The tensile testing machine shall be capable of continuous recording of load and displacement in order to report load/displacement graphs for all test specimens.

6 Test specimens

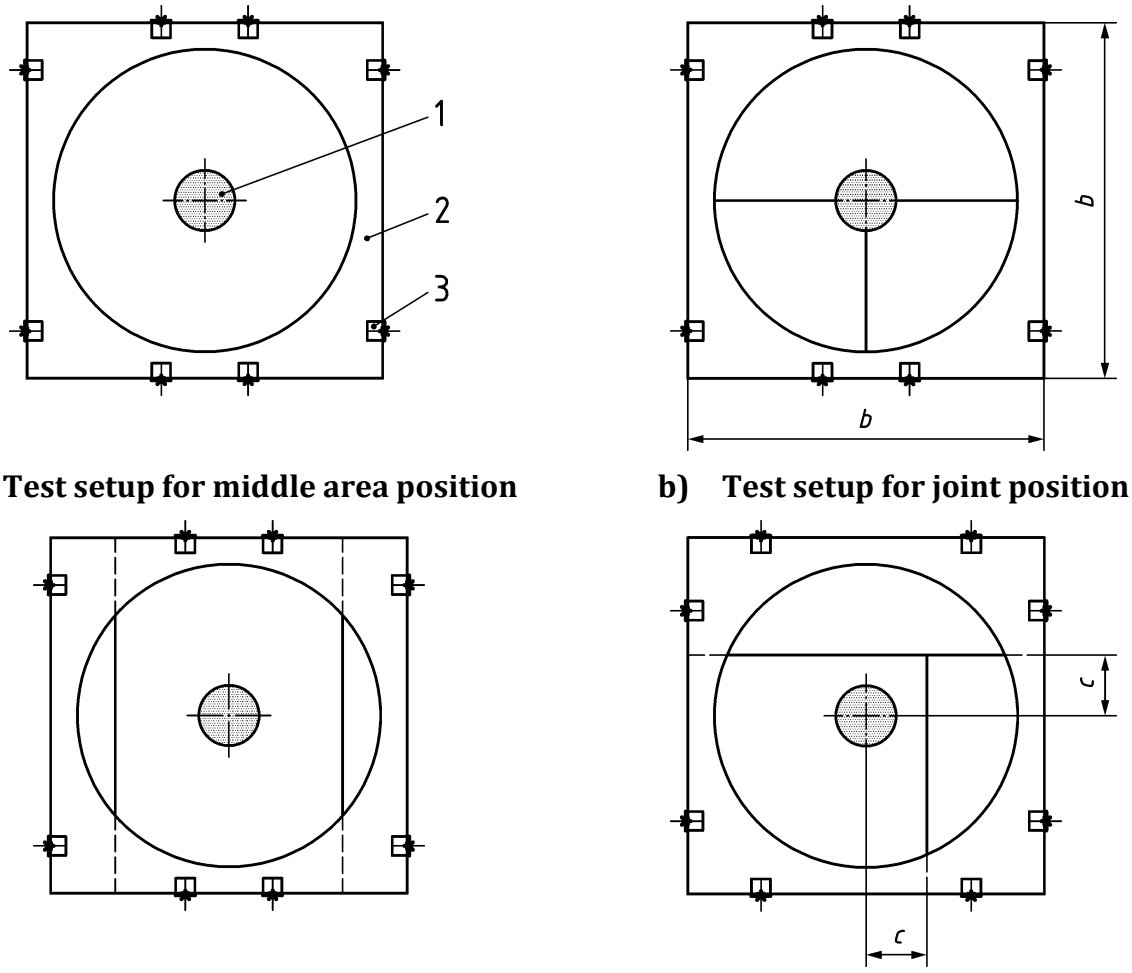
6.1 Thermal insulation product and anchor position

The specimen of the thermal insulation product shall be at least as large as the outer dimensions of the template described in 5.2.

To determine the pull-through resistance in the middle area position a specimen without a joint shall be used as shown in Figure 4, a). If the insulation board is smaller than the side length b of the template, the tests shall be performed as shown in Figure 4, c).

To determine the pull-through resistance in joint position a T-joint between three insulation boards is used. The specimen shall be arranged as shown in Figure 4, b).

To determine the pull-through resistance in the edge/corner position a specimen with three insulation boards shall be used as shown in Figure 4, d).



a) Test setup for middle area position

b) Test setup for joint position

c) Test setup for middle area position with limited width of the thermal insulation product

d) Test setup for edge/corner position

Key

1 plate anchor covered with a suitable non-adhesive foil

2 template

3 clamp

b width of the square template

c distance which defines the anchor setting position edge or corner at the insulation board

c may be chosen according to the mounting guidelines of the ETIC system.

Figure 4 — Arrangement of the thermal insulation product in the test setup

6.2 Preparation of the test specimens

The plate anchor shall be placed according 6.1. In case of test setups according Figure 4, b), c) and d), the insulation boards shall be secured together on the edges with a suitable circumferential adhesive tape, to counter a movement of the boards in horizontal direction.

If the anchor is fixed in a concrete slab, a concrete slab with a minimum strength corresponding to class C20/25 according to EN 206 shall be used (see Figure 6). The spacer to the thermal insulation product shall be equivalent to the thickness of the lower template plus the clamps. The anchor shall be installed

following the manufacturer's instructions. Size and thickness of the concrete slab shall correspond to the embedment requirements of the anchor.

To locate the position of the tension plate, place the template on the insulation board and mark the position of the circular recess. The tension plate shall be fixed in the marked position with a suitable glue. The tension plate shall not touch the edges of the upper template and shall be separated from the anchor plate by using a suitable non-adhesive foil.

Anchors with additional plates to increase the plate diameter shall be fully covered with a non-adhesive foil.

After curing of the glue the specimen shall be clamped between the templates without compressing the thermal insulation product.

The specimen shall be conditioned at (23 ± 3) °C and (50 ± 10) % relative humidity for at minimum 24 h.

6.3 Number of test specimens

For the determination of the characteristic pull-through strength at least 5 test specimens are required.

NOTE Minimum 5 valid measurements are needed for the statistic evaluation.

7 Procedure

7.1 Test conditions

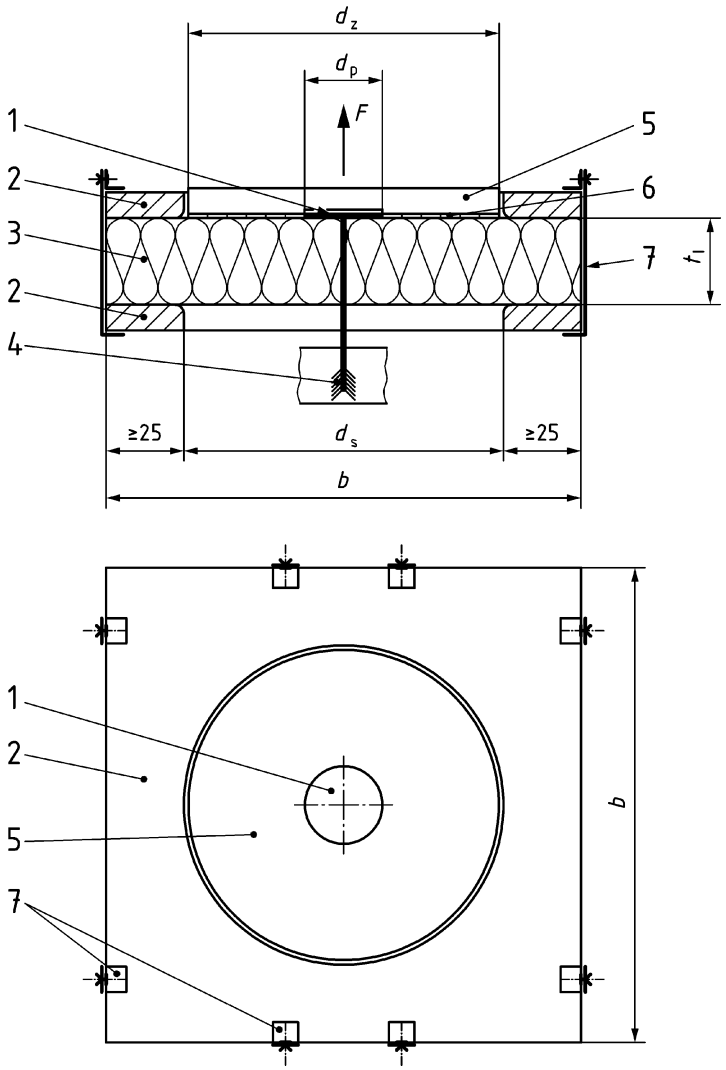
The test shall be carried out at (23 ± 3) °C and (50 ± 10) % relative humidity.

7.2 Attachment of the test specimens to the tensile testing machine

Attach the test specimen to the tensile testing machine according Figure 5 or Figure 6.

The load shall be transferred via a load cell centrally and perpendicularly to the tension plate.

Dimensions in millimetres

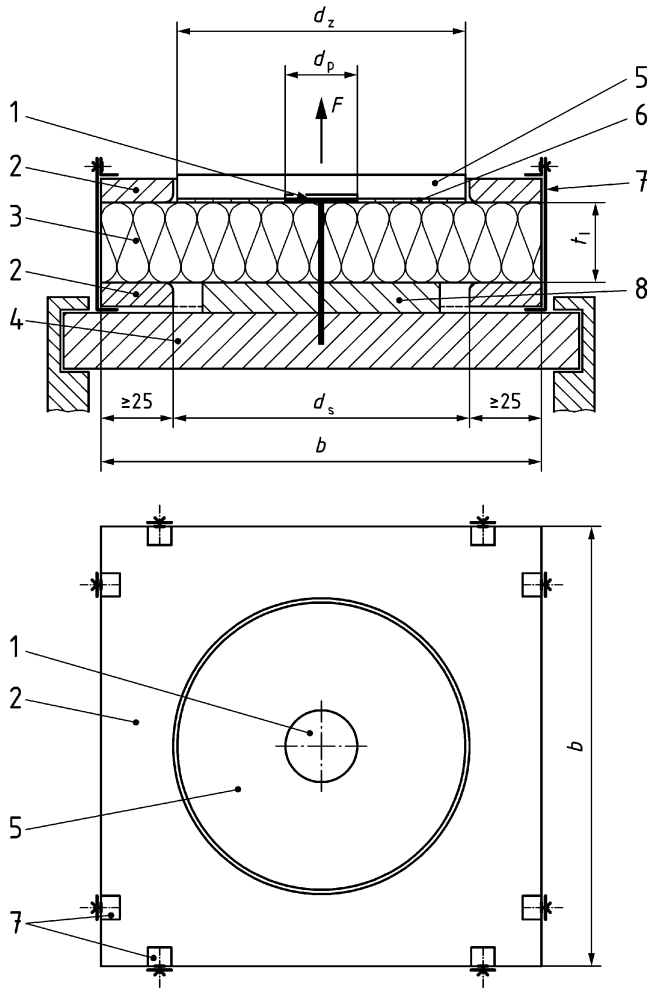


Key

1 plate anchor covered with a suitable non-adhesive separating foil
2 template
3 thermal insulation product
4 suitable device for fixation of the anchoring area of the anchor
5 tension plate
6 glue
7 clamp
b width of the square template in mm ($b \geq d_S + 50$)
d_p diameter of the anchor plate including additional plates if used in mm
d_S diameter of the circular recess in the template in mm ($d_S \geq d_p + 2 \times t_I + 50$)
d_Z diameter of the tension plate in mm ($d_Z = d_S - 10$)
F tensile load in kN
t_I thickness of the thermal insulation product in mm

Figure 5 — Attachment of the test specimen to the tensile testing machine

Dimensions in millimetres



Key

1 plate anchor covered with a suitable non-adhesive foil
2 template
3 thermal insulation product
4 suitable concrete substrate for fixation of the anchoring area of the anchor
5 tension plate
6 glue
7 clamp
8 Spacer made of non sticking material used to ensure a consistent gap between the insulation board and the concrete slab (e.g. laminated wood plates)

b width of the square template in mm ($b \geq d_S + 50$)

d_p diameter of the anchor plate including additional plates if used in mm

d_S diameter of the circular recess in the template in mm ($d_S \geq d_p + 2 \times t_I + 50$)

d_Z diameter of the tension plate in mm ($d_Z = d_S - 10$)

F tensile load in kN

t_I thickness of the thermal insulation product in mm

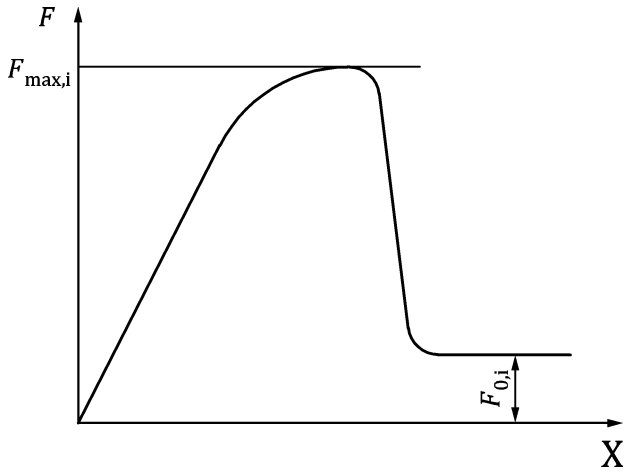
Figure 6 — Attachment of the test specimen to the tensile testing machine using a concrete slab with spacer

7.3 Test procedure

Carry out the tensile force measurement according to EN 1607 until failure occurs. Apply the tensile load perpendicular to the test specimen.

Increase the load with a constant crosshead speed adjusted to (20 ± 1) mm/min.

Record the force-displacement graph and the maximum tensile force F_{max} as shown in Figure 7.



Key

F	load
$F_{max,i}$	tensile load at failure in kN
$F_{0,i}$	dead load caused by the test equipment in kN
X	displacement

Figure 7 — Determination of the tensile load at failure F_{max} from the force-displacement graph

Measure the maximum radius r_i of the fully developed breaking cone according to Figure 3 if it is the mode of failure.

Reject any test if:

— the mode of failure is a fracture between the test specimen and the tension plate;

— the anchor failed in the fixing device or the substrate;

— the failure does not occur within the thermal insulation product or the anchor plate;

— the minimum distance of the circular recess to the breaking cone is less than 25 mm in case of cone mode of breaking failure.

8 Calculation and expression of results

8.1 Failure load

Calculate the mean value for the failure load $\overline{F}_{Test}$ as follows:

$$F_i = F_{max,\,i} - F_{0,\,i} \qquad (2)$$

$$\overline{F}_{\text{Test}} = \frac{\sum_{\text{i=1}}^{\text{n}} F_{\text{i}}}{n} \tag{3}$$

where

F_{i} is the failure tensile load in kN;

$F_{\text{max, i}}$ is the maximum tensile load at failure in kN;

$F_{0, \text{i}}$ is the dead load caused by the test equipment in kN;

$\overline{F}_{\text{Test}}$ is the mean value of the failure load in kN;

n is the number of valid measurements.

8.2 Pull-through resistance $F_{5\ \%}$

The pull-through resistance $F_{5\ \%}$ is the 5 %-quantile of the failure loads F_{i} with the mean value of failure load $\overline{F}_{\text{Test}}$ measured in one test series. It shall be calculated according to statistical procedures for a confidence level of 75 % according to EN 1990:2002, Annex B, Class CC1. If a precise verification does not take place, in general, a normal distribution and an unknown standard deviation of the population shall be assumed:

$$F_{5\%} = \overline{F}_{\text{Test}} \times \left(1 - k_{\text{s}} \times \upsilon\right) \tag{4}$$

$$\nu = \frac{s_{\text{n-1}}}{\overline{F}_{\text{Test}}} \tag{5}$$

where

$F_{5\ \%}$ is the pull-through resistance as the 5 %-quantile of a test series in kN;

$\overline{F}_{\text{Test}}$ is the mean value of the failure load in one test series in kN;

k_{S} is the statistical coefficient according to ISO 12491:1997, Table 6;

$s_{\text{n-1}}$ is the standard deviation of one test series according to ISO 12491 in kN;

ν is the variation coefficient of one test series.

NOTE For n = 5 measurements, k_{S} = 2,46; for n = 10 measurements, k_{S} = 2,10.

The pull-through resistance ($F_{5\ \%}$) shall be determined on thermal insulation products having the declared material properties according to the relevant product standard.

$F_{5\%,\text{a}}$ pull through resistance in the middle area position in kN;

$F_{5\%,\text{j}}$ pull through resistance in the joint position (T-Joint or I-Joint) in kN;

$F_{5\%,\text{ec}}$ pull through resistance in the edge/corner position in kN.

8.3 Determination of the mean breaking cone

Calculate the mean value of the maximum radii of the breaking cones:

$$r_{tI} = \frac{\sum_{i=1}^{n} r_i}{n} \quad (6)$$

where

r_{tI} is the mean value of the distance from the centre of the anchor sleeve to the remotest point of the breaking cone in the measurements with the insulation thickness t_I in mm.

r_i is the distance from the centre of the anchor sleeve to the remotest point of the breaking cone in mm;

n is the number of measurements;

9 Test report

The test report of each series shall include the following information:

a) reference to this European Standard (EN 16382);

b) product identification of the tested components:

1) thermal insulation product:

i) identification by the designation code according to the relevant product standard respectively harmonized technical specification;

ii) trade name, batch number, production date or other product identification;

iii) packaging when the product arrived at the laboratory;

iv) nominal thickness according to EN 823;

v) determination method of the characteristic pull-through resistance according to the relevant product standard;

2) anchor:

i) type, product name and manufacturer;

ii) marking according to European Technical Specification;

iii) diameter of the anchor plate;

iv) length of the plate anchor;

v) anchor plate stiffness according to European Technical Specification;

c) test procedure:

1) pre-test history and sampling, e.g. who sampled and where;

2) conditioning;

3) type and name of the glue used;

4) material and dimensions of the template;

5) material and dimensions of the tension plate;

6) used test setup according to 6.1;

7) used configuration according to Figure 5 and Figure 6;

8) deviations from Clause 5 and Clause 6;

9) date of test;

10) number of test specimens;

11) displacement speed;

12) general information regarding the test;

13) observations which may have affected the results;

14) number and type of test specimens which have been rejected and reason why;

15) diameter of the circular recess of the template;

d) results:

1) all individual values and the mean value of the pull-through force at failure;

2) pull-through resistance for each tested setting position;

3) description of the failure mode;

4) load/displacement graphs of all pull-through measurements;

5) measured thickness of the tested thermal insulation product according to EN 823;

6) measured material properties of the thermal insulation product for determination the characteristic pull-through resistance according to the relevant product standard or specification;

7) distances r_i of the breaking cone to the circular recess of the template, if any;

8) mean value r_{tI};

9) the distance c of the anchor setting position used in setting position edge/corner if carried out.

Information about the apparatus and identification of the technician should be available in the laboratory. It does not need to be recorded in the report.

The documentation of the test specimens after testing by photographs is recommended.

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