BRITISH STANDARD

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Thermal insulating products for building applications — Determination of behaviour under cyclic loading

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ICS 91.100.60

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National foreword

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EUROPEAN STANDARD

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English version

Thermal insulating products for building applications - Determination of behaviour under cyclic loading

Produits isolants thermiques destinés aux applications du bâtiment - Détermination du comportement sous charge cyclique

Wärmedämmstoffe für das Bauwesen - Bestimmung des Verhaltens unter zyklischer Belastung

This European Standard was approved by CEN on 1 August 2003.

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Contents

Foreword

This document (EN 13793:2003) 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of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

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 may also be used in other areas where it is relevant.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies equipment and procedures for determining behaviour of test specimens under cyclic loading conditions. It is applicable to thermal insulating products.

The selection of the conditions of the test shall be derived from the specific requirements of the intended application.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

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

3 Terms and definitions

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

3.1
thickness, d_s
initial thickness of the test specimen

3.2
compressive stress, $_c$
compressive force referred to the initial area of the cross section of the test specimen

¾ $_{min}$: Lower stress level of one load cycle;

¾ $_{max}$: Upper stress level of one load cycle.

3.3
deformation, *X*
reduction in thickness of the test specimen equal to $X_i - X_0$ both for $X_{i, min}$ and $X_{i, max}$

¾ $X_{i, min}$: Reduction in thickness of the test specimen under the lower stress level, $_{min}$, at a given number of load cycles, i;

¾ $X_{i, max}$: Reduction in thickness of the test specimen under the upper stress level, $_{max}$, at a given number of load cycles, i.

3.4
relative deformation,
quotient of the deformation *X* of the test specimen and its thickness d_s

3.5
load cycle
cycle during which the compressive force is applied to the test specimen, starting at $_{min}$, to be increased to $_{max}$ and then reduced back to $_{min}$, so that the cycle of loading and unloading describes a type of sine wave, where $_{min}$ is the bottom and $_{max}$ is the top of the wave

4 Principle

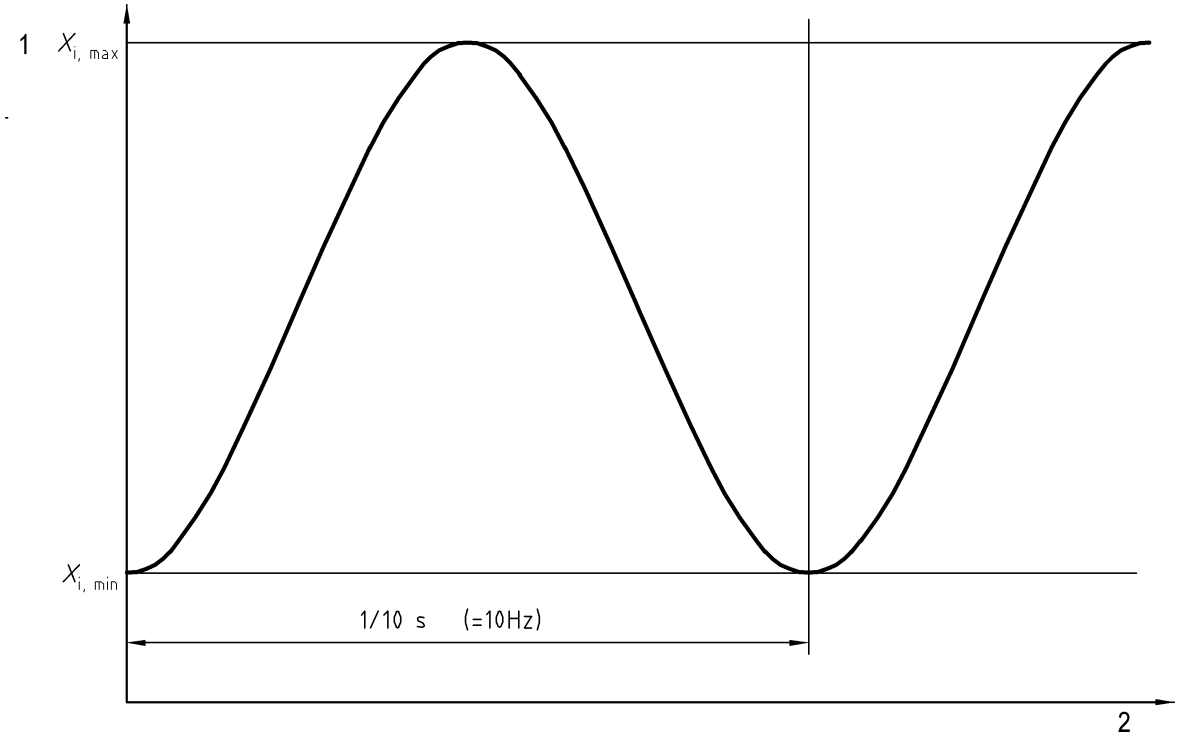
The vertical deformation of test specimens subjected to repetitive load cycles is determined.

5 Apparatus

5.1 Testing machine

A testing machine appropriate for the range of force and displacement involved with two rigid, polished, square or circular plane parallel plates of which the length of one side (or the diameter) is at least as large as the test specimen side (or diagonal) to be tested. One of the plates shall be fixed and the other movable with a centrally positioned ball joint, if appropriate, to ensure that only axial force is applied to the test specimen. The movable plate shall be capable of following a sinusoidal waveform displacement in accordance with the conditions laid down in clause 7 and illustrated in Figure 1.

NOTE The load cycle should be considered as a sinusoidal waveform if the deviation of the actual curve compared to the theoretical sine curve at every point following the time axis does not exceed 5 % of the duration of one cycle.



Key

1 Displacement
2 Time

Figure 1 — Illustration of a load cycle

5.2 Measurement of displacement

Device for the measurement of the displacement fitted to the compression testing machine which allows continuous measurement of the displacement of the movable plate or of the distance between the two plates and which permits reading to ± 5 % or ± 0,1 mm, whichever is the smaller (see 5.3).

5.3 Measurement of force

Sensor fitted to one of the machine plates to measure the force produced by the reaction of the test specimen upon the plates. This sensor shall be such that its own deformation during the course of the measuring operation is negligible compared with that being measured or if not, it shall be taken into account by calculation. The sensor shall allow the continuous measurement of the force permitting reading to ± 3 %.

5.4 Recording device

Device for the simultaneous recording of the force, *F*, and the displacement, *X*, which provides a curve of *F* as a function of *X*.

NOTE It is most likely that only those machines, which incorporate a high precision aligned loading frame with a servo-hydraulic system control and a computer controlled actuator will comply with the required level of accuracy.

The measuring devices for displacement and force are likely to comprise electronic transducers and sensors. In order to achieve the maximum level of accuracy, it is desirable that all test controlling, data generation and data management (including all output of tables and plots) are concentrated in one computer system.

6 Test specimens

6.1 Dimensions of test specimens

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

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

Test specimens shall be squarely cut and square with recommended cross section areas as follows:

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 choice of dimensions to be used shall be as specified in the relevant product standard.

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

The linear dimensions shall be determined in accordance with EN 12085 with a limit deviation of ± 0,5 %.

The tolerance on parallelism and flatness between the two faces of the test specimen shall not be greater than 0,5 % of the specimen side with a maximum of 0,5 mm.

If the test specimens are not flat, they shall be ground flat or an appropriate levelling layer shall be applied to prepare the surface for the test. No significant deformation shall occur in the levelling layer during the test.

In case that a gypsum levelling layer is used, the determination of the dimensions shall occur prior to the application of the layers.

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

6.2 Number of test specimens

The number of test specimens shall be as specified in the relevant product standard. In the absence of such a specification, five test specimens shall be used for each stress selected.

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

6.3 Preparation of test specimens

The test specimens shall be cut so that they do not include product edges. The test specimens shall be prepared by methods that do not change the original structure of the product. Any skins, facings and/or coatings shall be retained.

NOTE Special methods of preparation, when needed, are given in the relevant product standard or any other European technical specification.

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 specified in the relevant product standard, for a minimum of 6 h.

7 Procedure

7.1 Test conditions

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

7.2 Stress selection

The test is carried out at one or more different stresses.

The different stresses, $_{max}$, for the cyclic load investigation shall be based on either the compressive strength, $_{m}$, or the compressive stress at 10 % deformation, $_{10}$, measured in accordance with EN 826, and shall be calculated as follows:

¾ $_{max} = 0,15 \times _{m}$ or $_{max} = 0,15 \times _{10}$

¾ $_{max} = 0,20 \times _{m}$ or $_{max} = 0,20 \times _{10}$

¾ $_{max} = 0,25 \times _{m}$ or $_{max} = 0,25 \times _{10}$

¾ $_{max} = 0,30 \times _{m}$ or $_{max} = 0,30 \times _{10}$

¾ $_{max} = 0,35 \times _{m}$ or $_{max} = 0,35 \times _{10}$

If appropriate other values of $_{max}$ may be chosen.

The corresponding stresses $_{min}$ shall be 5 % of the respective $_{max}$.

7.3 Frequency selection

The test is carried out at a frequency within the range of 0,5 Hz to 10 Hz.

The frequency shall be selected so that any possible increase of the temperature in the center of the test specimen will not affect the test result.

The load cycle, following a sinusoidal waveform, is applied at a required number of cycles per second. The frequency of the wave shall be given in the relevant product standard or may be agreed upon between parties within the range given above.

NOTE Different frequencies can lead to different results.

7.4 Number of load cycles

The number of load cycles shall be such that:

¾ the relative deformation of the test specimen, at the maximum stress, reaches 5 % or

¾ failure if this should occur first.

In any event the maximum number of load cycles shall not exceed 2×10^6.

If appropriate other levels for the maximum relative deformation and/or the maximum number of load cycles may be chosen.

7.5 Test procedure

Determine the linear dimensions of the test specimen in accordance with EN 12085 with a limit deviation of ± 0,5 %.

Place the test specimen centrally between the two parallel plane plates of the compression testing machine.

Preload the test specimen to $_{min}$ ± 50 %, record $X_{0,\,min}$, compress with the movable plate to reach the maximum stress $_{max}$ ± 5 %, record $X_{0,\,max}$, then reduce the load back to $_{min}$ (one complete load - cycle).

Continue testing at a constant load cycle frequency until the deformation limits or the maximum number of load cycles as defined in 7.4 are reached.

Read and continuously record the deformation $X_{i,\,min}$ and $X_{i,\,max}$ during the course of the test.

Record the number of load cycles at which the test specimens relative deformations reach 1 %, 2 %, 3 %, 4 % and 5 % at $_{max}$.

If appropriate other values of relative deformation may be chosen.

Terminate the test as soon as the specified maximum relative deformation of the test specimen is reached or when failure occurs or when the maximum number of load cycles is reached.

The test shall be deemed to be invalid if interrupted.

8 Calculation and expression of results

The test results shall be the mean value of the individual values. They shall be expressed to three significant figures.

Results shall not be extrapolated to any other thickness.

Tabulate the deformation values, $X_{i,\,min}$ and $X_{i,\,max}$, in millimetres, and the relative deformation values, $_{i,\,min}$ and $_{i,\,max}$, as percentages for each test specimen together with the respective number of load cycles.

Calculate the relative deformation, $_{i,\,min}$ and $_{i,\,max}$, as percentages using the equations (1) and (2):

$$_{i,min} = \frac{X_{i,min} \quad X_{0,min}}{d_s} \quad 100 \tag{1}$$

$$_{i,max} = \frac{X_{i,max} \quad X_{0,max}}{d_s} \quad 100 \tag{2}$$

where:

X_i is the deformation at $_{min}$ and $_{max}$ after the cyclic loading, in millimetres;

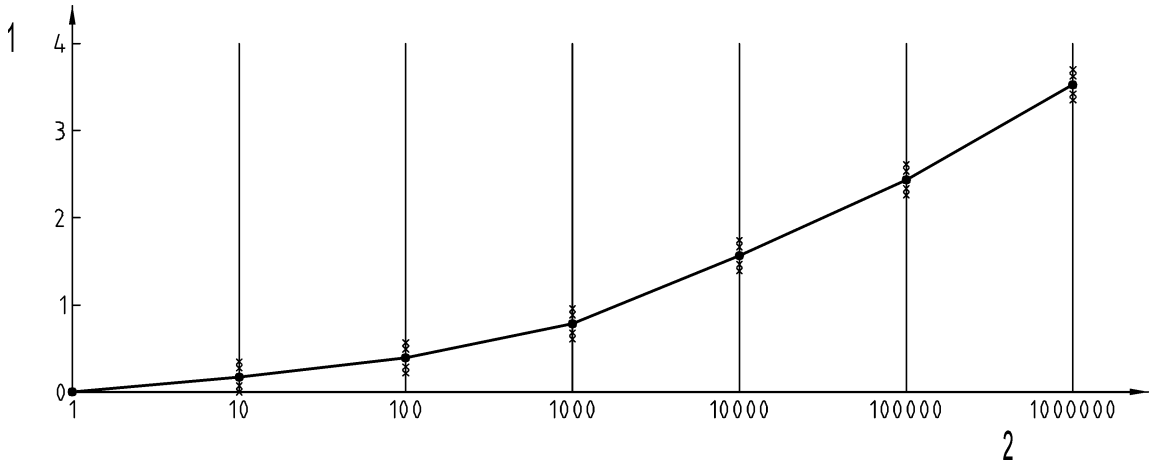
X_i is the deformation at X_0 is the deformation at $_{min}$ and $_{max}$ before the cyclic loading, in millimetres;

d_s is the initial thickness of the test specimen, in millimetres.

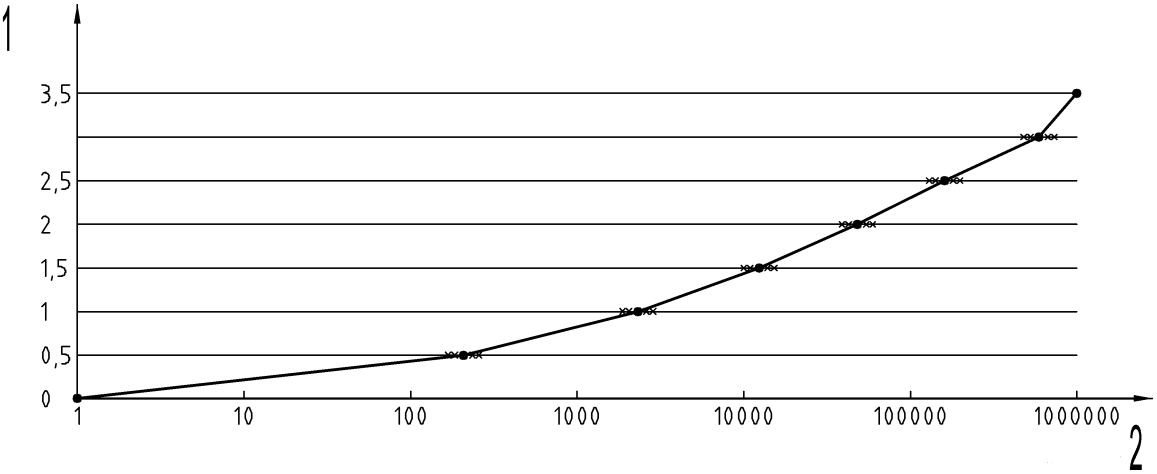
The relative deformation for each test specimen and the mean value of the relative deformation of the test specimens for each chosen stress level shall be plotted in one or more linear/logarithmic (number of load cycles) diagrams, and the results of the 1 % to 5 % relative deformation intermediate readings shall be indicated on the plots (see Figures 2a and 2b).

If more than one stress level has been chosen the compressive stress versus number of load cycles for different relative deformations shall be plotted in a linear/logarithmic (number of load cycles) diagram for each relative deformation (see Figure 3).

Results obtained under different test conditions shall not be compared.



a) Selected number of load cycles

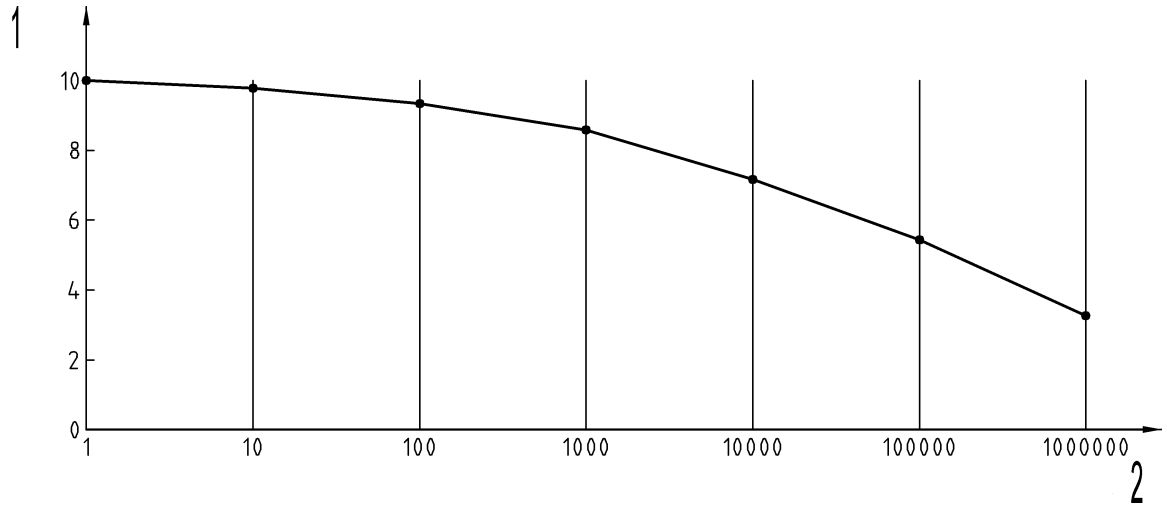


b) Selected percentage of relative deformation

Key

1 Relative deformation at $_{max}$, in %
2 Number of load cycles

Figure 2 — Examples of relative deformation versus number of load cycles at one fixed stress



Key

1 Compressive Stress at $_{max}$, in kPa
2 Number of load cycles

Figure 3 — Example of compressive stress versus number of load cycles for a fixed relative deformation of 4 %

9 Accuracy of measurement

NOTE It has not been possible to include a statement on the accuracy of the measurements 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) other information as appropriate, e.g. nominal thickness, nominal density;

c) Test procedure

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

   2) conditioning;

   3) if any deviation from clauses 6 and 7;

4) date of testing;

5) number of test specimens;

6) selected stress levels, $_{min}$ and $_{max}$, frequency, and number of load cycles;

7) general information relating to the test;

8) events which may have affected the results;

NOTE 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) tabulated values of the deformations and the relative deformations;

2) $_{i, min}$ and $_{i, max}$ after the specified number of load cycles, or the number of load cycles at which $_{i, max}$ and 5 % relative deformation occurred together with the corresponding value for $_{i, min}$;

3) if available, linear/logarithmic diagrams showing stress versus number of load cycles at 1 %, 2 %, 3 %, 4 % and 5 % relative deformation for each test specimen;

4) if failure occurs, report the stress level and the number of load cycles.

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