BS EN 12091:2013

BSI Standards Publication

Thermal insulating products for building applications — Determination of freeze-thaw resistance

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/540, Energy performance of materials components and buildings.

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

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EN 12091

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English Version

Thermal insulating products for building applications - Determination of freeze-thaw resistance

Produits isolants thermiques destinés aux applications du bâtiment - Détermination de la résistance aux effets du gel-dégel

Wärmedämmstoffe für das Bauwesen - Bestimmung des Verhaltens bei Frost-Tau-Wechselbeanspruchung

This European Standard was approved by CEN on 15 December 2012.

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Foreword

This document (EN 12091:2013) 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of an identical text or by endorsement, at the latest by September 2013, and conflicting national standards shall be withdrawn at the latest by September 2013.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 12091:1997.

The revision of this standard contains no major changes, only minor corrections and clarifications of an editorial nature.

This European Standard is one of a series of standards which specify test methods for determining dimensions and properties of thermal insulating materials and products. It supports a series of product standards for thermal insulating materials and products which derive from the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (Directive 89/106/EEC) through the consideration of the essential requirements.

This European Standard has been drafted for applications in buildings but it may also be used in other areas where it is relevant.

This European test standard is one of the following group of inter-related standards on test methods for determining dimensions and properties of thermal insulation materials and products, all of which fall within the scope of CEN/TC 88:

— EN 822, *Thermal insulating products for building applications — Determination of length and width*

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

— EN 824, *Thermal insulating products for building applications — Determination of squareness*

— EN 825, *Thermal insulating products for building applications — Determination of flatness*

— EN 826, *Thermal insulating products for building applications — Determination of compression behaviour*

— EN 1602, *Thermal insulating products for building applications — Determination of the apparent density*

— EN 1603, *Thermal insulating products for building applications — Determination of dimensional stability under constant normal laboratory conditions (23 °C/50 % relative humidity)*

— EN 1604, *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*

— EN 1605, *Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions*

— EN 1606, *Thermal insulating products for building applications — Determination of compressive creep*

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

— EN 1608, *Thermal insulating products for building applications — Determination of tensile strength parallel to faces*

— EN 1609, *Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion*

— EN 12085, *Thermal insulating products for building applications — Determination of linear dimensions of test specimens*

— EN 12086, *Thermal insulating products for building applications — Determination of water vapour transmission properties*

— EN 12087, *Thermal insulating products for building applications — Determination of long-term water absorption by immersion*

— EN 12088, *Thermal insulating products for building applications — Determination of long-term water absorption by diffusion*

— EN 12089, *Thermal insulating products for building applications — Determination of bending behaviour*

— EN 12090, *Thermal insulating products for building applications — Determination of shear behaviour*

— EN 12091, *Thermal insulating products for building applications — Determination of freeze-thaw resistance*

— EN 12429, *Thermal insulating products for building applications — Conditioning to moisture equilibrium under specified temperature and humidity conditions*

— EN 12430, *Thermal insulating products for building applications — Determination of behaviour under point load*

— EN 12431, *Thermal insulating products for building applications — Determination of thickness for floating floor insulating products*

— EN 13793, *Thermal insulating products for building applications — Determination of behaviour under cyclic loading*

— EN 13820, *Thermal insulating materials for building applications — Determination of organic content*

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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the equipment and procedures for determining the effect of successive cycling from dry conditions at -20 °C to wet conditions at 20 °C on the mechanical properties and moisture content of the product. It is applicable to thermal insulating products.

It is intended to simulate freeze-thaw effects on thermal insulating products which are frequently exposed to water and low temperature conditions, e.g. inverted roofs and unprotected ground insulation.

This test method is not recommended for all thermal insulating products. If relevant, the product standards will state for which products this standard is applicable.

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 826, *Thermal insulating products for building applications — Determination of compression behaviour*

EN 12087, *Thermal insulating products for building applications — Determination of long term water absorption by immersion*

EN 12088, *Thermal insulating products for building applications — Determination of long term water absorption by diffusion*

3 Terms and definitions

For the purposes of this document, the following term and definition applies.

3.1
freeze-thaw resistance
ability of a product to withstand repeated wetting followed by freezing conditions, quantified by water absorption and change in compression behaviour

4 Principle

The freeze-thaw resistance is determined as the change in the amount of water absorbed and the change in compression strength or stress of a test specimen which is subjected to 300 successive cycles from dry conditions at -20 °C to wet conditions at 20 °C. Testing is carried out in conjunction with either one of the following long term water absorption tests:

a) Water absorption by diffusion according to EN 12088;

b) Water absorption by total immersion according to EN 12087.

The chosen long-term water absorption test a) and/or b) is given in the relevant product standard in accordance to the application. Freezing takes place in the air; thawing in the water.

5 Apparatus

5.1 Cold chamber, with a constant temperature of (-20 ± 2) °C.

5.2 Watertank, with a constant water temperature of (20 ± 2) °C equipped with a device for keeping the test specimen in position.

Normally no accelerated thermal exchange is provided, e.g. fan assistance in the cold chamber or turbulent water circulation in the watertank.

5.3 Balance, which permits reading to 0,1 g.

5.4 Compression testing machine, including measuring devices according to EN 826.

6 Test specimens

6.1 General

The freeze-thaw test shall be made on the same test specimens, referred to as set A, which have been used for the determination of long-term water absorption by diffusion according to EN 12088, or by total immersion according to EN 12087.

6.2 Dimensions of test specimens

The thickness of the test specimens shall be the original product thickness.

The test specimens for set A shall be squares with squarely cut edges having sides of (500 ± 1) mm or (200 ± 1) mm depending on the chosen water absorption test.

6.3 Number of test specimens

The number of test specimens for set A is determined by the requirement that two sets of test specimens for the compression test (set B1 and B2) can be prepared from set A.

The number and dimensions of test specimens for each set B1 and B2 for the compression test shall be as specified in the relevant product standard or any other European Technical Specification. In the absence of such a specification, the number and dimensions of test specimens shall be as defined in EN 826.

The number of test specimens for the long-term water absorption should be adapted accordingly.

6.4 Preparation of test specimens

If possible, the test specimens shall be cut so that they do not include original product edges.

Cutting of the test specimens shall be by methods that do not change the original structure of the product. Any skins, facings and/or coatings shall be retained.

6.5 Conditioning of test specimens

The test specimens shall be stored for at least 6 h at (23 ± 5) °C. In case of dispute they shall be stored at (23 ± 2) °C and (50 ± 5) % relative humidity for the time specified in the relevant product standard with a minimum of 6 h.

7 Procedure

Carry out the freeze-thaw test in accordance with the procedure indicated in Figure 1. All test specimens shall be taken from the same sample.

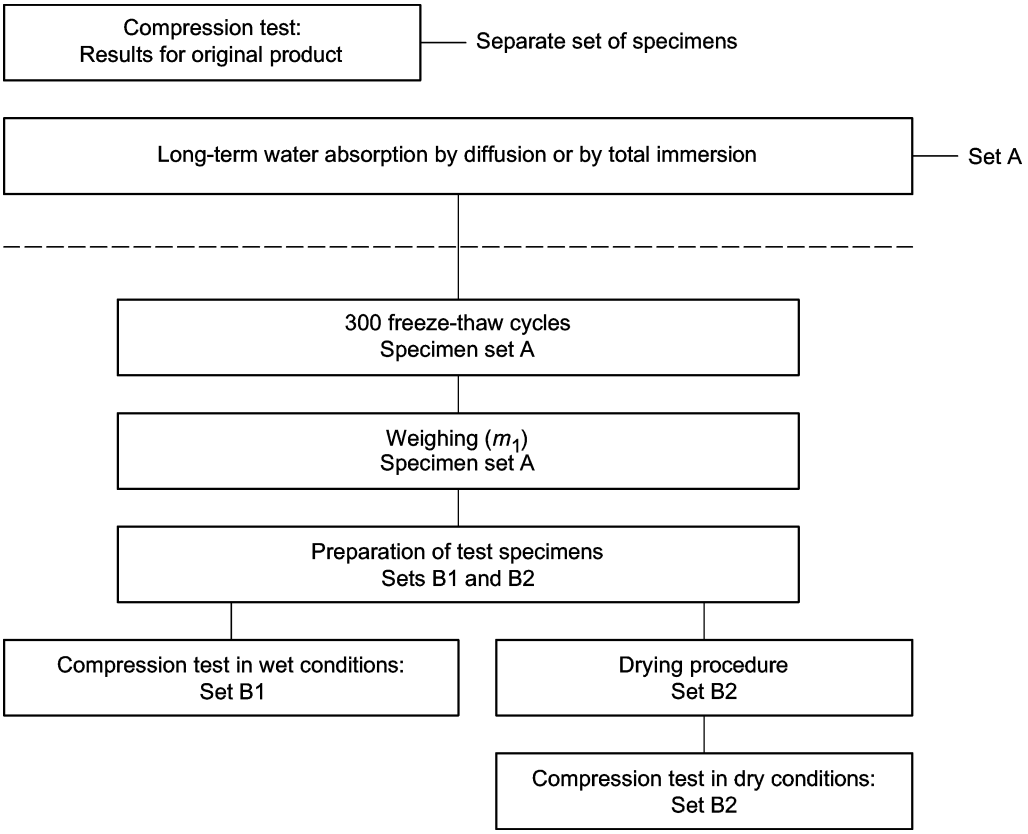

Figure 1 — Flow chart for the test procedure

Determine the compression behaviour of the original product in accordance with EN 826 (σ_m or σ_{10}).

Determine the long-term water absorption of the test specimens using either EN 12088 or EN 12087.

Record m_0, the mass of test specimens at the end of the diffusion test ($m_0 = m_D$) or the total immersion test ($m_0 = m_{28}$).

Place the test specimens in the cold chamber and maintain the temperature at (-20 ± 2) °C for 1 h.

Remove the test specimens from the cold chamber and immerse them in water. Maintain the temperature at (20 ± 2) °C for 1 h.

Continue the test for 300 cycles (see Figure 2).

When there are breaks longer than 1 h, e.g. during the night or the weekend, the test specimens shall be left in the cold chamber.

Determine the mass m_1, of each of the test specimens (set A) to the nearest 0,1 g after completion of all cycles.

Examine the test specimens visually for defects, e.g. cracks, blisters.

Prepare the test specimens for set B1 and set B2.

Determine the compression behaviour of the test specimens, in accordance with EN 826, from set B1 (compression behaviour in wet conditions, $\sigma_{m,wet}$ or $\sigma_{10,wet}$) within 24 h of the last freeze-thaw cycle.

Dry the test specimens from set B2 in a ventilated drying chamber for the time and temperature specified in the relevant product standard or any other European Technical Specification. In the absence of such a

specification, the test specimens shall be dried until constant mass. For the purpose of this test the constant mass is considered as reached, when the change in mass between two subsequent weighings with a 24 h interval is lower than 0,5 % of the total mass at a minimum drying temperature of 40 °C.

Commonly used drying conditions are 105 °C for 24 h, 70 °C for 4 days or 40 °C for 7 days.

Determine the compression behaviour of the test specimens, in accordance with EN 826, from set B2 (compression behaviour in dry conditions, $\sigma_{m,dry}$ or $\sigma_{10,dry}$).

The freeze-thaw test is ideally carried out immediately after the test for long-term water absorption. In the event that this is not possible, the wet test specimens should be wrapped in polyethylene film and stored at ambient laboratory conditions.

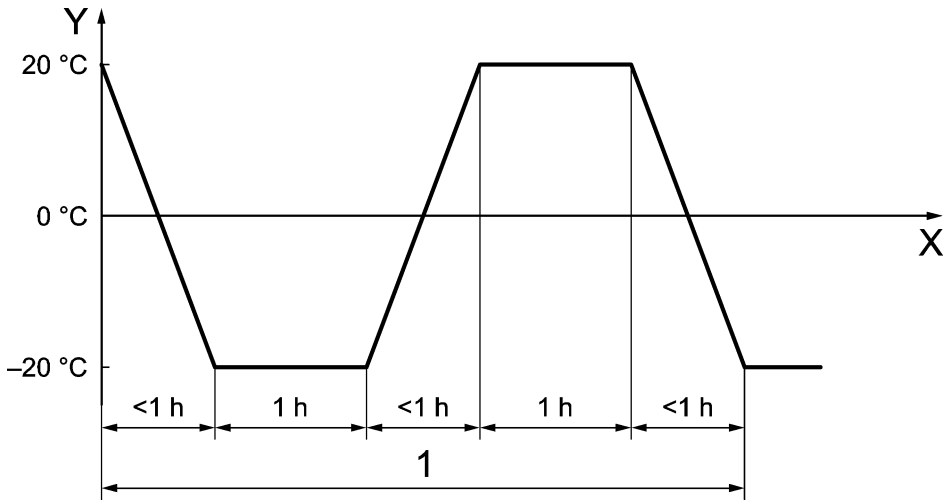

Figure 2 — Test cycle duration

8 Calculation and expression of results

8.1 Water absorption

The test results, W_m or W_v, shall be the mean values of the individual values.

Calculate the water absorption for each test specimen, W_m or W_v, in percent by mass or in percent by volume using Formula (1) or (2):

$$W_m = \frac{m_1 - m_0}{m_0} \times 100 \quad (1)$$

$$W_v = \frac{m_1 - m_0}{V \times \rho_W} \times 100 \quad (2)$$

where

m_1 is the mass of the test specimen after 300 freeze-thaw cycles, in grams;

m_0 is the mass of the test specimen at the end of the water absorption by diffusion or by total immersion, in grams;

V is the volume of the test specimen, in cubic centimetres;

ρ_W is the density of water, assumed to be 1 g/cm^3.

W_m shall be rounded to the nearest 0,1 percent by mass.

W_v shall be rounded to the nearest 0,1 volume percent.

8.2 Changes in the compression behaviour

Calculate the mean change in the compression behaviour based on the test result for each condition, $\Delta\sigma_{wet}$ and $\Delta\sigma_{dry}$, in percent using Formula (3) or (4) and Formula (5) or (6):

$$\Delta\sigma_{wet} = \frac{\sigma_{m,wet}}{\sigma_m} \times 100 \quad (3)$$

or

$$\Delta\sigma_{wet} = \frac{\sigma_{10,wet}}{\sigma_{10}} \times 100 \quad (4)$$

and

$$\Delta\sigma_{dry} = \frac{\sigma_{m,dry}}{\sigma_m} \times 100 \quad (5)$$

or

$$\Delta\sigma_{dry} = \frac{\sigma_{10,dry}}{\sigma_{10}} \times 100 \quad (6)$$

where

$\sigma_{m,wet}$ is the compressive strength of the test specimen in wet conditions, in kilopascals;

$\sigma_{10,wet}$ is the compressive stress of the test specimen at 10 % relative deformation in wet conditions, in kilopascals;

$\sigma_{m,dry}$ is the compressive strength of the test specimen in dry conditions, in kilopascals;

$\sigma_{10,dry}$ is the compressive stress of the test specimen at 10 % relative deformation in dry conditions, in kilopascals;

σ_m is the compressive strength of the original product, in kilopascals;

σ_{10} is the compressive stress at 10 % relative deformation of the original product, in kilopascals.

The result shall be expressed to two significant figures.

9 Accuracy of measurement

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

10 Test report

The test report shall include the following information:

a) reference to this European Standard;

b) product identification:

   1) product name, factory, manufacturer or supplier;

   2) production code number;

   3) type of product;

   4) packaging;

   5) the form in which the product arrived at the laboratory;

   6) presence of facing or coating;

   7) other information as appropriate, e.g. nominal thickness, nominal density;

c) test procedure:

   1) pre-test history and sampling (e.g. who sampled and place of sampling);

   2) conditioning;

   3) deviation from Clauses 6 and 7, if any;

   4) date of testing;

   5) general information relating to the test:

      i) long term water absorption method used;

      ii) temperature;

      iii) relative humidity;

      iv) duration;

      v) dimensions of test specimens;

      vi) number of cycles;

   6) events which may have affected the results. Information about the apparatus and identity of the technician should be available in the laboratory, but it need not be recorded in the report;

d) results

   1) all individual values and the mean values;

   2) any visual observations after the freeze-thaw cycles, e.g. cracks.

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