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Textiles — Man-made fibres — Determination of breaking strength and elongation of individual fibres

Textiles — Fibres chimiques — Détermination de la force de rupture et de l'allongement de rupture sur fibres individuelles

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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.

International Standard ISO 5079 was developed by Technical Committee ISO/TC 38, *Textiles,* and was circulated to the member bodies in March 1976.

It has been approved by the member bodies of the following countries:

Australia	Hungary	Poland
Belgium	India	South Africa, Rep. of
Brazil	Ireland	Spain
Bulgaria	Italy	Sweden
Chile	Korea, Rep. of	Switzerland
Czechoslovakia	Mexico	Turkey
Denmark	Netherlands	United Kingdom
Finland	New Zealand	U.S.S.R.
France	Norway	
Germany	Philippines	

No member body expressed disapproval of the document.

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Textiles — Man-made fibres — Determination of breaking strength and elongation of individual fibres

0 INTRODUCTION

This International Standard specifies the procedure to be followed for the determination of the breaking strength and elongation of man-made fibres.

Determination of these fibre properties, when carried out on different types of testing equipment, will not generally give identical results. To minimize the differences between results obtained on different types of apparatus, this International Standard has been restricted to two types of testing equipment :

a) equipment giving a constant rate of extension of the fibre;

b) equipment giving a constant rate of loading of the fibre.

Nevertheless, differences up to 20 %, depending on the rate of application of force and elongation, are to be expected between results for a given fibre when tested by the two types of equipment. For this reason, it is recommended that comparative tests should only be carried out on one type of machine, which should be agreed by the interested parties.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the method and conditions of test for the determination of the breaking strength and elongation of individual fibres.

The method is applicable to man-made fibres, including crimped fibres, provided that the available length of fibre enables a gauge length (effective distance between the fibre mountings) of 10 mm or 20 mm to be used. The accuracy in the measurement of the elongation which arises from increased test length indicates that, wherever possible, the longer gauge length should be used.

NOTE — The field of application is limited to man-made fibres. In fact, for these fibres, the variations in the linear density, for a given type of fibre, are small; this is not so for natural fibres, for which results obtained by this method (test on an individual fibre) will be of debatable significance.

2 REFERENCES

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

ISO 1130, *Textile fibres — Some methods of sampling for testing.*

ISO 1973, *Textile fibres — Determination of linear density — Gravimetric method.*

3 DEFINITIONS

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

3.1 breaking strength : The maximum tensile force observed during a test in which the specimen is stretched until it breaks. It is expressed in centinewtons.

3.2 elongation (extension) : The increase in length of a specimen during a tensile test expressed in units of length, for example millimetres.

3.3 elongation, % (extension, %) : The increase in length of a specimen during a tensile test expressed as a percentage of the nominal length.

3.4 elongation at break : The elongation produced by the breaking force (i.e. the maximum force applied during the determination of breaking strength).

4 PRINCIPLE

Extension of a suitably mounted single fibre until rupture, by means of an apparatus operated under specified conditions. Recording of the breaking strength and elongation of the fibre.

NOTE — For the determination of other tensile properties of the fibre, it may be necessary for the machine to produce an autographic force-elongation curve. For the determination of tenacity, the linear density of the fibre, or at least the mean linear density of the test sample, is required (see ISO 1973).

5 APPARATUS AND MATERIALS

5.1 Tensile machine with suitable clamps for gripping the test specimen at a gauge length of 10 mm or 20 mm, a means for stretching the fibre to rupture, and a method of indicating the force applied to the test specimen and the corresponding elongation. The error of the indicated breaking strength shall not exceed 1 % of the mean breaking strength of the fibres, and the error of the indicated elongation at the breaking strength shall not exceed 0,1 mm. The machine shall be either of the type described in 5.1.1 or of the type described in 5.1.2, and shall be designed so as to avoid any jerking in the early stages of application of force.

5.1.1 *Constant-rate-of-extension machine*

The machine shall be capable of applying a constant rate of extension to the fibre, such that after the first 2 s of the test the rate of increase in the distance between the clamps does not differ by more than 5 % from the average rate of increase over the whole period of the test.

The machine shall include facilities for producing different constant rates of elongation in order to break the test specimens in an average time-to-break of 20 ± 3 s.

5.1.2 *Constant-rate-of-loading machine*

The machine shall be capable of applying force at a constant rate, such that after the first 5 s of the test the average rate of increase of force in any 2 s interval does not differ by more than 25 % from the average rate of increase of force over the whole period of the test. The machine shall include facilities for applying force at different constant rates in order to break the test specimens in an average time-to-break of 20 ± 3 s.

5.2 Means for enabling individual fibres to be placed, without damage, between the clamps of the instrument (see annex A).

5.3 Equipment for producing the atmospheres for conditioning and testing the fibres as specified in clause 6.

5.4 Distilled or de-ionized water.

5.5 Non-ionic wetting agent.

6 CONDITIONING AND TESTING ATMOSPHERES

The standard atmospheres for pre-conditioning, conditioning and testing the fibres are those specified in ISO 139.

7 SAMPLING

To ensure that the laboratory sample is representative of the bulk material and that the test specimen taken from the laboratory sample is representative of that sample, sampling shall be carried out in accordance with the appropriate method of ISO 1130.

8 PROCEDURE

8.1 Pre-condition and then condition the test specimens in the atmosphere for testing specified in ISO 139 (see clause 6).

8.2 Set the machine to give the required duration of test between the limits specified in 5.1.1 and 5.1.2.

8.3 Prepare and mount an individual fibre in the jaws of the testing machine (see annex A). Ensure that the fibre lies along the axis of elongation of the machine.

8.3.1 *Slack mounting*

Mount the fibres individually, slightly slack, either directly between suitable jaws or on card carriers.

8.3.2 *Pre-tensioned mounting*

Mount the fibres individually between suitable jaws and apply a tension of 5,0 mN/tex for the dry test and 2,5 mN/tex for the wet test, calculated from the mean linear density of the fibre.

NOTE — A higher pre-tension, to remove crimp, can be applied subject to agreement between the interested parties.

8.4 If card carriers are used, cut the card across so that the fibre is free, set the traversing jaw in motion and extend the test specimen to the point of rupture.

8.5 Unless otherwise agreed by the interested parties, test at least 50 test specimens. Note jaw breaks, i.e. breaks in which either of the broken ends is not visible, and exclude the results obtained on such test specimens. The condition of the apparatus shall be such that the number of jaw breaks does not exceed 10 % of the number of test specimens tested.

8.6 If a wet test is required, first immerse the mounted test specimens in distilled or de-ionized water, at a temperature of 20 ± 2 °C, to which has been added a non-ionic wetting agent to give a maximum concentration of 0,1 %, either until the test specimens sink freely or for a period of 2 min.

Carry out the test on totally immersed mounted test specimens.

9 EXPRESSION OF RESULTS

9.1 Calculate the mean breaking strength of the fibres tested, and express the result in centinewtons.

9.2 Calculate the mean elongation at break of the fibres and the mean elongation at break as a percentage of the gauge length (see annex B).

9.3 Calculate the coefficients of variation of the breaking strength and of the elongation at break.

NOTE — In addition, if required, calculate any other required tensile properties, for example tenacity, modulus.

10 TEST REPORT

The test report shall include the following particulars :

a) a statement that the test has been conducted in accordance with this International Standard;

b) the type of tensile testing machine used, stating either constant-rate-of-extension or constant-rate-of-loading (see clause 5);

c) the method of mounting the fibres and the type of mounting, i.e. pre-tensioned or on support card;

d) the gauge length used;

e) the mean breaking strength of the fibres, in centinewtons;

f) the mean elongation at break, in per cent;

g) the number of fibres tested;

h) the coefficient of variation of the breaking strength and the elongation at break;

i) the details of conditioning or of wet treatment of the specimens;

j) the results of any other tensile properties required.

ANNEX A

MOUNTING OF TEST SPECIMENS

It must be emphasized that great care should be taken to ensure that the fibre is not damaged; for example, the length of fibre under test must not be held with tweezers.

A.1 **For slack-mounted fibres** a carrier may be used. A rectangular hole, whose length is equal to the gauge length, is cut in thin card and the fibre is mounted across the hole by means of some suitable adhesive. It is essential that the adhesive should not spread over the length of fibre under test. For wet tests, both the card and the adhesive must be water-proof.

A.2 **For pre-tensioned mounting,** suitable fibre clips must be attached to the testing machine. These can also be used for slack-mounting if desired.

ANNEX B

MEASUREMENT OF ELONGATION

In measuring breaking elongation, particularly of crimped fibres, a difficulty lies in deciding the starting point of the test.

The initial portion of the curve is rarely linear, this part of the curve representing the fibre bedding in the grips, or the removal of the crimp, or a combination of these.

For this reason, in particular where the start of the force-elongation curve is very rounded, it may be useful to determine the theoretical start of elongation by extrapolation to zero force, from the straight portion of the force-elongation curve adjacent to the initial portion of the curve.

In most cases, it is quicker to proceed as indicated below.

B.1 SLACK MOUNTING

From the force-elongation curve, and taking account of the gauge length used (10 mm or 20 mm), determine the length between the jaws of each test specimen, under a force of 5 mN/tex or 2,5 mN/tex (see 8.3.2). Use this length to calculate the percentage elongation at break of the fibre.

8.2 PRE-TENSIONED MOUNTING

The effective length of each test specimen between the jaws being equal to the gauge length, the percentage elongation at break of the fibre can be calculated directly from this gauge length.