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Rigid cellular plastics — Determination of shear properties

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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

This fifth edition cancels and replaces the fourth edition (ISO 1922:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— title has been modified as: Rigid cellular plastics — Determination of shear properties;

— Clauses 2, 4, 5, 7, 8, 9 have been technically revised.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Rigid cellular plastics — Determination of shear properties

1 Scope

This document specifies a procedure of determining the shear strength of rigid cellular plastics. It also provides for the determination of shear modulus and shear strain.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1923, *Cellular plastics and rubbers — Determination of linear dimensions*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Principle

A shear stress is applied to a test specimen of defined shape by means of rigid specimen supports bonded to the specimen.

There are two procedures:

— Procedure A, which is recommended for shear strength measurement only;

— Procedure B, which uses an extensometer or similar device to measure displacement and is, thus, the recommended method to calculate the shear modulus and strain (and strength as well).

5 Apparatus

5.1 Test machine

5.1.1 General

A test machine capable of applying a sufficient force within the maximum displacement experienced in the shear test.

It shall be capable of operating at a constant rate of movement of the movable head of (1 ± 0,5) mm/min in a direction parallel to the longitudinal axis of the test specimen assembly.

The test machine, conforming to class 1 of ISO 7500-1 shall exert a force on the test specimen, and produce a displacement of the movable support relative to the fixed supports, having a maximum error of 1 %.

If the shear modulus and strain is required, the force and the displacement shall be simultaneously recorded.

5.1.2 Single test specimen arrangement

The test machine shall exert longitudinal shear forces through parallel plates bonded to a single test specimen of dimensions as in 6.2. The parallel plates shall be rigid with one plate attached to the fixed parts and the other to the movable parts of the test machine.

5.1.3 Double test specimen arrangement

The test machine shall exert longitudinal shear forces through parallel plates bonded to a double test specimen of dimensions as in 6.3. The parallel plates shall be rigid with the outer plates attached to the fixed parts and the central plate to the movable parts of the test machine.

5.2 Specimen supports

5.2.1 Single test specimen assembly

Two flat rigid specimen supports with a length 330 mm, a width of 50 mm and a thickness of (16 ± 1) mm shall be attached to the grips of the test machine via an adaptor and universal joint.

The procedure of attaching the specimen supports to the grips is shown in Figure 1. The thickness of the adaptors that connect the specimen supports to the test machine grips shall be the same as the thickness of the test specimen.

NOTE Flat, rectangular-sectioned mild steel plates with a thickness of 16 mm have proved to be suitable for the support material.

5.2.2 Double test specimen assembly

Three flat rigid specimen supports with a length of 330 mm, a width of 50 mm and a thickness of (16 ± 1) mm shall be attached to the grips of the test machine via an adaptor and universal joint.

NOTE The essential features are three flat rigid supports of which two can be maintained with their planes parallel and vertical. A suitable arrangement is shown in Figure 2.

Experience gained using both the single and double test specimen procedures with several products indicated that it is of paramount importance that the specimen supports are very rigid. With the double test specimen arrangement, the fixed support should be maintained in parallel vertical plates, the arrangements shown in Figure 2 have proved suitable.

5.3 Measurement of displacement

5.3.1 Procedure A

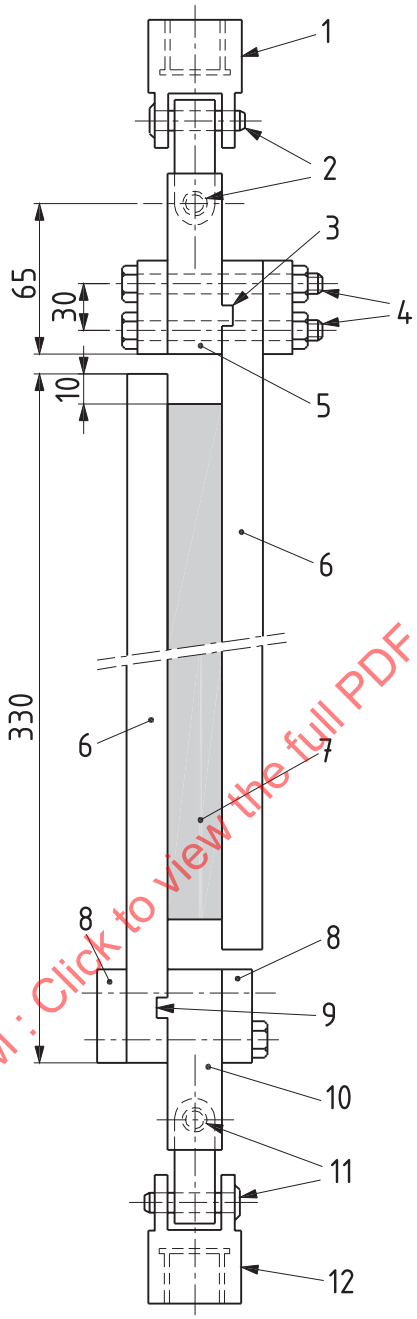
The testing machine shall be fitted with a system allowing continuous measurement of the displacement x of the movable plate with an accuracy of ±5 % or ±0,1 mm if this latter value is a more accurate measurement.

Procedure A is not recommended for measuring modulus but for shear strength only.

5.1.2 Procedure B

An extensometer or a similar device shall be capable of measuring the displacement between the rigid specimen supports with a precision of at least ±1 %.

Dimensions in millimetres

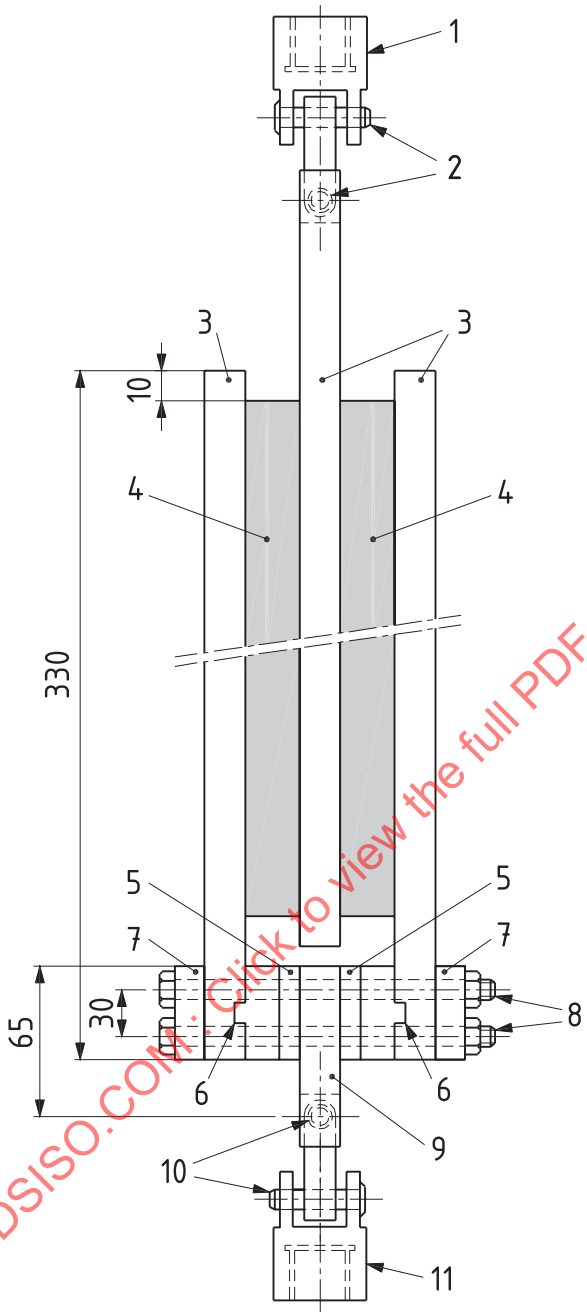


Key

1	fixed machine grip	7	test specimen
2	universal joint connection pins, allowing rotation	8	load spreading plates measuring (50 × 50 × 5) mm about axis
3	tongue and groove	9	tongue and groove
4	nut and bolt supports, ⌀10 mm	10	adaptor
5	rigid specimen support	11	universal joint connection pins, allowing rotation about axis
6	rigid specimen supports	12	movable machine grip

Figure 1 — Single plate test assembly

Dimensions in millimetres



Key

1 fixed machine grip
2 universal joint connection pins, allowing rotation
3 rigid specimen support
4 test specimen
5 spacer(s)
6 tongue and groove
7 load spreading plates measuring (50 × 50 × 5)
8 nut and bolt support ø 10
9 adaptor
10 universal joint connection pins, allowing rotation
11 fixed machine grip

Figure 2 — Double plate test assembly

5.4 Adhesive

The adhesive used to fix the rigid specimen supports to the test specimen shall be such that the shear strength and modulus of the adhesive film are significantly greater than that of the cellular material under test, so as to ensure ultimate failure in the cellular material rather than at the adhesive interface. The adhesive shall also be compatible with the material under test. Details of a suitable adhesive and the method of application are given in Annex A.

6 Dimensions of test specimens

6.1 General

The thickness of the test samples taken from the product, shall be the original product thickness.

The dimensions of the specimens shall be determined in accordance with ISO 1923.

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

6.2 Single shear test specimen

6.2.1 The test specimen shall be cut square with 90° corners and with the following dimensions:

— Length, *l*: 250^{+0}_{-5} mm;

— Width, *b*: 50^{+0}_{-1} mm;

— Thickness, *h*: (25 ± 0,5) mm.

6.2.2 Prepare test specimens without moulding skins. Machine their surfaces without modifying the original structure.

Bond the two machined surfaces of the rigid specimen supports to the larger surfaces of the dust-free test specimens so that the edges of the two rigid specimen supports are parallel to each other.

6.3 Double shear test specimen

6.3.1 The test specimen shall be cut square with 90° corners and with dimensions:

— Length: 250^{+0}_{-5} mm;

— Width: 50^{+0}_{-1} mm;

— Thickness: As produced.

6.3.2 Machine or cut their surface without modifying the original structure.

Bond the four surfaces of the rigid specimen supports to the larger surfaces of the dust-free test specimens so that the edges of the rigid specimen supports are parallel to each other.

Any moulded skins, facings and/or coatings shall be retained.

7 Number of test specimens

Test a set of five specimens. When testing materials suspected of being anisotropic, prepare sets of specimens having their major axes parallel with and normal to the suspected directions of anisotropy.

Reject specimens that fail at the adhesive interface before failure of the cellular material and test additional specimens so that the number of significant results is not less than five.

8 Conditioning and test temperature and humidity

The test should be carried out 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.

9 Procedure

Carry out the test at the same temperature and humidity as were used for conditioning.

Attach a test specimen to the grips of the test machine and apply a force by separating the movable grip from the fixed grip at a rate of (1 ± 0,5) mm per minute, with a variation not greater than 10 % during the test.

If procedure B is used, use the extensometer such that it measures the relative displacement between the two rigid loading plates. The extensometer shall be centred along the length of the specimen. Set the extension measurement to zero when a tensile force of 5 N is reached.

Record the force-displacement diagram.

Repeat the test on the remaining specimens.

The following procedure is suggested to correct for the force imposed on the specimen by the rigid specimen supports and their attachments: after attaching the test assembly to the machine attachments, adjust the test machine to zero force.

10 Calculation and expression of results

10.1 Shear strength

The shear strength, τ_M, of the specimen, expressed in megapascals, is given by Formula (1):

$$\tau_M = \frac{F_m}{A} \quad (1)$$

where

F_m is the maximum force applied to the test specimen, in newtons;

A is $I \times b$ for a single test specimen, in square mllimetres; or

is $2 \times I \times b$ for a double test specimen, in square mllimetres;

where

I is the initial length of the test specimen, in mllimetres;

b is the initial width of the test specimen, in mllimetres.

10.2 Shear modulus

If desired, calculate the shear modulus G of the specimen, in megapascals, using Formula (2):

$$G = \frac{h \times \theta}{A} \quad (2)$$

where

h is the thickness, in millimetres, of the specimen;

θ is the slope of the linear portion of the force-displacement diagram, expressed in newtons per millimetre;

A is $I \times b$ for a single test specimen, in square mllimetres; or

is $2 \times I \times b$ for a double test specimen, in square mllimetres.

10.3 Shear strain at fracture

If desired, determine the shear strain at fracture or the strain at which the load dropped by 10 % after the maximum load, whichever occurs first, using Formula (3).

If desired, determine the shear strain as the strain developed at fracture or at 90 % of maximum load, whichever occurs first, using Formula (3):

$$\gamma = \frac{\Delta s}{h} \quad (3)$$

where

γ is the core shear strain (mm/mm);

Δs is the displacement between the rigid specimen plates (mm);

h is the thickness of the specimen (mm).

11 Precision and bias

The precision of this procedure is unknown, and data obtained by the procedure shall not be used in resolving disputes between suppliers and users.

12 Test report

The test report shall include the following particulars:

a) a reference to this document, i.e. ISO 1922:2018;

b) all the details necessary for complete identification of the material tested;

c) where applicable, the direction of application of the force with respect to any anisotropy;

d) the individual shear strength test results and the average shear strength for each direction of test;

e) if double or single specimen has been used;

f) if calculated, the individual shear modulus and shear strain values and the average shear modulus and strain values for each direction of test; the used procedure (A or B) shall be specified;

g) the mode of failure;

h) any deviation from the procedure specified, any operational details not specified in this document, and any circumstances liable to have had an influence upon the results;

i) the date of testing.