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Rigid cellular plastics — Determination of compression properties

Plastiques alvéolaires rigides — Détermination des caractéristiques de compression

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

This sixth edition cancels and replaces the fifth edition (ISO 844:2007), which has been technically revised to specify the choice of the procedure for the determination of the compressive strength and corresponding relative deformation, the compressive stress at 10 % relative deformation and the compressive modulus of rigid cellular plastics.

Rigid cellular plastics — Determination of compression properties

1 Scope

This International Standard specifies a method of determining:

a) the compressive strength and corresponding relative deformation,

or

b) the compressive stress at 10 % relative deformation,

and

c) when desired, the compressive modulus of rigid cellular plastics.

There are two procedures:

— Procedure A employs crosshead motion for determination of compressive properties. Procedure A is intended to be used when compressive stress at 10 % relative deformation has to be determined.

— Procedure B employs strain measuring devices mounted on the specimen (contact extensometer) or similar device which measures directly sample deformation. Procedure B is intended to be used when compressive modulus has to be determined.

NOTE Compressive strength (at maximum load) can be determined either with Procedure A and B.

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.

ISO 1923, *Cellular plastics and rubbers — Determination of linear dimensions*

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 relation to its initial value) in thickness of the test specimen (Procedure A) or of extensometer gauge length (Procedure B)

Note 1 to entry: It is expressed as a percentage.

Note 2 to entry: ε_m is the relative deformation corresponding to σ_m (see 3.2).

3.2
compressive strength
σ_m
maximum compressive force F_m divided by the initial cross-sectional area of the test specimen when the relative deformation ε is < 10 %

3.3
compressive stress at 10 % relative deformation
σ_{10}
ratio of the compressive force F_{10} at 10 % relative deformation ε_{10} to the initial cross-sectional area of the test specimen

3.4
compressive modulus of elasticity
E
compressive stress divided by the corresponding relative deformation below the proportional limit, i.e. when the relation is linear

4 Symbols and abbreviated terms

A_0	initial cross-sectional area, in square millimetres
E	compressive modulus of elasticity, in megapascals
F_e	force corresponding to x_e (conventional proportional limit), in newtons
F_m	maximum force, in newtons
F_{10}	force at 10 % relative deformation, in newtons
h_0	initial thickness of test specimen (Procedure A) or extensometer gauge length (Procedure B), in millimetres
ε_m	relative deformation corresponding to compressive strength σ_m, in percent
σ_m	compressive strength, in megapascals
σ_{10}	compressive stress at 10 % relative deformation, in megapascals
x_e	displacement at F_e in the conventional elastic zone, in millimetres
x_m	displacement at maximum force, in millimetres
x_{10}	displacement at 10 % relative deformation, in millimetres

5 Principle

A compressive force is applied in an axial direction to the faces of test specimen.

The maximum stress supported by the test specimen is calculated.

If the value of the maximum stress corresponds to a relative deformation of less than 10 %, it is noted as the “compressive strength”. Otherwise, the compressive stress at 10 % relative deformation is calculated and its value noted as the “compressive stress at 10 % relative deformation”.

6 Apparatus

6.1 Compression-testing machine

Use a compression-testing machine suited to the range of force and displacement involved and having two square or circular plane, parallel plates which are polished and cannot be deformed and of which the length of one side (or the diameter) is at least 10 cm. One of the plates shall be fixed and the other movable; the latter shall be capable of moving at a constant rate of displacement in accordance with the conditions laid down in Clause 8. Neither plate shall be self-aligning.

6.2 Devices for measuring displacement and force

6.2.1 Measurement of displacement

Procedure A — The compression-testing machine shall be fitted with a system allowing continuous measurement of the displacement *x* of the movable plate with an accuracy of ± 5 % or ± 0,1 mm if this latter value is a more accurate measurement (see second paragraph in 6.2.2).

Procedure B — The measure of displacement shall be obtained by attaching an extensometer to the sample or by using similar devices that measure directly the sample deformation, with an accuracy of ± 1 %.

6.2.2 Measurement of force

A force sensor shall be fixed to one of the machine plates in order to measure the force *F* produced by the reaction of the test specimen upon the plates during the test. This sensor shall be such that its own deformation during the course of the measurement operation is negligible compared with that being measured and, in addition, it shall allow the continuous measurement of the force at any point in time with an accuracy of ± 1 %.

It is recommended that a device be used for the simultaneous recording of the force *F* and the displacement *x* that allows, by obtaining a curve of $F = f(x)$, the graphical determination of the pair of values *F*, *x* required in Clause 9 with the accuracy laid down in 6.2.1 and this subclause, and provides additional information on the behaviour of the product.

6.2.3 Calibration

Devices for measuring and, if applicable, recording graphically the force and displacement produced by the test machine shall be checked periodically. The devices shall be checked by using a series of standard weights, the masses of which are known to accuracies better than ± 1 % and which correspond to the forces applied during the test. To check the devices, spacers shall be used which have thicknesses known to accuracies better than either ± 0,5 % or ± 0,1 mm, whichever is more restrictive.

6.3 Instruments for measuring the dimensions of the test specimens

These instruments shall be in accordance with ISO 1923.

7 Test specimens

7.1 Dimensions

The test specimens shall be (50 ± 1) mm in thickness except for products with moulded skins which are intended to remain integral with the product in use. With such products, the specimens shall be the full thickness, provided that the minimum thickness is 10 mm or greater and that the maximum thickness is not greater than the width or diameter of the specimen.

The test specimen base shall be either square or circular, with a minimum area of 25 cm^2 and maximum of 230 cm^2. The preferred geometry and dimensions are a right prism with a base of (100 ± 1) mm × (100 ± 1) mm.

The distance between two faces shall not vary by more than 1 % (tolerance on parallelism).

Under no circumstances may several test specimens be piled up to produce a greater thickness for testing.

Since sample geometry and dimensions may have an influence on results, it is recommended to compare results only if obtained by testing samples having the same geometry and dimensions.

7.2 Preparation

Test specimens shall be cut so that the specimen base is normal to the direction of compression of the product in its intended use. In some cases with anisotropic materials where a more complete characterization is desired or where the principal direction of anisotropy is unknown, it may be necessary to prepare additional sets of specimens.

Cutting of the test specimens shall be accomplished by methods that do not change the structure of the cellular material. Moulding skins that do not remain with the product in use shall be removed.

In general, any anisotropy is characterized by a plane and the direction perpendicular to this plane; thus, two sets of test specimens need to be considered.

7.3 Number

Regarding the method of selecting the samples for preparation of the test specimens from the blocks or slabs of rigid cellular products and also the number of test specimens to be provided for the test, refer to the specification relating to the type of cellular product under test. In the absence of such specifications, use at least five test specimens.

7.4 Conditioning

Condition the test specimens at:

(23 ± 2) °C and (50 ± 10) % relative humidity

or

(23 ± 5) °C and 50^{+20}_{-10} % relative humidity

or

(27 ± 5) °C and 65^{+20}_{-10} % relative humidity

for a minimum of 6 h.

8 Procedure

The test conditions shall be those used for conditioning the test specimens.

Measure the three dimensions of each test specimen in accordance with ISO 1923. Place a test specimen centrally between the two parallel plates of the compression-testing machine and compress it at a rate as close as possible to 10 % of its original thickness per minute. Compress the specimen until σ_m or/and σ_{10} are determined

NOTE Using Procedure B, strain is calculated on extensometer gauge length. For contact extensometers, a gauge length of 25 mm has been found satisfactory, on samples having 50 mm thickness.

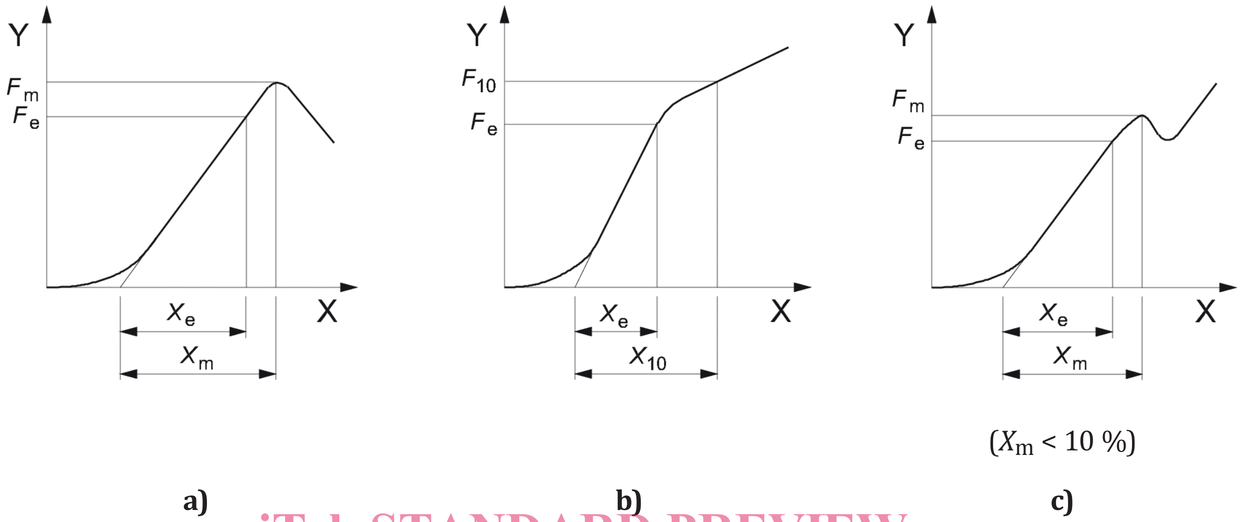
If the compressive modulus of elasticity is to be determined, record a force-displacement curve and find the most linear steepest part of the curve (see 9.4).

Repeat for each of the remaining specimens.

9 Expression of results

9.1 General

Depending upon the case, it will be necessary to calculate σ_m and ε_m [see 9.2 and Figure 1a)], or σ_{10} [see 9.3 and Figure 1b)], or all three properties [see Figure 1c)] if the material yields before completion of the test but still resists an increasing force.



Key

X displacement

Y force

Figure 1 — Examples of force-displacement curves — Procedure A

Using Procedure B, the behaviour of the force-displacement curves are as per Figure 2 and differently from Figure 1, X_e and X_m start from the origin of the X and Y-axis, where also the linear part of the curve starts.

NOTE Stress-strain curves are preferred to load-displacement curves.