INTERNATIONAL STANDARD

ISO 3597-1

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Textile-glass-reinforced plastics — Determination of mechanical properties on rods made of roving-reinforced resin —

Part 1: General considerations and preparation of rods

Plastiques renforcés verre textile — Détermination des propriétés mécaniques sur joncs de stratifils —

Partie 1: Notions générales et préparation des joncs

Reference number
ISO 3597-1:1993(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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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.

International Standard ISO 3597-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 13, *Composites and reinforcement fibres*.

This first edition, together with the other parts of ISO 3597, cancels and replaces ISO 3597:1977, which has been technically revised.

ISO 3597 consists of the following parts, under the general title *Textile-glass-reinforced plastics — Determination of mechanical properties on rods made of roving-reinforced resin*:

— *Part 1: General considerations and preparation of rods*

— *Part 2: Determination of flexural strength*

— *Part 3: Determination of compressive strength*

— *Part 4: Determination of apparent interlaminar shear strength*

Annex A of this part of ISO 3597 is for information only.

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Textile-glass-reinforced plastics — Determination of mechanical properties on rods made of roving-reinforced resin —

Part 1:
General considerations and preparation of rods

1 Scope

This part of ISO 3597 provides general information and specifies a method for preparing specimens (rods) intended to be used for tests specified in the other parts of ISO 3597.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 3597. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 3597 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 291:1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 7822:1990, *Textile glass reinforced plastics — Determination of void content — Loss on ignition, mechanical disintegration and statistical counting methods.*

3 Principles

The testing methods briefly described hereafter are generally performed on as-made rods. They may however, also be carried out on rods which have been submitted to a boiling water pretreatment for a specified time.

The preparation of rods as detailed in clause 5 includes the manufacture and division of rods into specimens of given length and their treatment in boiling water, if such treatment is required.

In order to obtain consistent results, conditions for the preparation of the rods (resin mixture, impregnation system and pulling speed, cure conditions, etc.) shall be as uniform as possible. Furthermore, if the roving specification requires that the void content of rods to be tested shall be within given limits, this characteristic shall be determined in accordance with ISO 7822.

3.1 Determination of flexural strength

The specimen is laid horizontally on two supports and deformed at constant speed by applying a stress at midspan until the specimen breaks or until the strain has reached a predetermined level.

The flexural strength of the specimen, expressed in megapascals, is the stress measured at that moment.

3.2 Determination of compressive strength

The specimen is axially compressed by applying a stress on the flanges at constant speed until the specimen breaks or until the deformation has reached a predetermined level.

The compressive strength of the specimen, expressed in megapascals, is the stress measured at that moment.

3.3 Determination of apparent interlaminar shear strength

A simple flexural test is carried out as described in 3.1 on a specimen, using however a span shorter than that used for the standard flexural test.

The apparent interlaminar shear strength of the specimen, expressed in megapascals, is the stress measured at failure or the maximum stress that is reached in the test.

4 Conditioning and testing atmospheres

The atmosphere required for conditioning and for testing the specimens is specified in ISO 291.

5 Preparation of the test specimens

5.1 Apparatus and material

5.1.1 Mould, in the form of a rigid cylinder having a minimum length of 300 mm and a standard internal diameter of 4 mm ± 0,1 mm (for flexural and interlaminar shear strength tests) or 6 mm ± 0,1 mm (for compression test). If other diameters are chosen, these shall be selected by agreement between the interested parties from the range of 3 mm to 10 mm (with tolerances of ± 0,1 mm). It is highly recommended however that the standard diameter be chosen, since the use of different diameters will not allow true comparison of the results.

The mould may be constructed of glass or polytetrafluoroethylene.

A release agent may be used if the shrinkage after moulding is very low (typical of epoxy resins).

5.1.2 Resin.

Not all resin systems are necessarily suitable; the system 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; it may be the subject of an agreement between the interested parties. The selected resin system shall be mixed in accordance with the resin manufacturer's detailed instructions (see annex A for examples of resin formulas with curing conditions).

5.1.3 Metal wire or **synthetic yarn** (for example polyamide or polyester), for pulling the roving through the mould (5.1.1).

5.1.4 Impregnation equipment (see figure 1), including 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 mm/s to 12 mm/s.

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

5.1.6 Diamond-tipped saw.

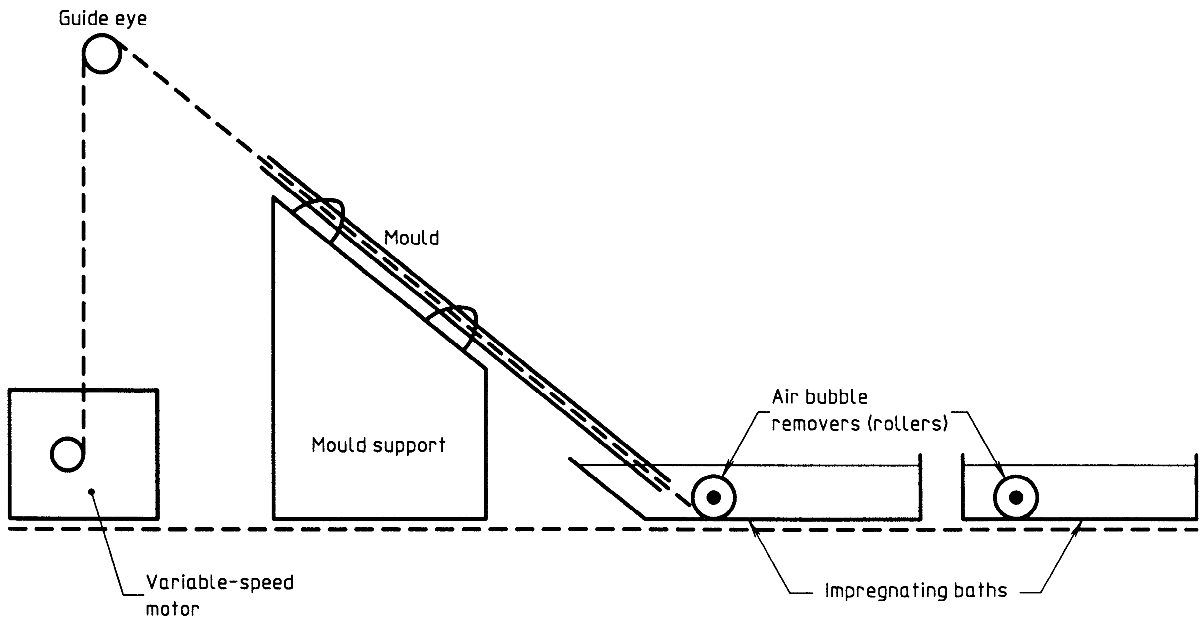

Figure 1 — Example of equipment set-up for impregnation of rovings

5.1.7 Heating plate and **glassware**, if boiling water pretreatment of the test specimen is required.

5.2 Preparation of the rovings

Take a parallel assembly of rovings, 1 m long (or more, depending on the mould length) and of the correct mass (see note 1) to give a glass content in the moulded rod of 65 % (*m/m*) ± 3 % (*m/m*).

After the mass of the roving assembly has been ascertained and, if necessary, corrected by adding or removing one or more strands, the assembly is folded about its midpoint and secured with a piece of wire (5.1.3). Condition for at least 16 h in one of the standard atmospheres specified in ISO 291. Take care to minimize handling of the roving to avoid contamination.

NOTE 1 The following formula can be used to determine the mass of a roving assembly 1 m long to be used for preparing rods of varying diameters and glass contents. For assembly lengths other than 1 m, correct the formula accordingly.

$$m = \frac{w_f}{(w_f/\varrho_f) + (w_r/\varrho_r)} \times \frac{\pi d^2}{8}$$

where

m is the mass, in grams, of a 1 m roving assembly;

w_f is the glass content, in percent by mass;

ϱ_f is the glass density, in grams per cubic centimetre;

w_r is the resin content, in percent by mass;

ϱ_r is the resin density, in grams per cubic centimetre;

d is the inside diameter, in millimetres, of the mould.

5.3 Preparation of the rods

Prepare an amount of resin sufficient for preparing the desired number of rods. When the rovings have been conditioned, pour the resin in the impregnating bath(s).

Impregnate the roving by immersion in a bath containing the catalysed resin (see 5.1.2). In order to obtain good impregnation, air bubbles within the filaments should be eliminated. This may be achieved by pulling the impregnated rovings under metallic rollers or by pulling the specimen vertically. In both cases, the lower end of the mould (5.1.1) shall be immersed in the resin so as to avoid inclusion of air bubbles in the rod. When the roving is completely impregnated, draw it into the mould by means of the wire, at a constant speed, preferably using a variable-speed motor capable of pulling the wire at a speed in the range of 1 mm/s to 12 mm/s.

When the roving has been drawn into the mould, prevent flow-out of resin by sealing the opening of the mould with a cork, plastic stopper or cellophane bag fixed with cellulose tape.

Taking into account the length of specimen required for the test to be carried out, prepare enough rods to obtain a sufficient number of specimens, i.e.:

— for flexural and interlaminar shear strength: minimum 10 test specimens;

— for compressive strength: minimum 15 test specimens.

These numbers shall be doubled if testing after boiling water treatment is required.

5.4 Curing the rods

Cure the rods in the mould. Support the mould in the vertical position in the curing oven (5.1.5). The curing and post-curing conditions shall be in accordance with the resin system used. The curing conditions shall be reported in the test report.

5.5 Cutting the rods and conditioning the specimens

Remove the rod from the mould. If required, prior to such demoulding cut off the tail of impregnated roving protruding from the lower end of mould.

After removing the ends of the rods (by removing at least 10 mm) by means of a water-cooled diamond-tipped saw (5.1.6), cut specimens to the length specified in the part of this International Standard appropriate to the mechanical test (ISO 3597-2, ISO 3597-3 or ISO 3597-4).

This standard length is:

25 times the diameter for the flexural test;

22,5 mm for the compressive strength on rods of 6 mm diameter;

8 times the diameter for the interlaminar shear strength test.

For the test on as-made rods (without treatment), condition the specimens for 24 h in accordance with ISO 291.

5.6 Boiling water treatment

When the test is also required on rods pretreated with boiling water, submit the appropriate specimens to immersion in boiling distilled or deionized water.

The standard immersion time is 16 h for polyester-resin-based rods and 32 h for epoxy-resin-based rods.

After this treatment, the specimens are left in the water and allowed to cool to room temperature. Wipe the specimens and run the test within 6 h after treatment.

Annex A
(informative)

Examples of resin systems and cure conditions

A.1 **Unsaturated polyester resin system** (general purpose)

Polyester resin:	100 parts by mass
Cumene hydroperoxide:	0,4 parts by mass
Methyl isobutyl ketone peroxide:	0,8 parts by mass
Cure:	7 h at (100 $^{+5}_{-2}$) °C

A.2 **Another unsaturated polyester resin system** (general purpose)

Polyester resin:	100 parts by mass
Benzoyl peroxide:	2 parts by mass
Cure:	16 h at (100 $^{+5}_{-2}$) °C

A.3 **Epoxy resin** (anhydride system)

Epoxy resin:	100 parts by mass
(Dimethylaminomethyl)phenol:	1,5 parts by mass
Methylbicyclo[2.2.1]heptene-2,3-dicarboxylic 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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