International Standard 3341

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Textile glass — Yarns — Determination of breaking force and breaking elongation

Verre textile — Fils — Détermination de la force de rupture et de l'allongement à la rupture en traction

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Foreword

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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.

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Textile glass — Yarns — Determination of breaking force and breaking elongation

0 Introduction

This International Standard has been drawn up on the basis of ISO 2062, *Textiles — Yarn from packages — Method for determination of breaking load and elongation at the breaking load of single strands — (CRL, CRE and CRT testers).*

1 Scope and field of application

1.1 This International Standard specifies a method for the determination of the tensile breaking force and breaking elongation of glass yarns taken from packages.

1.2 This method is applicable to various types of glass yarn (single, folded, cabled, strands, structures without twist, rovings, etc.). It is basically intended for single, folded and cabled glass yarns having a diameter of less than 2 mm, or a linear density lower than 2 000 tex taken from packages. However, for yarns having a diameter greater than 2 mm or a linear density exceeding 2 000 tex, and for other types of textile glass yarn, the method can be applied with the reservation that the conditions are acceptable to all parties concerned with the test results.

NOTE — If required, this method can be used in the case of individual yarns removed from a fabric.

1.3 The method is not applicable to glass yarns which, in equilibrium with the standard atmosphere and under a pre-tension of 5 mN/tex, are elongated by more than 0,5 %. Such yarns can be tested using a lower pre-tension (for example 2,5 mN/tex or 1 mN/tex), acceptable to all parties concerned with the test results. This would occur mainly when dealing with staple fibre yarns.

2 References

ISO 139, *Textiles — Standard atmospheres for conditioning and testing.*

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

ISO 1886, *Textile glass — Method of sampling applicable to batches.*

ISO 1889, *Textile glass products — Continuous filament yarns, staple fibre yarns and roving in the form of packages — Determination of linear density.*

ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

ISO 3534, *Statistics — Vocabulary and symbols.*

3 Definitions

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

3.1 breaking (or maximum) force: The maximum force (or load) required to break the test specimen in a tensile test carried to rupture. It is generally expressed in newtons.

3.2 breaking tenacity: The tensile breaking force per unit linear density of the unstrained specimen, expressed for example in newtons/tex.

3.3 elongation: The increase in the gauge length of the specimen, produced by a tensile force expressed either in units of length, for example millimetres, or as a percentage of the nominal gauge length, called in this case "percentage elongation".

Depending on the force under which it is produced, one speaks of

a) elongation at maximum force, or

b) elongation at break.

3.4 time to break: The interval, measured in suitable units such as seconds, during which the specimen is under a (generally increasing) tension, i.e. absorbing the energy required to reach the maximum force.

NOTE — Time to break does not include the time to remove slack from the specimen. On machines fitted with an autographic recorder, the time to break is indicated by the time elapsing after the pen registers the initial force sustained by the specimen until the pen registers the maximum force.

3.5 nominal gauge length: The length, including any non-linear portions of test specimens under the prescribed pre-tension, measured from nip to nip of the jaws of the clamps in their starting positions.

3.6 moisture equilibrium: The condition reached by a sample, when the net difference between the amount of moisture absorbed and the amount desorbed, as shown by a change in mass of the sample, shows no trend and becomes insignificant (see 7.2.1).

3.7 moisture equilibrium for testing: The condition reached by a sample or specimen freely exposed to moving air controlled at specified conditions. For test purposes the moisture equilibrium shall be reached by absorption, starting from a lower moisture content. A sample or test specimen is considered to have reached moisture equilibrium for testing when the rate of increase in the mass of the sample or test specimen does not exceed the prescribed value (see 7.2.2). [1)]

3.8 package: A length of one or more yarns in a form suitable for handling, storage or transport. Packages may be unsupported or prepared with various winding patterns on bobbins, cops, cones, pirns, flanged bobbins or tubes.

4 Principle

4.1 Elongation of the specimen until rupture, by suitable mechanical means which indicate the maximum force and elongation at break. Elongation at a specified force, or alternatively the force at a specified elongation, may also be reported if required.

4.2 The derived value for the breaking force per unit linear density of the yarn, i.e. the breaking tenacity or the breaking length, may also be calculated if required.

5 Apparatus

5.1 Tensile testing machine

5.1.1 All tensile testing machines shall include

a) a pair of suitable clamps to grip the specimen;

b) means for elongating the specimen;

c) a mechanism which will indicate or record the load applied to the specimen and the corresponding elongation.

An autographic recorder is desirable for the recording of the elongation corresponding to a specified force. The inertia of the recording system must be sufficiently low to avoid distortion of the "force-elongation" curve.

The method authorises the use of the following types of testing machines in common use:

a) constant rate of load;

b) constant rate of specimen extension;

c) constant rate of traverse of the driven clamp.

5.1.2 The maximum error of the indicated force, at any point in the range in which the machine is used, shall not exceed 1 % of the true force. The error allowed for the indicated clamp separation shall not exceed 1 mm. Before use, verify dynamically the accuracy of the graduated scale of the apparatus, for example by means of calibrated springs of appropriate characteristics.

5.1.3 The testing machine shall be capable of testing specimens having a nominal gauge length of 500 mm (or 250 mm, see 9.1).

5.1.4 The clamps shall be capable of holding the specimens without slippage and without apparent damage and shall be so designed that break does not occur within 10 mm of the jaws (see, for example, the figure below). Indirect holding of the specimen is allowed.

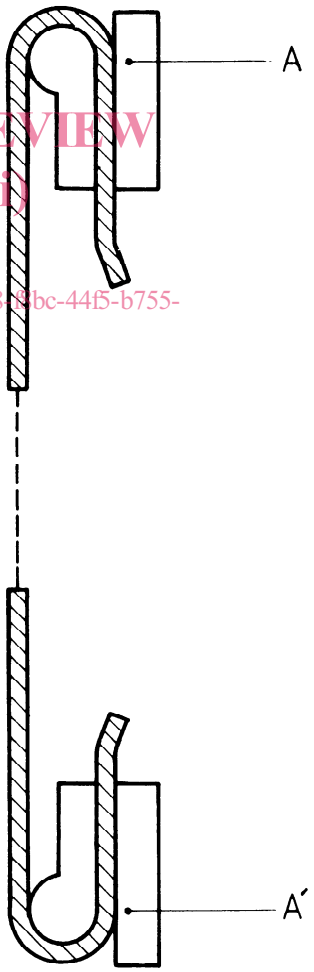

Figure — Tensile test on glass yarns: example of clamps suitable for this test
[BISFA [2)] type clamp]

1) Rather than specifying a value for this variation of mass, the test described later requires the sample to spend a set time in the prescribed atmosphere, which time is known to allow the sample or specimen to acquire its moisture equilibrium.

2) International Bureau for the Standardization of Man-Made Fibres.

5.2 Equipment for producing and maintaining the standard atmosphere for testing in the laboratory (see 6.1).

5.3 Equipment for producing and maintaining a suitable atmosphere for pre-conditioning (see 6.2).

5.4 Stop-watch.

6 Standard atmosphere

6.1 The standard test atmosphere shall be chosen from among those given in ISO 139 and ISO 291.

Report the chosen atmosphere in the test report.

6.2 An atmosphere suitable for pre-conditioning has a relative humidity no greater than 10 %, and a temperature of 80 ± 2 °C.

NOTE — Except for yarns having a size containing volatile components, in which case a lower maximum temperature shall be agreed in advance in each case.

7 Sampling and conditioning

7.1 Method of sampling

Sampling of the yarns shall be carried out in accordance with ISO 1886.

7.2 Conditioning of the laboratory samples

7.2.1 Pre-condition laboratory samples from which the test specimens are to be selected by exposing in the atmosphere required for this conditioning (see 6.2) until a substantially constant mass is obtained (i.e. constant to about 0,5 %).

7.2.2 After pre-conditioning, as laid down in 7.2.1, bring the test specimen to a state of moisture equilibrium for testing by exposing the packages to an appropriate standard test atmosphere (see 6.1) for at least 3 h.

8 Test specimens

8.1 Length

Each test specimen shall have a length of at least 600 mm of yarn; a length of 1 000 mm facilitates handling and preservation of twist.

8.2 Number

8.2.1 Ten specimens from each package of the laboratory sample (see 8.3) shall be subjected to test.

8.2.2 When the tests are being carried out in accordance with the instructions in clauses 8 and 9, it is possible to calculate the two-sided confidence interval (see ISO 3534) of the average tensile strength of the laboratory sample.

If the two-sided confidence interval, for a probability level of 95 %, is less than or equal to 2,5 %, the mean will be accepted as representative of the lot.

If the two-sided confidence interval is greater than 2,5 %, the number of packages selected from the lots which have already been sampled (the number of specimens always being ten per package) shall be increased until the two-sided confidence interval is equal to or lower than 2,5 %. The number of specimens can be expressed by $0{,}6\ V^2$, where V is the coefficient of variation of the individual breaks.

8.3 Selection of specimens

The yarns to be tested shall be taken from the package in such a way as to avoid any abnormal change in twist. Preferably the yarn shall be unwound tangentially, by causing the package to rotate around its own axis, in such a way that the yarn remains constantly under tension; if it is known that the yarn is to be unwound over end, this method of sampling shall be used and this shall be stated in the test report.

Remove at least the outer layer of yarn and then without cutting carry out the first sampling.

Take the first five test specimens successively, each test specimen consisting of an entirely new portion of yarn; then unwind approximately 100 m of the yarn before taking the last five test specimens successively, these being made up from an entirely new portion of yarn.

NOTE — For each measurement, the test specimen shall be brought directly, without cutting it from the package, to the tensile tester, where it shall be gripped at the standard pre-tension between the jaws. In these operations, before the yarn has been gripped in the jaws, any abrasion of the yarn and anything which might cause a displacement of the twist shall be avoided.

9 Procedure

9.1 Check that the distance between the grips of the testing machine is 500 ± 1 mm. Check that the grips are correctly aligned and parallel in such a way that the force applied to the test specimen does not produce any angular displacement of the grips. Check that the surrounding atmosphere complies with the standard atmosphere (see 6.1). Check that the recording apparatus, if one exists, is functioning correctly.

NOTE — By agreement between the interested parties, it is possible to employ a nominal gauge length of 250 ± 1 mm although in these conditions the test results may be slightly higher than those obtained with the gauge length of 500 mm.

9.2 After conditioning as specified in 7.2, grip the test specimen in the tensile tester so that the axis of the test specimen is perpendicular to the edge of the clamps. Do not touch with the bare hand the part of the test specimen that will be submitted to tension, i.e. the part lying between the clamps.

9.3 Apply to the test specimen a pre-tension of 5 ± 0,5 mN/tex, calculated from the nominal linear density of the yarn, unless the pre-tension extends the specimen by more than 0,5 %, in which case see 1.3.

9.4 Set the moving clamp in motion. The speed of the moving clamp shall be chosen as follows:

a) apparatus where both clamps move (as for example a pendulum machine):

select a test speed producing a break in 20 ± 3 s;

b) apparatus where one of the two clamps is virtually fixed:

test speed of 50 mm/min.

After breaking of the specimen, record the maximum force and the elongation at the maximum force. Note the time to break. Return the moving clamp to its zero position and remove the ends of the broken test specimen.

9.5 When a constant-time-to-break method is used [see 9.4 a)], proceed in the following manner:

9.5.1 If the average time to break of the first five test specimens lies outside the prescribed 20 ± 3 s, the results shall be disregarded. Make the required mechanical or electrical adjustments to bring the average breaking time within the prescribed limits. Carry out five additional tests under the newly adjusted conditions, note the time to break and if necessary make further adjustments.

9.5.2 After the five tests have been carried out (as described in 9.5.1) with the average time to break in the 20 ± 3 s limits, carry out the required number of determinations under precisely identical conditions. Note the time to break for each test specimen and disregard all results outside the prescribed limits.

9.6 Disregard any observations made on test specimens that slip between the jaws, or that break in, or within 10 mm of, the jaws. The number of observations that are ignored shall be counted; if it exceeds 10 % of the number of specimens tested, the clamps shall be readjusted. If necessary, the specimens shall be held by, for example, capstan or other type of clamp with indirect clamping, although in these conditions the values observed for elongation are not comparable with those obtained with the jaws normally used.

10 Expression of results

10.1 Units (all tests)

The breaking force shall be expressed in newtons. Elongation shall be noted in millimetres and then calculated as a percentage of the nominal gauge length of the test specimen under pre-tension.

10.2 Calculation of breaking force (maximum force) and elongation at break

10.2.1 Breaking force, in newtons

Calculate the arithmetic mean of the individual results obtained to four significant figures and round it off to three significant figures.

10.2.2 Percentage elongation at break

For each specimen, calculate the percentage elongation at break:

$$\frac{L - L_0}{L_0} \times 100$$

where

L is the length, in millimetres, between the grips at the moment of break;

L_0 is the nominal gauge length, in millimetres, of the test specimen.

Calculate the arithmetic mean of the values obtained and round off to the nearest 0,2 % if the mean elongation is lower than 10 %, and to the nearest 0,5 % when the mean elongation is greater than 10 %.

10.3 Precision of measurements

The coefficient of variation of the breaking load as well as of the elongation at break shall be calculated by recognised statistical methods (see ISO 2602), assuming that all the measurements come from the same population, i.e. without taking into account the within- and between-package variations.

10.4 Breaking tenacity

If desired, breaking tenacity can be calculated in newtons per tex from the breaking load determined by the present method and the linear density of the glass yarns, as determined by the method given in ISO 1889. The calculated value shall be quoted to three significant figures.

11 Test report

The test report shall include the following particulars:

a) a statement that the tests were performed in accordance with this International Standard and also all the test conditions which are not prescribed or are optional;

b) the type of package (for example cops, cones, bobbins, etc.), their processing and the manner in which the yarn has been removed from the package;

c) a complete reference to the glass yarn tested;

d) the sampling technique employed;

e) the number of specimens per test;

f) the method of pre-conditioning and the test atmosphere;

g) the length of the specimens;

h) the type, capacity and the scale of the tensile tester used and the type of clamps employed;

j) the method used, i.e. constant-time-to-break or constant speed, and in the latter case the average time to break;

k) the breaking force in newtons:

1) of the individual packages,

2) of the lot;

m) the percentage elongation at break (or elongation at maximum force):

1) of the individual packages,

2) of the lot;

n) the coefficient of variation of the breaking force of the lot;

p) the coefficient of variation of the breakage elongation of the lot;

q) the confidence limits for both the breaking force and elongation of the lot;

r) the linear density of the bulk sample in tex units; [1)]

s) the average breaking tenacity, in newtons per tex. [1)]

1) Carry out these calculations if agreed.

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