INTERNATIONAL STANDARD

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Textile glass — Woven fabric — Determination of tensile breaking force and elongation at break by the strip method

Verre textile — Tissus — Détermination de la force de rupture en traction et de l'allongement à la rupture par la méthode de la bande

Reference number
ISO 4606:1995(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 4606 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

This second edition cancels and replaces the first edition (ISO 4606:1979), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

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Textile glass — Woven fabric — Determination of tensile breaking force and elongation at break by the strip method

1 Scope

This International Standard specifies a method for the determination of the tensile breaking force and elongation at break of frayed strips of woven textile glass fabrics conditioned in a standard test atmosphere.

The method is applicable to unimpregnated textile glass fabrics and to textile glass fabrics that have been impregnated with sizing or stiffening materials, but not to fabrics coated with rubber or plastics (see annex A for informative references).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 139:1973, *Textiles — Standard atmospheres for conditioning and testing.*

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

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 initial gauge length: The length of a specimen under a specified pre-tensioning force, measured from nip to nip of the jaws of the clamps holding the specimen, with the clamps in their starting position.

3.2 breaking force: The maximum force applied to a test specimen in stretching it to rupture.

3.3 elongation; extension: The increase in length of a specimen under tension, usually expressed as a percentage of the initial length.

4 Principle

A strip of woven fabric is stretched to rupture by a suitable mechanical apparatus which indicates the breaking force and the elongation at break. The breaking force and the elongation at break may be determined either by taking readings directly from the indicating instruments on the apparatus or from an autographic force/extension curve.

Provision is made for two different types of test specimen:

— Type I is intended for use with stiff fabrics (e.g. scrim fabrics made with coarse yarns, i.e. yarns with a linear density greater than or equal to 300 tex, or fabrics in which the yarns are bonded to each other by a finish or stiffening).

— Type II is intended for more pliable fabrics, due to its easier handling, and thereby reduction of the experimental error.

5 Apparatus

5.1 Tensile-testing machine

The tensile-testing machine shall comprise the elements described in 5.1.1 to 5.1.4.

5.1.1 Pair of clamps, suitable for holding the specimen.

The clamps shall be wider than the unravelled specimen (see 7.1 and 7.2), i.e. more than 50 mm (or more than 25 mm — see 7.1) wide. The faces of the clamps shall be flat and parallel and shall exert a uniform pressure over the entire width of the specimen. They shall not allow the specimen to slip or to become damaged in any way (a hydraulic or a pneumatic pressure system, for example, may be necessary).

The faces of the clamps should preferably be smooth, but when specimens cannot be held satisfactorily, even with packing, serrated or corrugated clamps may be used. Paper, felt, leather or sheets of plastic or rubber may be used as jaw-packing materials.

The clamps shall be designed so that the axis of the test specimen remains aligned with the direction of the applied force throughout the test. The initial distance between the clamps (gauge length) shall be 200 mm ± 2 mm for type I test specimens and 100 mm ± 1 mm for type II test specimens.

5.1.2 Tensile-testing machine, the reference system being a constant-rate-of-extension (CRE) machine capable of producing a specimen-extension rate of 100 mm/min ± 5 mm/min for type I test specimens and 50 mm/min ± 3 mm/min for type II test specimens.

Other types of machine may be used, i.e. constant-rate-of-traverse (CRT) and constant-rate-of-loading (CRL) machines, but there may be no overall correlation between the results obtained with the CRE machine and those obtained with other machines. In cases of dispute, the CRE method shall be the reference method.

In the case of CRT and CRL machines, the speed of operation of the machine shall be set to break the specimen within 5 s ± 2 s or, by agreement between the interested parties, within a period of time calculated from the extension at break using the following equation:

$$t_B = \frac{E_L \times 60}{CRE}$$

where

t_B is the time to break, in seconds;

E_L is the extension at break, in millimetres;

CRE is the constant rate of extension, in millimetres per minute (taken from table 1).

Table 1 — Test specimens and test parameters

Test parameters	Units	Test specimen	
		Type I	Type II
Length of specimen	mm	350	250
Width of specimen (before unravelling)	mm	65	40
Gauge length	mm	200	100
Unravelled width	mm	50	25
Rate of extension	mm/min	100	50

5.1.3 Mechanism for indicating or recording the force applied to the specimen, practically free from inertia at the specified speed of testing. The maximum error in the indicated force shall not, under the conditions of use, be greater than 1 % of the actual force.

5.1.4 Mechanism for indicating or recording the specimen extension, practically free from inertia at the specified speed of testing and accurate to within 1 % of the measured value, or better.

5.2 Other equipment

5.2.1 Template (see figure 1), for use in cutting out, from the laboratory sample, an intermediate sample measuring 350 mm × 370 mm if type I test specimens are to be prepared or 250 mm × 270 mm if type II test specimens are to be prepared. The template has two apertures for marking out the limits of the central (test) portion of the specimens (the gauge length).

5.2.2 Suitable cutting tool, for example a knife, pair of scissors or cutting wheel.

6 Sampling

Unless specified otherwise, either in the product specification or by agreement between the interested parties, take a laboratory sample approximately 1 m long after having removed the outer layer of the roll or piece of fabric, which is susceptible to damage (remove at least 1 m).

7 Test specimens

7.1 Dimensions

7.1.1 Type I test specimen

The length of the test specimen shall be 350 mm to allow a gauge length of 200 mm ± 2 mm. The width of the test specimen, excluding any fringes (unravelled portions of specimen), shall be 50 mm (see 7.2.7).

7.1.2 Type II test specimen

The length of the test specimen shall be 250 mm to allow a gauge length of 100 mm ± 1 mm. The width of the test specimen, excluding any fringes (unravelled portions of specimen), shall be 25 mm (see 7.2.7).

7.1.3 Alternative widths

If the number of yarns in the warp and/or weft of the fabric is very small (less than 3 per centimetre, for instance), a width of more than 50 mm may be used for type I test specimens and a width of more than 25 mm for type II test specimens.

NOTE 1 The results obtained with test specimens of different dimensions and with different rates of extension are not equivalent, and cannot be compared in most cases.

7.2 Preparation

Special preparation of the test specimens is necessary to prevent the ends of the specimen from being damaged by the clamps of the test machine. The following method shall be used.

7.2.1 Take a sheet of stiff paper or cardboard with dimensions at least as large as those of the template (5.2.1).

7.2.2 Spread the fabric out completely flat on the stiff paper or cardboard, ensuring that the warp and weft yarns are completely straight and perpendicular to one another.

7.2.3 Place the template (see 6.2.1) on the fabric so that the whole of the template lies over the stiff paper or cardboard and, using the cutting tool (5.2.2), cut through the fabric and paper or cardboard round the outside of the template to produce an intermediate sample with the same external dimensions as the template. For warp-direction specimens, the gauge-length side of the template shall lie parallel to the warp threads; for weft-direction specimens, the gauge-length side of the template shall lie parallel to the weft threads.

7.2.4 With a soft pencil, and taking care not to fray the yarns, trace a line along the inside edge of each of the two template apertures. Remove the template.

7.2.5 Impregnate the ends of the fabric up to a point 75 mm in from each end with a suitable adhesive, and bond the ends to the paper or cardboard backing, leaving the central portion between the two pencil lines untreated.

NOTE 2 The following materials are recommended for impregnating the ends of the specimens:

a) natural rubber or neoprene solution;

b) a solution of poly(butyl methacrylate) in xylene;

c) a solution of poly(methyl methacrylate) in diethyl ketone or methyl ethyl ketone;

d) epoxy resin (particularly for high-strength materials).

The fabric may also be impregnated by placing each end between poly(vinyl butyl) sheets so as to leave the central area uncovered. The top surface of the sandwich is covered with a second sheet of stiff paper or cardboard and an electric iron is applied to soften the poly(vinyl butyl) and cause it to penetrate into the fabric.

7.2.6 After the intermediate sample has dried, cut it, perpendicular to the two pencil lines, into strips 65 mm wide for type I test specimens, thus giving specimens measuring 350 mm × 65 mm, and into strips 40 mm wide for type II test specimens, giving specimens measuring 250 mm × 40 mm.

Each specimen thus has an untreated central portion of length 200 mm for type I specimens and 100 mm for type II specimens, as well as bonded end tabs each of length 75 mm (see figure 1).

7.2.7 Remove yarns in approximately equal numbers from each of the long edges of each specimen, by careful cutting and unravelling until the width of the unravelled portion of the specimen is 50 mm (type I) or 25 mm (type II), or as near to these values as possible.

In the case of fabrics made from yarns ⩾300 tex (e.g. woven rovings) and open-weave fabrics, remove a whole number of threads, ensuring that the specimen width is as near as possible to, but not less than, 50 mm (type I) or 25 mm (type II), or the alternative width chosen (see 7.1.3). In such a case, all test specimens from the same fabric shall contain the same number of threads; the actual width of each

specimen shall be measured, the arithmetic mean of the five specimens calculated and the mean value reported, to the nearest 1 mm, in the test report.

8 Atmosphere for conditioning and testing

8.1 Conditioning atmosphere

Condition the specimens for 16 h, or for a period of time agreed between the interested parties, in one of the standard atmospheres specified in ISO 291 or ISO 139.

8.2 Test atmosphere

Carry out the test in the same standard atmosphere as used for conditioning.

9 Procedure

9.1 Set the clamps (5.1.1) 200 mm ± 2 mm apart for type I specimens and 100 mm ± 1 mm apart for type II specimens. Ensure that the clamps are properly aligned with each other and parallel. Secure the specimen in one clamp so that its longitudinal axis passes through the centre points of the front edges of the clamps. Before tightening the other clamp, cut the cardboard across the middle along a line perpendicular to the longitudinal axis of the specimen and apply a pre-tensioning force uniformly across the width of the strip, this tension being equivalent to (1 ± 0,25) % of the expected breaking force. Then tighten the other clamp.

If the test machine (5.1) is equipped with a recorder (5.1.3) or a computer, the pre-tensioning force can be applied by displacing the moving clamp. The value calculated for the pre-tensioning force shall be subtracted from the breaking force.

9.2 Set the moving clamp in motion and stretch the specimen to rupture under the conditions appropriate for the type of machine and test specimen being used, as specified in 5.1 and 7.1, respectively.

9.3 Record the resultant breaking force. When a fabric breaks in two or more stages, as with double fabrics and more complex weave structures, record the maximum force indicated during the breaking of the first set of yarns as the breaking force for the fabric, unless otherwise agreed between the interested parties.

9.4 Record the elongation at break to the nearest 1 mm.

9.5 If rupture of any test specimen starts within 10 mm of either of the clamps, record this fact in the test report, but reject the results for calculation of the breaking force and the elongation at break and repeat the test with a new test specimen.

NOTE 3 There are three causes of rupture at or near the clamps, viz:

— weak points in the fabric (these will be distributed at random);

— concentrations of stress in the neighbourhood of the clamps;

— damage caused to the specimen by the clamps.

The problem is how to distinguish between damage caused by the clamps and the other two causes of rupture at or near the clamps. In practice, this is rarely possible, so the best thing to do is to reject low values. There are statistical criteria for picking out abnormal values, but in the routine testing of fabrics they are hardly applicable.

10 Expression of results

10.1 Breaking force

For each direction (warp and weft), calculate the arithmetic mean of the breaking force in newtons, expressed to two places of decimals. The two means thus obtained constitute the result of the determination of the breaking force. In cases where the actual width of the test specimen differs from 50 mm or 25 mm, convert the result recorded in 9.3 to a width of 50 mm or 25 mm.

10.2 Elongation at break

For each direction (warp and weft), calculate the arithmetic mean of the elongation at break, expressed to two significant figures, as a percentage of the initial length of the test specimen between the clamps. The two means thus obtained constitute the result of the determination of the elongation at break.

11 Precision

The precision of this test method is not known because interlaboratory data are not available. When interlaboratory data are obtained, a precision statement will be added at the next revision.

12 Test report

The test report shall include the following particulars:

a) a reference to this International Standard;

b) all details necessary for identification of the textile glass fabric tested;

c) the method of sampling used, if different from that described in this International Standard;

d) the temperature and relative humidity chosen for conditioning and testing;

e) the conditioning time, in hours, if different from 16 h;

f) the number of warp and weft specimens tested, if different from the minimum specified;

g) the type of specimen used;

h) the width of the specimens, if different from the standard width;

i) the type of adhesive used and the method of application, as well as the drying and/or curing procedure used;

j) the result of the determination of the breaking force in each direction (warp and weft), together with the value obtained for each specimen which gave a valid result;

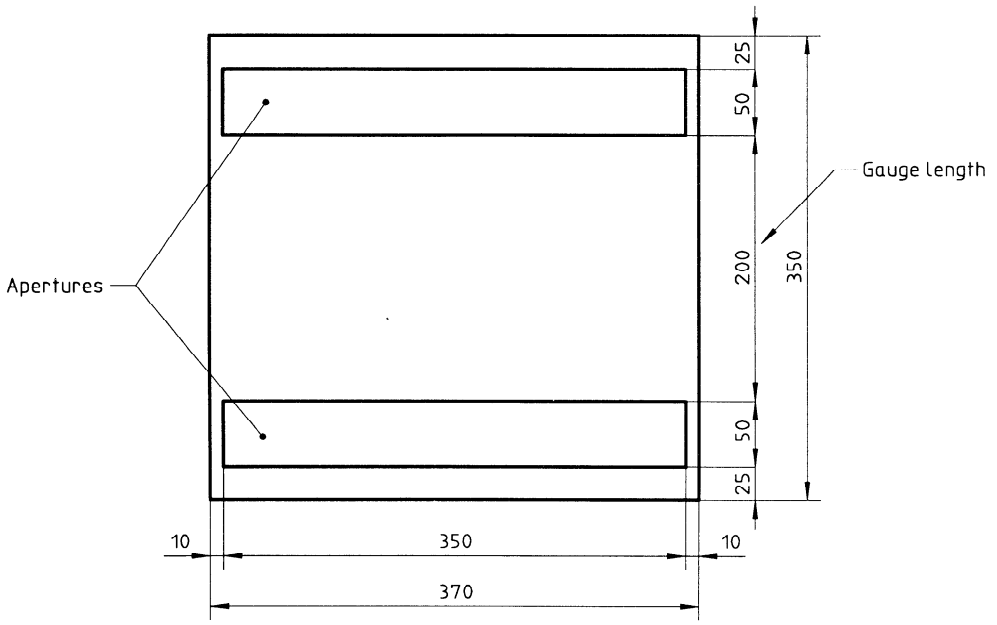
k) the result of the determination of the elongation at break in each direction (warp and weft), together with the value obtained for each specimen which gave a valid result;

l) the number of specimens for which the test results were rejected;

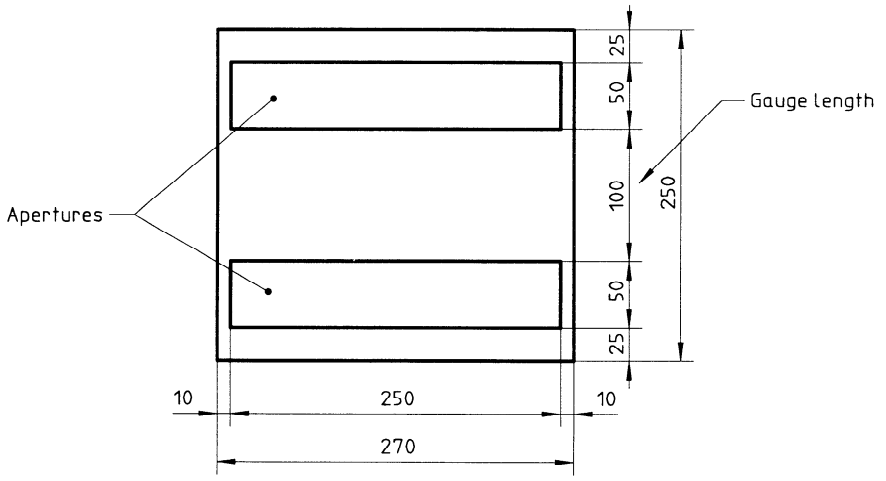
m) the type of machine and type of clamps used and, in the case of CRL and CRT machines, the time to break at which the machine was set;

n) any operational details not specified in this International Standard and any circumstances liable to have had an influence upon the results.

Dimensions in millimetres



Template for type I specimens



Template for type II specimens

NOTE — The specimens cut from intermediate samples obtained using these templates are subsequently unravelled to a standard width.

Figure 1 — Examples of templates for cutting out samples

Annex A
(informative)

Related International Standards

ISO 1421:1977, *Fabrics coated with rubber or plastics — Determination of breaking strength and elongation at break.*

ISO 5081:1977, *Textiles — Woven fabrics — Determination of breaking strength and elongation (Strip method).*

ISO 5082:1982, *Textiles — Woven fabrics — Determination of breaking strength — Grab method.*

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Descriptors: textile glass, woven fabrics, glass cloth, tests, tension tests, determination, breaking load, elongation at break, test equipment, test specimens.

Price based on 7 pages