INTERNATIONAL STANDARD

ISO
12344

First edition
2010-05-01

Thermal insulating products for building applications — Determination of bending behaviour

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

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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 12344 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*.

ISO 12344 is based on EN 12089:1997, prepared by Technical Committee CEN/TC 88, *Thermal insulating materials and products*. However,

— 6.4, Conditioning of the test specimens,

— 7.1, Test conditions, and

— Clause 10, Test report,

have been modified to reflect the conditions for tropical countries.

Introduction

This International Standard is based on EN 12089:1997, 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 test 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	Title	Respective EN standard
ISO 12344	*Thermal insulating products for building applications — Determination of bending behaviour*	EN 12089
ISO 12968	*Thermal insulation products for building applications — Determination of the pull-off resistance of external thermal insulation composite systems (ETICS) (foam block test)*	EN 13495
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 bending behaviour

1 Scope

This International Standard specifies the equipment and procedures for determining the bending behaviour of full-size products (Method A) and test specimens (Method B) under the action of three-point loading. It is applicable to thermal insulating products for building applications.

The test is designed to determine the bending strength of products and their deflection at a given load.

The method can be used to determine the resistance of the product to bending stresses during transport and application.

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 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

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*

ISO 29465, *Thermal insulating products for building applications — Determination of length and width*

ISO 29466, *Thermal insulating products for building applications — Determination of thickness*

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

3 Terms and definitions

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

3.1
bending strength
σ_b
maximum stress calculated from the maximum force, F_m, recorded during the bending procedure

3.2
bending stress
σ_X
stress calculated from the force, F_X, at the deflection, X

3.3
deflection
X
vertical displacement of the test specimen at mid-span, at the force F_X, measured at the loading edge

4   Principle

The test method consists of applying, at a given speed, a force, F, by means of a loading edge in an axial direction to the faces of a squarely cut rectangular test specimen, which is placed on two support edges. The force is applied to the test specimen at a position midway between the supporting positions, length $L/2$ (see Figure 1).
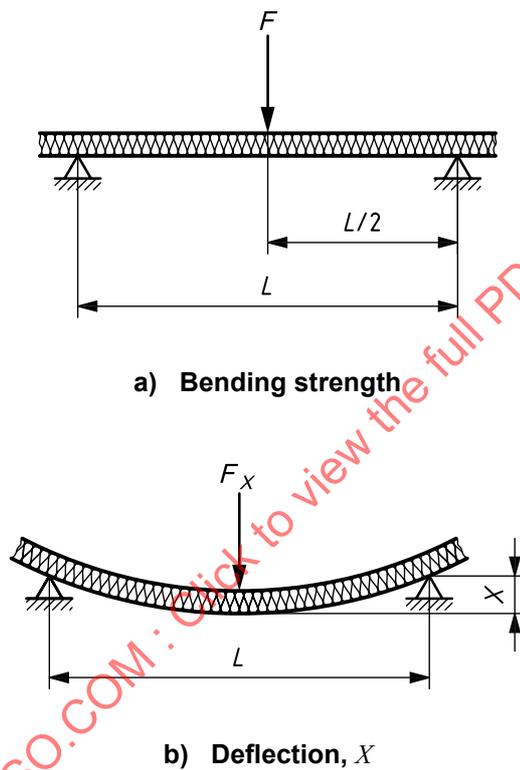

a)   **Bending strength**

b)   **Deflection,** X

Figure 1 — Principle of test method

5   Apparatus

5.1   Test machine, suitable for the range of force and displacement involved, and with a loading edge and adjustable support edges.

The test machine shall be capable of operating at a constant rate of movement of the movable head.

The test machine includes the elements described in 5.1.1 to 5.1.3.

5.1.1   Two adjustable support edges, comprising the test specimen supports of two adjustable cylindrical support edges placed parallel to each other and in the same horizontal plane. The diameter of the supports shall be (80 ± 3) mm or (30 ± 3) mm (see Figure 2). The length of the support edges shall be at least equal to the width of the test specimens.

The span, L (see Figure 2), between the support edges shall be adjustable in the range 300 mm to 1 200 mm (Method A) or 200 mm to 500 mm (Method B).

5.1.2   Loading edge, with the same shape and dimensions as the support edges. The loading edge shall be located centrally between and parallel to the supporting edges.

5.1.3   Load distribution plates, made of steel, with a thickness of at least 1 mm for products which may be subject to crushing by the loading and support edges. The width of the distribution plates shall be (30 ± 1) mm or (80 ± 3) mm and their length shall be at least equal to the width of the test specimen.

5.2   Measuring devices for displacement and force

5.2.1   Measurement of displacement

The test machine shall be fitted with a system that allows continuous measurement of the displacement of the movable loading edge with an accuracy of ± 5 % or $\pm 0,1$ mm, whichever is the smaller. The measured displacement corresponds to the deflection, X, of the test specimen.

5.2.2   Measurement of force

A force sensor shall be fixed to the loading edge in order to measure the force, F, produced by the reaction of the test specimen upon the edges during the test. This sensor shall be such that its own deformation during the course of the measuring operation is negligible compared with that being measured or may be taken into account by calculation. In addition, it shall allow the continuous measurement of the force at all times permitting readings to ± 1 %.

A device shall be used for the simultaneous recording of the force, F, and the deflection, X, to provide the force-deflection curve, required in Clause 7.
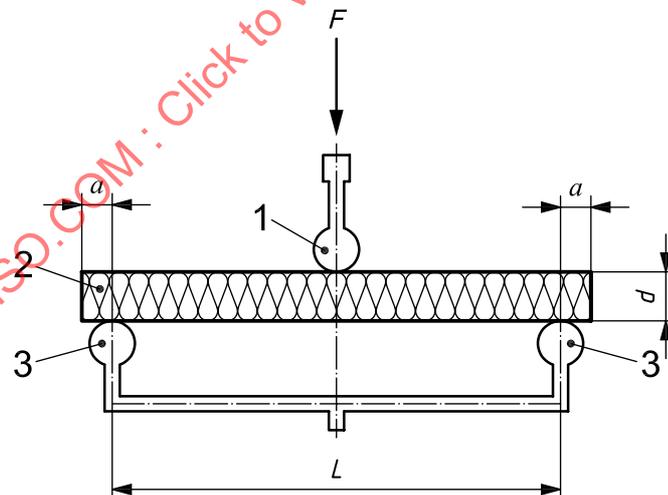
Key

1   loading edge
2   test specimen with thickness d
3   support edges
a 50 mm for Method A, 25 mm for Method B
L span between the support edges

Figure 2 — Principles of apparatus for testing of bending behaviour

6 Test specimens

6.1 Dimensions of test specimens

6.1.1 Method A

The test specimen is a full-size product. It shall be a squarely cut rectangle having the following dimensions:

— thickness: original product thickness;

— length: length of the full-size product, with a maximum of 1 300 mm;

— width: width of the full-size product. If this is impossible because of limitations caused by the testing machine, the width shall be at least 300 mm.

6.1.2 Method B

The test specimen shall be a squarely cut rectangle having the following dimensions:

— thickness: original product thickness with a maximum of 100 mm;

— length: 5 times the nominal thickness plus 50 mm (but not greater than 550 mm);

— width: 150 mm.

Other dimensions of the test specimen may be given in the relevant product standard or any other European technical specification, or agreed between the parties involved.

6.2 Number of test specimens

The number of test specimens shall be as specified in the relevant product standard or any other European technical specification. In the absence of such a specification, at least three test specimens shall be used.

In the absence of a product standard or any other European technical specification, the number of test specimens may be agreed between the parties involved.

If the direction of the bending force on the product in its application is not known, and/or the product has different surface skins, facings and/or coatings on its two main faces, then additional sets of test specimens shall be used.

6.3 Preparation of test specimens

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

6.4 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 stated in the relevant product standard with a minimum of 6 h.

In tropical countries, different conditioning and testing conditions can be relevant. In this case, the conditions shall be (27 ± 2) °C and (65 ± 5) % relative humidity and shall be stated clearly in the test report.

7 Procedure

7.1 Test conditions

The test shall be carried out at $(23 \pm 5)\,°C$. In case of dispute, it shall be carried out at $(23 \pm 2)\,°C$ and $(50 \pm 5)\,\%$ relative humidity.

In tropical countries, different conditioning and testing conditions can be relevant. In this case, the conditions shall be $(27 \pm 2)\,°C$ and $(65 \pm 5)\,\%$ relative humidity and shall be stated clearly in the test report.

7.2 Test procedure

Measure the length and width for full-size products (Method A) in accordance with ISO 29465 and the thickness in accordance with ISO 29466.

Measure the length, width and thickness of test specimens (Method B) in accordance with ISO 29768 with an accuracy of $\pm 1\,\%$.

The span, L, between the support edges shall be within $\pm 0,5\,\%$ of the following:

— Method A: the length of the full-size product minus 100 mm;

— Method B: five times the nominal thickness.

Other spans may be given in the relevant product standard or agreed between the parties involved.

Place the test specimen symmetrically upon the support edges, such that the direction of loading is perpendicular to the longitudinal axis of the test specimen.

Adjust the speed of the test machine to 10 mm/min, with a tolerance of $\pm 10\,\%$.

Record the force-deflection curve and note the maximum force, F_m, obtained (see Figure 3).

Record the way in which the product failed.

8 Calculation and expression of results

8.1 General

The results shall be the mean values of the individual values and shall be expressed to three significant figures.

The results shall not be extrapolated to other thicknesses.

8.2 Bending strength

Calculate the bending strength, σ_b, in kilopascals, using Equation (1):

$$\sigma_b = 3 \times 10^3 \times \frac{F_m \times L}{2 \times b \times d^2} \tag{1}$$

where

F_m is the maximum applied force, in newtons;

L is the span between the support edges, in millimetres;

b is the width of the test specimen, in millimetres;

d is the thickness of the test specimen, in millimetres.

8.3 Bending stress and deflection

All displacements, X, and the corresponding force, F_X, can be derived from the force-deflection curve. This procedure is illustrated in Figure 3.

The bending stress, σ_X, in kilopascals, is calculated using Equation (2):

$$\sigma_X = 3 \times 10^3 \times \frac{F_X \times L}{2 \times b \times d^2} \tag{2}$$

where

F_X is the applied force corresponding to the displacement, X, in newtons;

L is the span between support edges, in millimetres;

b is the width of the test specimen, in millimetres;

d is the thickness of the test specimen, in millimetres.

NOTE 1   This method is not intended for the calculation of the bending modulus of elasticity.

NOTE 2   The calculated stress, σ_X, is not a material constant; it is dependent on the test and product parameters and cannot be compared with other mechanical properties.
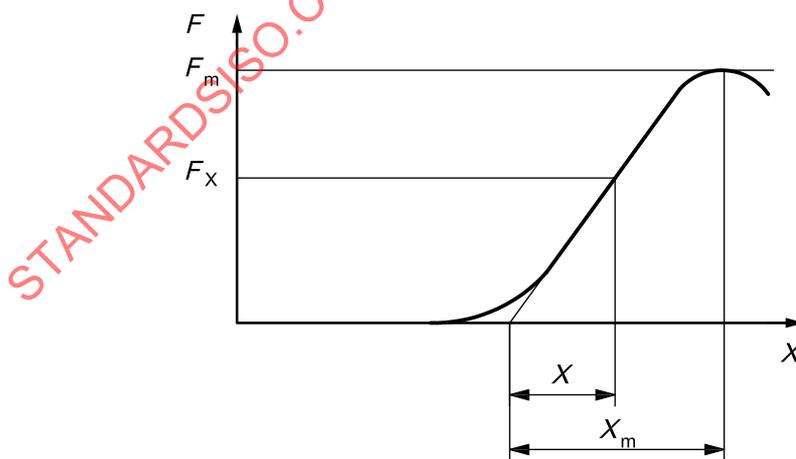
Key

F_m maximum force

F_X force corresponding to the displacement X

X_m displacement for maximum force F_m

X displacement for force F_X

Figure 3 — Example of a force-deflection curve