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Thermal insulating products for building applications — Determination of compression behaviour

Produits isolants thermiques destinés aux applications du bâtiment — Détermination du comportement en compression

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 29469 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*.

Introduction

This International Standard comprises the original EN 826:1996 prepared by Technical Committee CEN/TC 88, *Thermal insulating materials and products*, which has been amended by ISO/TC 163/SC 1 with reference to conditioning and testing conditions in tropical countries.

This International Standard is one of a series of documents specifying test methods, based on existing European Standards, that are being adopted by ISO. This "package" of standards includes the following group of interrelated documents.

International Standard	Respective EN standard
ISO 29465, *Thermal insulating products for building applications — Determination of length and width*	EN 822
ISO 29466, *Thermal insulating products for building applications — Determination of thickness*	EN 823
ISO 29467, *Thermal insulating products for building applications — Determination of squareness*	EN 824
ISO 29468, *Thermal insulating products for building applications — Determination of flatness*	EN 825
ISO 29469, *Thermal insulating products for building applications — Determination of compression behaviour*	EN 826
ISO 29470, *Thermal insulating products for building applications — Determination of the apparent density*	EN 1602
ISO 29471, *Thermal insulating products for building applications — Determination of dimensional stability under constant normal laboratory conditions (23°C/50 % relative humidity)*	EN 1603
ISO 29472, *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*	EN 1604
ISO 29764, *Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions*	EN 1605
ISO 29765, *Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces*	EN 1607
ISO 29766, *Thermal insulating products for building applications — Determination of tensile strength parallel to faces*	EN 1608
ISO 29767, *Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion*	EN 1609
ISO 29768, *Thermal insulating products for building applications — Determination of linear dimensions of test specimens*	EN 12085
ISO 29769, *Thermal insulating products for building applications — Determination of behaviour under point load*	EN 12430

ISO 29770, *Thermal insulating products for building applications — Determination of thickness for floating-floor insulating products*	EN 12431
ISO 29771, *Thermal insulating materials for building applications — Determination of organic content*	EN 13820
ISO 29803, *Thermal insulation products for building applications — Determination of the resistance to impact of external thermal insulation composite systems (ETICS)*	EN 13497
ISO 29804, *Thermal insulation products for building applications — Determination of the tensile bond strength of the adhesive and of the base coat to the thermal insulation material*	EN 13494
ISO 29805, *Thermal insulation products for building applications — Determination of the mechanical properties of glass fibre meshes*	EN 13496

Thermal insulating products for building applications — Determination of compression behaviour

1 Scope

This International Standard specifies the equipment and procedures for determining the compression behaviour of specimens. It is applicable to thermal insulating products and can be used to determine the compressive stress in compressive creep tests and for applications in which insulation products are exposed only to short-term loads.

The method can be used for quality control purposes and can also be employed to obtain reference values from which design values can be calculated using safety factors.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 29768, *Thermal insulating products for building applications — Determination of linear dimensions of test specimens*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
relative deformation
ε
ratio of the reduction in thickness of the test specimen to its initial thickness, d_0, measured in the direction of loading and expressed as a percentage

3.2
compressive strength
σ_m
ratio of the maximum compressive force, F_m, reached when the strain, ε, at yield [see Figure 1 b)] or rupture [see Figure 1 a)] is less than 10 %, to the initial cross-sectional area of the test specimen

3.3
compressive stress at 10 % strain
σ_{10}
ratio of the compressive force, F_{10}, at 10 % strain, ε_{10}, to the initial cross-section of the test specimen [see Figure 1, c) and d)] for products presenting 10 % strain before possible yield or rupture

3.4
compression modulus of elasticity
E
compressive stress divided by the corresponding strain below the proportional limit, when the relationship is linear (see Figure 1)

4 Principle

A compressive force is applied at a given rate of displacement perpendicular to the major faces of a squarely cut test specimen and the maximum stress supported by the specimen calculated.

When the value of the maximum stress corresponds to a strain of less than 10 %, it is designated as compressive strength and the corresponding strain is reported. If no failure is observed before the 10 % strain has been reached, the compressive stress at 10 % strain is calculated and its value reported as compressive stress at 10 % strain.

5 Apparatus

5.1 Compression testing machine, designed to suit the range of force and displacement involved and having two very rigid, polished, square or circular plane parallel platens with a minimum side length (or diameter) equal to the side length (or diagonal) of the test specimen.

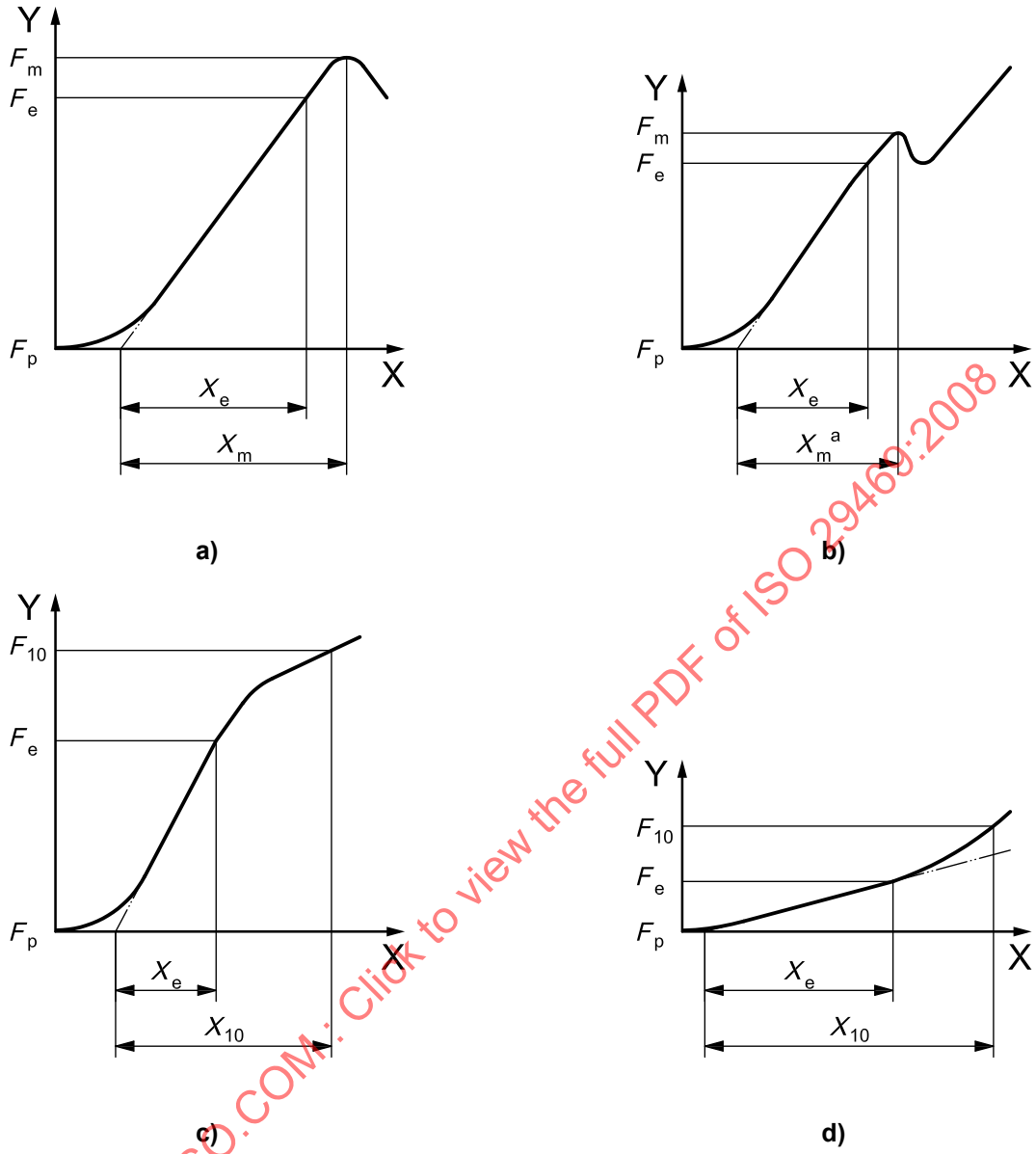
One of the platens shall be fixed and the other shall be movable, with a centrally positioned ball joint to ensure that only axial force is applied to the specimen, if appropriate. The movable platen shall be capable of moving at a constant rate of displacement in accordance with Clause 7.

5.2 Displacement measuring device, fitted to the compression testing machine, which allows continuous measurement of the displacement of the movable platen to an accuracy of ± 5 % or ± 0,1 mm, whichever is smaller (see 5.3).

5.3 Force measuring device, comprised of a sensor fitted to one of the machine platens to measure the force produced by the reaction of the specimen on the platens. This sensor shall be such that either its own deformation during the measuring operation is negligible compared with that of the object being measured or its own deformation shall be taken into account by calculation. In addition, it shall allow the continuous measurement of the force to an accuracy of ± 1 %.

5.4 Recording device, for the simultaneous recording of the force, F, and the displacement, X, which provides a curve of F as a function of X (see 7.2).

NOTE The curve gives additional information on the behaviour of the product and possibly enables the determination of the compression modulus of elasticity.



Key

X displacement
Y force

F_p force corresponding to the preload
F_m maximum force
X_m displacement at maximum force
F_{10} force at 10 % strain
X_{10} displacement at 10 % strain
F_e force corresponding to X_e (conventional proportional limit)
X_e displacement in the conventional elastic zone

[a] X_m is smaller than 10 %.

Figure 1 — Examples of force displacement curves

6 Test specimens

6.1 Dimensions of specimens

The test specimens shall have the original product thickness. The width of the specimens shall be not less than their thickness. Products with integrally moulded skins that are retained in use shall be tested with these skins intact.

Specimens shall not be layered to produce a greater thickness for testing.

Specimens shall be squarely cut and have the following dimensions:

— 50 mm × 50 mm; or

— 100 mm × 100 mm; or

— 150 mm × 150 mm; or

— 200 mm × 200 mm; or

— 300 mm × 300 mm.

The range of dimensions used shall be specified in the relevant product standard.

In the absence of a product standard, the specimen dimensions may be agreed between the parties involved.

The linear dimensions shall be determined in accordance with ISO 29768, to an accuracy of 0,5 %. The tolerance on parallelism and flatness between the two faces of the specimen shall be not greater than 0,5 % of the specimen side length or 0,5 mm, whichever is smaller.

If a specimen is not flat, it shall be ground flat or an adequate coating shall be applied to prepare the surface for the test. No significant deformation shall occur in the coating during the test.

NOTE The accuracy of the test result is reduced if the specimens have a thickness of less than 20 mm.

6.2 Specimen preparation

Specimens shall be cut so that their base is normal to the direction of compression of the product in its intended use. The specimen shall be cut by methods that do not change the structure relative to that of the original product. The method of selecting the specimens shall be as specified in the relevant product standard. In the case of tapered products, the parallelism of the two faces of the specimen shall be in accordance with 6.1.

In the absence of a product standard, the method of selecting the specimens may be agreed between the parties involved.

NOTE Special methods of preparation, when needed, are given in the relevant product standard.

In cases where a more complete characterization of anisotropic materials is desired or where the principal direction of anisotropy is unknown, it can be necessary to prepare additional sets of specimens.

6.3 Number of specimens

The number of specimens shall be as specified in the relevant product standard. In the absence of such a specification, either at least five specimens shall be used or the number of specimens may be agreed between the parties involved.

6.4 Conditioning of specimens

The 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.

In tropical countries, different conditioning and testing conditions can be relevant. In this case, the conditions shall be 27 °C and 65 % RH and be stated clearly in the test report.

7 Procedure

7.1 Test conditions

Testing shall be carried out at (23 ± 5) °C. In case of dispute, it shall be carried out at (23 ± 2) °C and (50 ± 5) % relative humidity.

In tropical countries, different conditioning and testing conditions can be relevant. In this case, the conditions shall be 27 °C and 65 % RH and be stated clearly in the test report.

7.2 Test procedure

Determine the specimen dimensions in accordance with ISO 29768.

Place the specimen centrally between the two platens of the compression testing machine. Preload with a pressure of (250 ± 10) Pa.

If significant deformation occurs under the preload pressure of 250 Pa, a preload corresponding to 50 Pa may be used if this is specified in the relevant product standard. In this case, the thickness, d_0, should be determined under the same preload.

Compress the specimen with the movable platen at a constant rate of displacement that shall be equal to 0,1 d/min (to within ± 25 %), where d is the thickness of the specimen, expressed in millimetres.

Continue compression until the specimen yields, providing a compressive strength value, or until a strain of 10 % has been reached, providing a compressive stress at 10 % strain.

Plot the force-displacement curve.

8 Calculation and expression of results

The results are the mean values of the measurements, which shall be expressed to three significant figures. Results should not be extrapolated to other thicknesses.

Depending on the deformation behaviour (see 7.2), σ_m and ε_m or σ_{10} (see Clause 3) shall be calculated.

8.1 Compressive strength and corresponding strain

8.1.1 Compressive strength

Calculate the compressive strength, σ_m, expressed in kilopascals, using Equation (1):

$$\sigma_m = 10^3 \frac{F_m}{A_0} \quad (1)$$

where

F_m is the maximum force, expressed in newtons;

A_0 is the initial cross-sectional area of the specimen, expressed in square millimetres.

8.1.2 Strain

Determine the zero-deformation point. Extend to the F_p-zero force line the steepest straight portion of the force-displacement curve using, for example, a straight edge (see 5.4).

Measure all displacements to calculate the strain from this zero-deformation point corresponding to F_p = (250 ± 10) Pa.

NOTE Illustration of this procedure is shown for four examples in Figure 1.

Calculate the strain, ε_m, expressed as a percentage, using Equation (2):

$$\varepsilon_m = \frac{X_m}{d_0} 100 \quad (2)$$

where

X_m is the displacement corresponding to the maximum force reached, expressed in millimetres;

d_0 is the initial thickness (as measured) of the specimen, expressed in millimetres.

8.2 Compressive stress at 10 % strain

Calculate the compressive stress at 10 % strain, σ_{10}, expressed in kilopascals, using Equation (3):

$$\sigma_{10} = 10^3 \frac{F_{10}}{A_0} \quad (3)$$

where

F_{10} is the force corresponding to a strain of 10 %, expressed in newtons;

A_0 is the initial cross-sectional area of the specimen, expressed in square millimetres.

NOTE If required, the compressive stress for strains lower than 10 % can also be calculated.

8.3 Compression modulus of elasticity

If required, calculate the compression modulus of elasticity, E, expressed in kilopascals, using Equations (4) and (5):

$$E = \sigma_e \frac{d_0}{X_e} \tag{4}$$

where

$$\sigma_e = 10^3 \frac{F_e}{A_0} \tag{5}$$

F_e is the force at the end of the conventional elastic zone (distinct, straight portion of the force-displacement curve), expressed in newtons;

X_e is the displacement at F_e, expressed in millimetres.

If there is no distinct, straight portion of the force-displacement curve or if the zero-deformation point obtained in accordance with 8.1.2 results in a negative value, this procedure shall not be used. In such cases, the zero-deformation point shall be the deformation corresponding to a stress of (250 ± 10) Pa.

9 Accuracy

An inter-laboratory test was performed with ten laboratories in 1993. Four products with different compression behaviour were tested, three of which were used for statistical evaluation of reproducibility (two test results for each product), and one product was used for statistical evaluation of repeatability (five test results).

The results, analysed in accordance with ISO 5725-2, are given in Tables 1 and 2.

Table 1 — Compressive strength, σ_m, or compressive stress at 10 % strain, σ_{10}

Range	95 kPa to 230 kPa %
Estimate of repeatability standard deviation, s_r	0,5
95 % repeatability limit	2
Estimate of reproducibility standard deviation, s_R	3
95 % reproducibility limit	9

Table 2 — Compression modulus of elasticity, E

Range	2 500 kPa to 8 500 kPa %
Estimate of repeatability standard deviation, s_r	3
95 % repeatability limit	8
Estimate of reproducibility standard deviation, s_R	10
95 % reproducibility limit	25

The above-mentioned terms are applied as described in ISO 5725-2.

10 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) product identification:

   1) product name, factory, manufacturer or supplier,

   2) production code number,

   3) type of product,

   4) packaging,

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

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

c) test procedure:

   1) pre-test history and sampling (e. g. sampling site and person taking the specimens),

   2) conditioning,

   3) any deviations from Clauses 6 and 7,

   4) conditioning and testing conditions in tropical countries, if applicable,

   5) date of testing,

   6) dimensions and number of test specimens,

   7) kind of surface treatment (grinding or type of coating),

   8) general information relating to the test,

   9) any events which may have affected the results;

NOTE It is expected that information about the apparatus and identity of the technician be available in the laboratory, but it is not necessary that it be recorded in the report.

d) results: all individual values of compressive strength and corresponding strain or compressive stress at 10 % strain, mean value, and the compression modulus of elasticity, if required.