



TECHNICAL REPORT

**Test methods for foam
adhesives for External
Thermal Insulation
Composite Systems (ETICS)**

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1 FOREWORD

EOTA Technical Reports were developed as supporting reference documents to European Technical Approval Guidelines (ETAG) and were also applicable to Common Understanding of Assessment Procedures (Art 9 (2) Directive (EEC) No 89/106 – referred to as CPD), an EOTA Comprehension Document or an European Technical Approval (ETA) issued under CPD, as far as reference is made therein. They are also developed under Regulation (EU) 305/2011.

EOTA Technical Reports go into detail in some aspects and express the common understanding of existing knowledge and experience of the EOTA Technical Assessment Bodies at a particular point in time.

Where knowledge and experience is developing, especially through assessment work, such reports can be amended and supplemented.

When this happens, the effect of the changes upon the relevant European assessment documents such as ETAG used as EAD or EAD will be laid down in Comprehension Documents, unless the assessment documents are revised as such.

Test procedures developed by FEICA, the Association of the European Adhesive & Sealant Industry (www.feica.com) were used as basis of some test procedures introduced in this TR (namely Density, Tack Free Time, Cutting Time and Shear Behaviour). It is advisable for FEICA and EOTA to inform each other about substantial changes in the relevant documents in order to maintain coherence of the methods in future.

2 SCOPE

This EOTA Technical Report specifies methods of identification and test methods for one component PUR foams used as adhesive for External Thermal Insulation Composite Systems (ETICS) based on Expanded Polystyrene (EPS) for the use on masonry or concrete.

Other foams, insulation products or substrates are not covered by this Technical Report.

3 GENERAL TEST CONDITIONS

If not determined otherwise, the test procedures shall be performed at (23 ± 2) °C and (50 ± 5) % RH (standard conditions). Any material (bottle/can, PE-foil, substrate, EPS board,...) used for testing shall be stored under the climate conditions for at least 3 days to ensure that it is fully acclimatized.

The bottle/can shall be shaken at least 20 times before application. The first approximately 100 g of foam is discarded by spraying.

The technique of application (straw/gun) shall be as given in the manufacturer's application instructions and recorded in the test report.

If not determined otherwise (either in the test procedure description or manufacturer's instructions), the spray speed is from 100 to 200 mm/s.

For the purpose of identification the time between production date and testing has to be taken into account.

3 METHODS OF IDENTIFICATION

3.1 Density

Tools:

- PE-foil
- Sharp and clean knife (cutting knife)
- Balance with an accuracy of 0,1 g
- Measuring cylinder with an increment of 10 ml
- Water

Preparation of test samples:

A full bottle/can shall be used for preparation of test samples.

The bottle/can is shaken at least 20 times before application. The first approximately 100 g of foam is discarded by spraying.

Cylindrically shaped beads with diameter of 20 to 30 mm and about 200 mm length are sprayed on a PE-foil from a distance of approximately 10 mm and left to harden.

After 24 hours minimum, the beads shall be cut on both sides to a length of 100 to 150 mm.

Test procedure:

The mass of the samples is measured in grams (**m**) with an accuracy of 0,1 g.

A measuring cylinder having an increment of 10 ml is filled with water and a reference volume (**V₀**) is set.

By pressing a cutting knife into one end of the bead, the sample is submerged into the measuring cylinder. The increased volume (**V₁**) is read off immediately.

Calculation:

The density of the PUR-Foam is determined by using the following formula:

$$\rho = \frac{m}{V_1 - V_0} * 1000$$

The results shall be expressed in kg/m³.

The test result shall be calculated as the mean of at least 5 single values.

3.2 Tack Free Time

Background and purpose:

The tack free time is the time after which a bead of foam has formed a skin, so that adhesion on the surface has stopped.

The tack free time is susceptible to temperature and humidity conditions. It is usually prolonged by lower temperature and / or lower humidity.

Tools:

- Paper or cardboard
- Small rod or tube made of PE (e.g. straw)
- Clock or stopwatch

Test procedure:

Cylindrically shaped beads with diameter of 20 to 30 mm are sprayed on the cardboard and the time is noted (t_0) or the stopwatch is started. The surface of the bead is touched gently with the small rod/tube (without penetrating the skin) several times after applying the foam, e.g. every 30 sec (see Figure 1). For every touch a clean part of the rod/tube and a new spot on the bead shall be used. The time when no foam adheres to the rod is noted (t_1).

Calculation:

$$t_{\text{tack free}} = t_1 - t_0$$

No calculation is needed when using a stopwatch.

The result is expressed in minutes (min).



Figure 1 – Touching the bead with the rod/tube

3.3 Cutting Time

Background and purpose:

The cutting time is the time after which cut surface of a cylindrically shaped bead of (not entirely hardened) foam, 30 mm in diameter, is not sticky anymore, the knife remains clean without pre-polymer residues and the cells are not squeezed.. It is a time after which the foam is not entirely hardened, but it can be processed. The foam hardening process is usually prolonged by lower temperature and/or lower humidity.

Tools:

- Sharp and clean knife (cutting knife)
- Paper or cardboard
- Clock or stopwatch
- Template with a window of 30 mm height and approximately 60 mm width. See Figure 1.

Test procedure:

Cylindrically shaped beads with diameter of 20 to 30 mm are sprayed on the cardboard (see Figure 2) and the time is noted (t_0) or the stopwatch is started. Measurements shall be started 10 minutes before the anticipated cutting time.

To check the bead diameter the template according to Figure 1 used.

The bead is cut in a place with 30 mm diameter, found by template (see Figure 3). The bead shall not be "sawn", but cut in one or two steps at a fast pace.

If fresh polymer remains on the knife, the foam cells are crushed or the cut surface is still sticky, the foam is still not cured. Another bead or part of bead is cut in the same way after 3 minutes. It shall be ensured that no impact on the foam due to a previous cut surface occurs.

This procedure is repeated every 3 minutes (respectively 1 minute when being close to the anticipated cutting time) until the foam cells are not squeezed by the knife and the cut surface is not sticky. Also the bead shall stay in shape.

The time is noted (t_1).

Calculation:

$$t_{\text{cutting}} = t_1 - t_0$$

No calculation is needed when using a stopwatch.

The result is expressed in minutes (min).

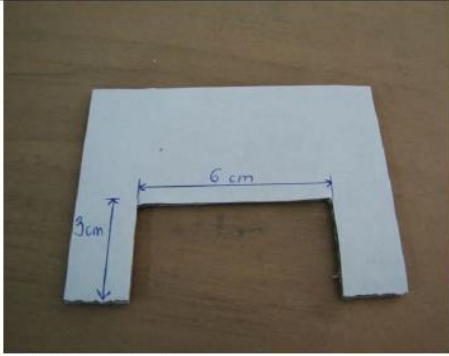


Figure 1: Template



Figure 2: Beads on the cardboard



Figure 3: How to find 3 cm diameter bead

4 TEST METHODS

4.1 Bond strength

Tools:

- Substrate (*concrete slab according to ETAG 004, chapter 5.1.4.1.2, thickness: 40-80 mm*)
- Insulation product (*EPS with tensile strength TR150, dimensions*: 50 mm x 50 mm x 30-100 mm*)
- Spacers (any non-sticking material, used to ensure a consistent gap between the specimens of insulation product)
- Weights or clamps, if substrate material is not heavy enough to ensure stability of test sample
- Cutting knife
- Tie anchors to connect the insulation product to a testing machine (e.g. made of square metal plates)
- Calliper (accuracy $\leq 0,1$ mm) for measuring sample surface area
- tensile testing machine

**Note: if the laboratory is equipped, one can also use a bigger EPS plate (max. 120 mm x 200 mm x 30-100 mm) and cut test samples afterwards*

Preparation of test samples:

The bottle/can is shaken at least 20 times before application. The first approximately 100 g of foam is discarded by spraying away.

After this, the foam is sprayed without interruption from a distance of approximately 10 mm onto the surface of the insulation product which shall be affixed to the substrate. The diameter of the beads shall be 20 to 30 mm without space between them. The foam shall be applied in longitudinal strips or in serpentine pattern (Figure 1). It is very important that, while spraying the next bead(s), the foam is not sprayed into the already applied foam bead(s). The surface shall be fully covered with foam.

If not determined differently (see Test conditions, 'Modification of processing time'), the sample components shall be assembled together after 180 ± 10 seconds from finishing the foam application by firmly pressing the concrete slab onto the foam. If not determined differently (see Test conditions, 'Modification of foam thickness') the thickness of foam shall be (8 ± 1) mm. The foam has to be able to expand to the lateral sides.

If not determined differently (see Test conditions) the samples are stored for at least 1 day (24 h) at the standard conditions. The required thickness is controlled by clamping the samples or using weights.

After one day curing, tie anchors may be affixed to the insulation product by using a suitable adhesive (see Figure 6), the adhesive may need one day for curing.

Samples shall be cut to the specified dimensions (50 mm x 50 mm) after curing in case larger EPS plates are used.

Figures on the bond strength test - specimen preparation



Figure 1: Spray pattern



Figure 2: Set-up with spacers (ex. 1)



Figure 3: Set-up with spacers (ex. 2)



Figure 4: Set-up with spacers (ex. 3)



Figure 5: Test sample during curing (48hrs)



Figure 6: Tie anchors



Figure 7: Cutting of the surplus

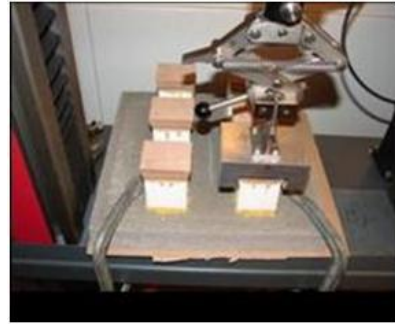


Figure 8: Test set-up in test machine

Test procedure:

The surplus foam shall be carefully cut off (see Figure 7).

The tensile test (pull-off test) is performed on at least five test samples at a tension speed of (10 ± 1) mm/min.

After testing the sample surface (s) shall be measured in mm², and the test results β_i are calculated by the formula

$$\beta_i = F_i/s_i$$

The test results (individual and mean values) are expressed in N/mm² (MPa) along with description of the failure mode. The way of application (straw/gun, application pattern) shall be given in the test report.

Test conditions

4.1.1. Standard application conditions

The tensile test is carried out at standard conditions (23 ± 2) °C / (50 ± 5) % RH with standard application conditions:

- Completion of test samples within 180 ± 10 seconds
- Thickness of foam: (8 ± 1) mm

4.1.2. Modification of application conditions

4.1.2.1 Modification of foam thickness

The tensile test is carried out at standard conditions (23 ± 2) °C / (50 ± 5) % RH with a thickness of foam of (15 ± 1) mm by using appropriate spacers.

4.1.2.2 Modification of processing time (open time)

The tensile test is carried out at standard conditions (23 ± 2) °C / (50 ± 5) % RH with the standard thickness of foam of (8 ± 1) . The time between spraying the beads and completion of test samples shall be in accordance with the maximum open time declared by the manufacturer.

4.1.2.3 Modification of temperature

Two tensile tests are carried out with the standard thickness of foam of (8 ± 1) mm. For preparation of test samples the following conditioning for substrate, insulation product, application, foam and curing is taken into account:

- 4.1.2.3.1 Low temperature: (5 ± 2) °C, no RH is required if not declared differently by the manufacturer

4.1.2.3.2 High temperature: $(35 \pm 2) ^\circ\text{C}$, $(30 \pm 5) \% \text{RH}$
if not declared differently by the manufacturer

The duration of storage must ensure the required temperature of all components.

After preparation and curing for 24 hours under the defined conditions, the samples are tested without delay at standard conditions $(23 \pm 2) ^\circ\text{C} / (50 \pm 5) \% \text{RH}$.

4.2 Post Expansion Behaviour

Background and purpose:

The post expansion behaviour is a process of increase of foam volume after application until finished hardening. The post expansion behaviour is a relevant characteristic for the determination of application instructions. Depending on the post expansion behaviour, it may be reasonable to use temporary fixings for bonding the insulation product in ETICS to avoid undesirable movements.

The post expansion behaviour is subject to temperature and humidity conditions.

Tools:

- board with flat surface (Chipboard or cement bonded particle board or cement bonded fibre board), dimensions: ≥ 500 mm x ≥ 500 mm, minimum thickness: 12 mm
- EPS-board with determined density (15 ± 5) kg/m³
dimension: 500 mm x 500 mm, thickness: 40 mm
- Weights (only if total weight of EPS-board is less than 200 g)
- caliper
- four spacers, dimension: 20 mm x 20 mm, thickness 8 mm, fixed on each corner of the chipboard
- clock or stopwatch

Preparation of test samples:

The bottle/can is shaken at least 20 times before application. Then, the foam is applied in a square-shaped (40x40cm) bead according to Figure 1.

The foam is sprayed from a distance of circa 1 cm to the EPS-board's surface and form beads of 20 to 30 mm diameter. The spray speed shall be from 100 to 200 mm/sec.

Without delay, the so prepared EPS-board is firmly pressed onto the chipboard until it touches the spacers. A total weight of 200 g shall be ensured by the EPS-board and additional weights, if necessary.

Test procedure:

The distance in millimeters between the base board and the EPS-board is measured by the caliper (see Figure 2). Measurements are taken in the following intervals:

- M1 after 5 minutes
- M2 after 10 minutes
- M3 after 20 minutes
- M4 after 40 minutes
- M5 after 60 minutes
- M6 after 24 hours

Note: In case of significant differences in the measurements within one interval, the test should be discarded and repeated.

The mean value of each measurement is calculated from the four single values measured at the corners of the EPS-board.

All the M1-M6 values shall be reported. The final result is the highest value out of the six measurements.

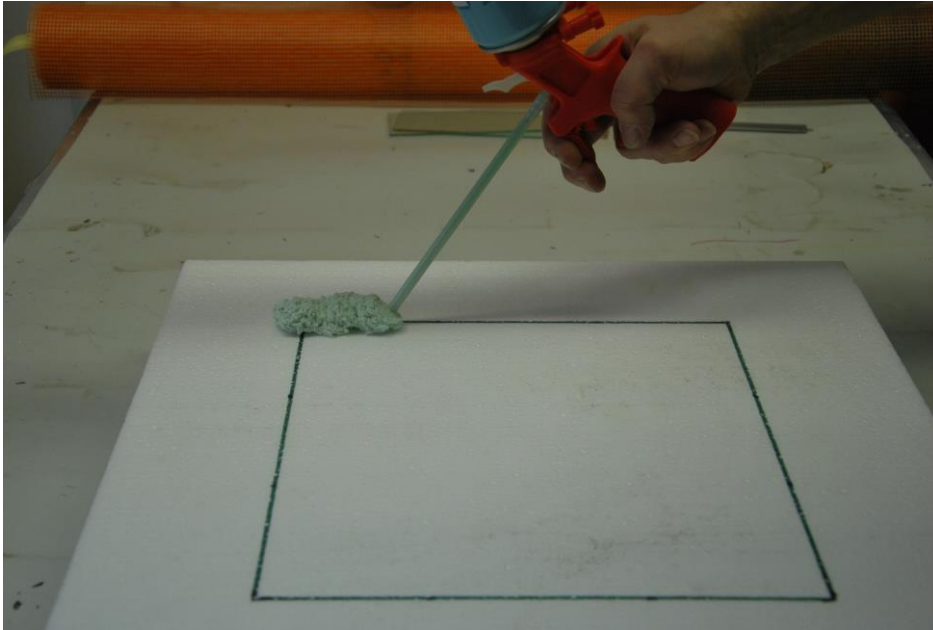


Fig. 1: Preparation of the sample

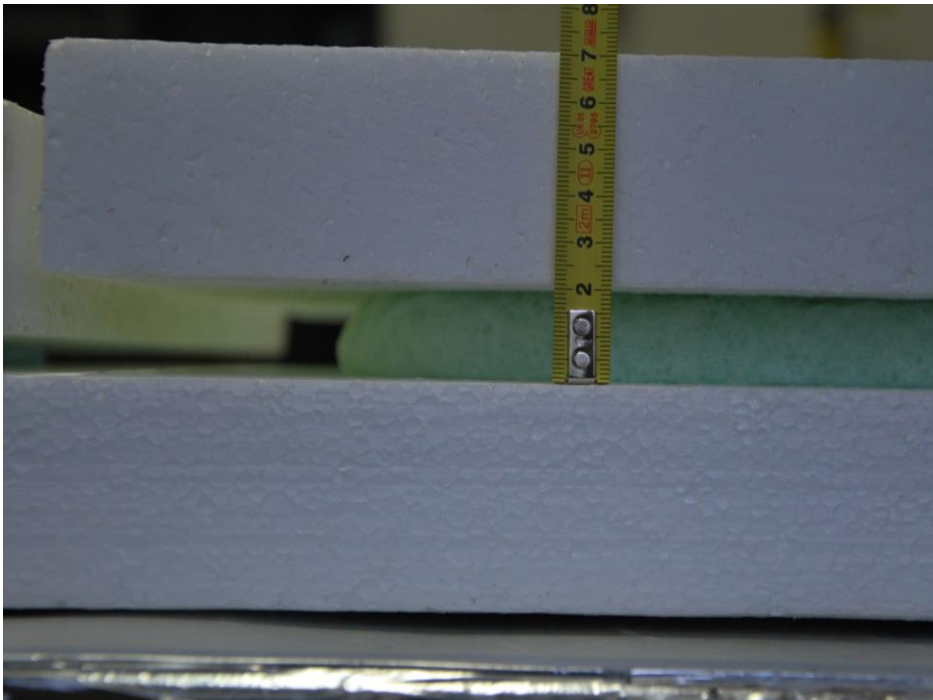


Fig. 2: Measurement by a caliper

4.3 Shear strength and shear modulus

Background and purpose:

The shear behaviour (shear strength and shear modulus) of a foam is a relevant characteristic when used for bonding the insulation product in ETICS with thick insulation boards, heavy rendering systems or other heavy facings such as brick slips or tiles.

Tools:

- Two chipboard plates (P5 according to EN 312), dimensions: 140 mm x 100 mm x min. 10 mm
- two spacers with the dimensions of 20 mm x 100 mm, thickness 8 ± 1 mm, fixed on each end of the test sample on one chipboard
- screw clamps or weights

Preparation of test samples

The foam is sprayed without interruption from a distance of approximately 10 mm onto the surface of the chipboard, onto which the spacers are temporarily fixed. The diameter of the beads shall be 20 to 30 mm without space between them. The foam shall be applied in longitudinal strips or in serpentine pattern. The surface (100 mm x 100 mm) shall be fully covered with foam.

The test sample shall be completed within 180 ± 10 seconds by pressing the second chipboard firmly onto the first chipboard until it touches the spacers.

During curing of at least 2 days at standard conditions, the required thickness (8 ± 1 mm) is controlled by clamping the samples or using weights.

Before testing, the spacers shall be removed and the overlapping foam shall be cut off.

Test procedure:

The test is carried out according to EN 12090 on at least 3 samples at the speed of $(3 \pm 0,5)$ mm/min.

The test results (individual and mean values) shall be expressed in kPa according to EN 12090 (chapter 8).

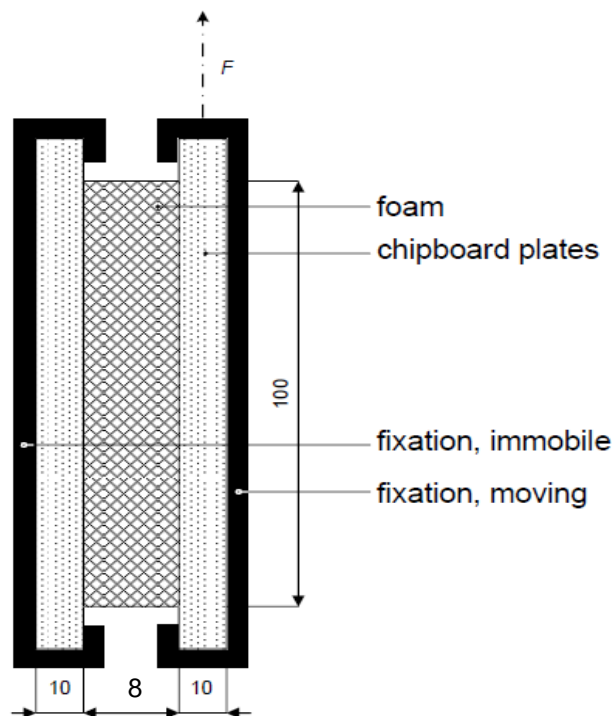


Figure: test sample ready for test