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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Textile glass — Rovings — Determination of compressive strength of rod composites

Verre textile — Stratifils — Détermination de la résistance à la compression sur joncs

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Reference number
ISO 3605:1987 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3605 was prepared by Technical Committee ISO/TC 61, *Plastics*.

This second edition cancels and replaces the first edition (ISO 3605 : 1978), clauses 1, 3, 4 and 5 of which have been technically revised.

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Textile glass — Rovings — Determination of compressive strength of rod composites

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1 Scope and field of application

This International Standard specifies a method for determining the compressive strength of composite rods of circular cross-section made from rovings.

This test may be made on rods as moulded, or on rods that have been in boiling water for a specified time.

This test is intended for inspection testing and quality control of rovings and the results obtained shall not be used for the generation of design data.

2 References

ISO 291, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 1172, *Textile glass reinforced plastics — Determination of the loss on ignition.*

3 Apparatus and material

3.1 Mould, in the form of a straight rigid cylinder having a minimum length of 400 mm and a standard internal diameter of $6 \pm 0,1$ mm; if other diameters are chosen, these shall be selected by agreement between the interested parties from the range of 4 to 10 mm (with tolerances of $\pm 0,1$ mm).

The mould may be constructed of glass or polytetrafluoroethylene.

3.2 Resin.

Not all resin systems are necessarily suitable and the system to be used shall be at the discretion of the roving supplier. In the event of dispute, the system used shall be declared and shall form the basis for the test, subject to an agreement between the interested parties. The selected resin system shall be mixed in accordance with the resin manufacturer's detailed instructions. (See the annex.)

3.3 Metal wire, for pulling the roving through the mould (3.1).

3.4 Impregnating equipment (figure 1).

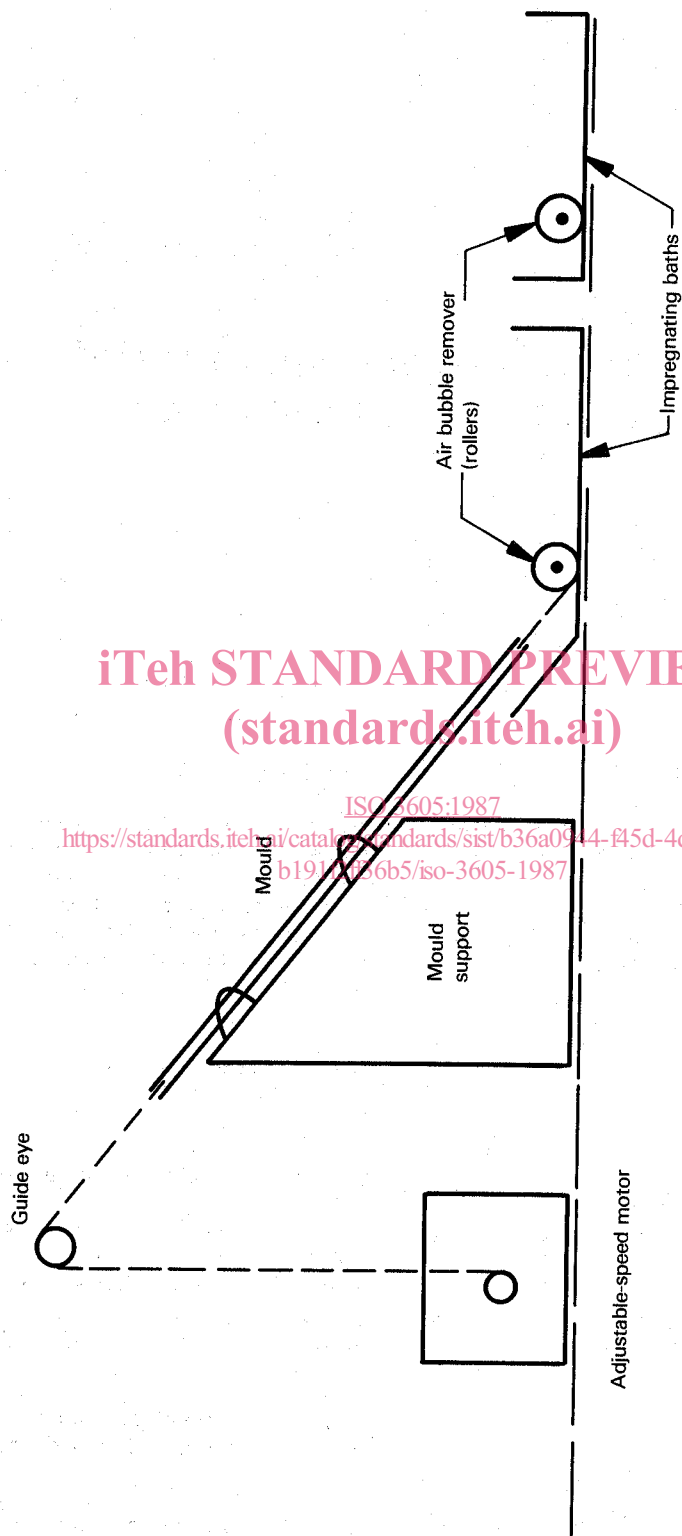
This equipment may include one or two impregnating baths. It is recommended that a device for removing air bubbles by means of rollers be included. It is also recommended that for pultrusion of the rods, the machine be adjustable to a constant speed in the range of 1 to 12 mm/s.

3.5 Oven with air circulation, for curing and/or postcuring the resin at the recommended temperature.

3.6 Diamond-tipped saw.

3.7 Micrometer.

3.8 Heating plate and glassware, if test after boiling-water treatment is required.



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Figure 1 — Example of equipment for impregnation of rovings

3.9 Compression testing machine, capable of maintaining a constant speed of 1 mm/min.

3.10 Two test jigs, as shown, for example, in figure 2, each consisting of

- a base plate X;
- an elastic compressive pad Y (for example of polyamide);
- a support ring Z.

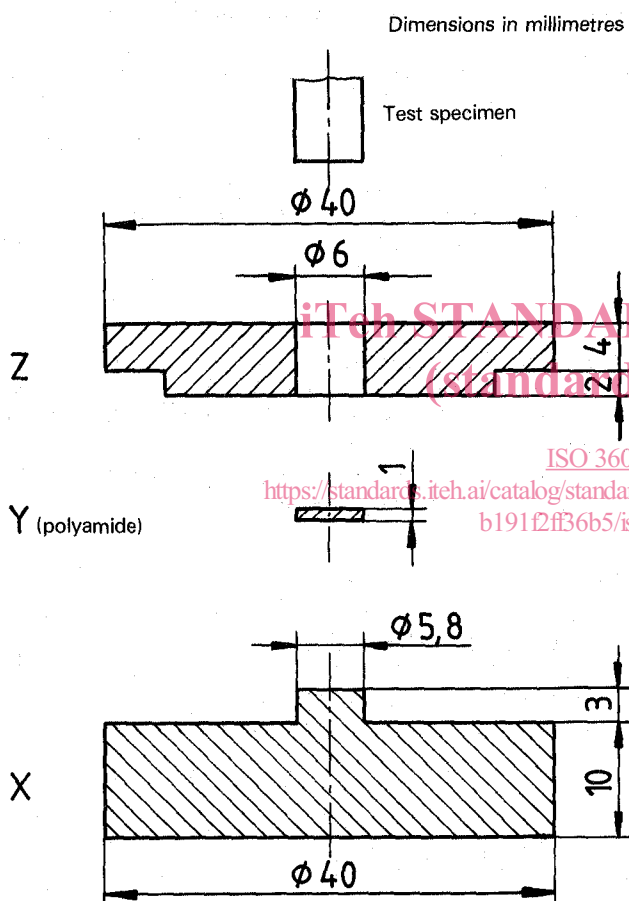


Figure 2 — Example of a jig for testing textile glass fibre reinforced plastic rods of 6 mm diameter

4 Conditioning and testing atmospheres

The specimen rovings shall be conditioned in one of the standard laboratory atmospheres defined in ISO 291.

The atmosphere during the test shall be one of those defined in ISO 291.

5 Procedure

5.1 Preparation of the rovings

Take a parallel assembly of rovings, 1 m long (or more according to mould length) and of the correct mass (approximately 15 g for the rods of 6 mm diameter) to give a glass content in the moulded rod of $65 \pm 3\%$ (m/m).

5.2 Preparation of reinforced rods

Fold the roving assembly about its midpoint and secure the hank at this point to a length of the wire (3.3). Condition for at least 16 h in one of the standard laboratory atmospheres defined in ISO 291. Take care to minimize contamination of the roving during handling.

Impregnate the roving by immersion in a bath containing the catalysed resin (3.2) or by any other suitable means. In order to obtain a good impregnation, it is desirable to eliminate air bubbles within the filaments. A good way to do this is to pull the impregnated rovings under metallic rollers. Another method is to pull the specimen vertically. When the roving is completely impregnated, draw it into the mould (3.1) by means of the wire. This drawing shall be done at a constant speed, preferably using an adjustable-speed motor capable of pulling the wire at a speed in the range of 1 to 10 mm/s.

Draw the lower end of the roving a few millimetres into the inside of the mould and prevent flow-out of resin by sealing the opening of the mould with a cork or plastic stopper, or by a cellophane bag sealed over the opening of the mould with cellulose tape.

Prepare in this way a number of rods sufficient to run at least 15 compressive strength tests (or 30 if the compressive strength is also to be determined after treatment with boiling water).

5.3 Curing of the rods

Cure the rods in the mould. Support the moulds in vertical position in the curing oven (3.5). The curing and post-curing conditions shall be in accordance with the resin system used. The curing conditions shall be mentioned in the test report.

5.4 Preparation and conditioning of test specimens

5.4.1 The procedure specified is suitable for rods of 6 mm internal diameter to be tested dry and also after treatment with boiling water. For this purpose, three rods shall be prepared as specified in 5.2 and 5.3.

If a test after treatment with boiling water is not required, only two rods shall be prepared, and in the procedure the instructions relating to the set of specimens (B) shall be cancelled.

After cutting off the ends of the cured rods, cut twelve test specimens, of length 22.5 ± 0.5 mm for 6 mm diameter rods, from each of the three rods (see figure 3) by means of a water-

cooled diamond-tipped saw. Ensure that the end faces of each test specimen are smooth and perpendicular to its axis, and are free from any visible defects. The ends of the test specimens shall be left untreated.

When test specimens other than 6 mm diameter have been chosen (see 3.1), the ratio of length to cross-sectional area shall be equivalent to that of a length of 22,5 mm to an area having a diameter of 6 mm.

Assemble two sets (A and B) of fifteen test specimens each by taking, for each set, five from each rod. Assemble three sets (C) of two test specimens from the remainder (see figure 3).

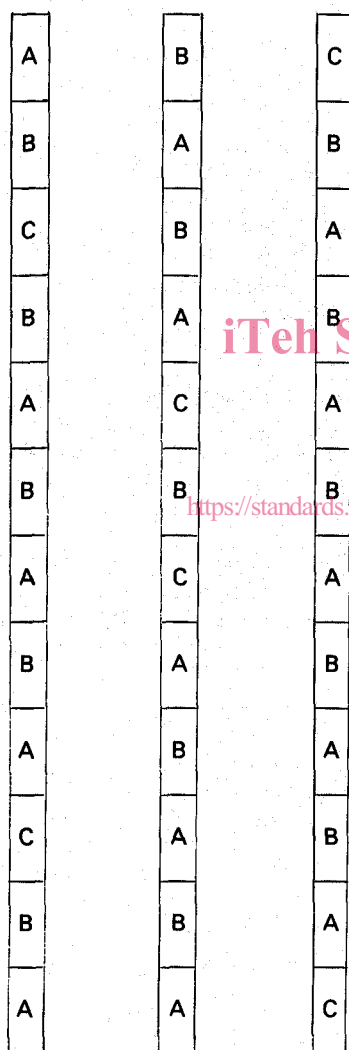


Figure 3 — Selection of sets of tests specimens from rods made from rovings

5.4.2 Condition the test specimens for at least 24 h in one of the standard laboratory atmospheres defined in ISO 291.

Keep one set (A) of fifteen test specimens for testing in the dry state.

Submit the other set (B) of fifteen test specimens to boiling in distilled water, for at least 16 h for polyester rods or for at least 16 or 48 h for epoxy rods; after cooling in water to room temperature, these specimens shall be tested wet within 6 h.

Set aside three sets (C) of two test specimens each for the determination of the glass content of each rod, in accordance with ISO 1172.

5.5 Determination of compressive strength

5.5.1 Determine the glass content of the three sets (C) of two specimens each according to ISO 1172, to verify that the glass content is $65 \pm 3 \% (m/m)$. If the glass content is outside the permitted tolerance, prepare new rods for testing.

NOTE — The two specimens of each rod are tested together for loss on ignition.

5.5.2 Before carrying out the compressive strength test, measure two perpendicular diameters to the nearest 0,01 mm at the centre of each test specimen. Use the average of these measurements in the calculation.

5.5.3 Conduct the compressive test in the same standard laboratory atmosphere as used for conditioning. Assemble the test specimen with a test jig (3.10) at each end. Place the assembly between the platens of the testing machine (3.9). Compress the test specimen at a speed of 1 mm/min. Record the force at which the specimen fails.

6 Expression of results

For each test specimen, the compressive strength σ_c , expressed in megapascals, is given by the formula

$$\sigma_c = \frac{4F}{\pi d^2}$$

where

F is the force, in newtons, at which the specimen fails;

d is the diameter, in millimetres.

For each set of test conditions ("dry" or "after immersion in boiling water") calculate the average of the 15 results obtained, discarding those results which do not fall within 50 % of this average. Report the average of the remaining values as the compressive strength of the material.

If less than five results remain for this calculation, a further set of test specimens shall be prepared and tested and the results of these treated as above. If this second set results in a similar failure, report this situation and repeat the procedure (clause 5), exercising more precise control in order to reduce variation on the test results obtained from the set of specimens.

7 Test report

The test report shall include the following particulars :

- a) reference to this International Standard;
- b) complete identification of the roving tested;
- c) complete identification of the type of resin used;
- d) curing and postcuring conditions;
- e) testing atmosphere;
- f) the chosen internal diameter of the rods tested, if different from the preferred internal diameter (6 mm);
- g) length of the test specimens, when different from the standard (22,5 mm);
- h) compressive strength of the material in the dry state and individual results;
- i) type of water, if different from that specified;
- j) time of immersion in boiling water;
- k) compressive strength of the material after boiling, and individual results;
- l) glass content of each rod;
- m) the type of failure observed (crushing, longitudinal splitting, or buckling of surface fibres).

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Annex

Examples of resin systems and cure conditions

(This annex forms an integral part of the Standard.)

A.1 Unsaturated polyester resin (general purpose)

Cumene hydroperoxide : 0,4 % (m/m)

Methyl isobutyl ketone peroxide : 0,8 % (m/m)

Cure : 7 h at 100 $\begin{smallmatrix} +5 \\ -2 \end{smallmatrix}$ °C

A.2 Unsaturated polyester resin (general purpose)

Benzoyl peroxide : 2 % (m/m)

Cure : 16 h at 100 $\begin{smallmatrix} +5 \\ -2 \end{smallmatrix}$ °C

A.3 Epoxy resin (anhydride system)

Epoxy resin : 100 parts by mass

Dimethylamine methylphenol : 1,5 parts by mass

Nadic methyl anhydride : 85 parts by mass

Cure : 4 h at 90 °C/4 h at 125 °C/4 h at 165 °C/12 h at 200 °C

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