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Textile fibres — Determination of breaking force and elongation at break of individual fibres

Fibres textiles — Détermination de la force de rupture et de l'allongement de rupture des fibres individuelles

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 248, *Textiles and textile products*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 5079:1995), which has been technically revised. The main changes compared to the previous edition are as follows:

— addition of “ISO 3696”, “ISO 7500-1”and “ISO 10012”as normative references;

— adjustment of “ISO 3060”and “IWTO 32” from normative references to bibliography;

— revision of the definitions of “breaking force” (3.1), “force at rapture” (3.2), “extension” (3.3), “elongation at break” (3.5), “elongation at rupture” (3.6) “gauge length” (3.7), “initial length” (3.8), “pretension” (3.9) and “breaking density” (3.11);

— deletion of terminological entry for “tension” (former 3.10);

— addition of terminological entry for “constant-rate-of-extension testing machine” (3.10);

— addition of a note in Clause 4;

— redrafting of text describing the requirements for CRE testing machine in 5.1;

— addition of “Tweezers” (5.2);

— revision of requirements for wetting solution in 5.3 (former 5.2);

— addition of details about preparation of test specimen in Clause 7;

— addition of 8.2 c);

— redrafting of the test procedure of wet test in 8.8 (former 8.6);

— redrafting of the test report in Clause 10;

— addition of Figure A.1;

— addition of Annex B.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Textile fibres — Determination of breaking force and elongation at break of individual fibres

1 Scope

This document specifies the method and conditions of test for the determination of the breaking force and elongation at break of individual fibres in the conditioned or wet state.

The determination of these fibre properties, when carried out on different kinds of testing equipment, will not generally give identical results. To avoid such differences, this document is restricted to the use of constant-rate-of-extension testing machine.

It is applicable to all fibres, including crimped fibres, provided that the length of fibre available enables the gauge length specified in this document.

NOTE For natural fibres (especially wool and cotton), the breaking test most commonly performed is that of bundles of fibres (see ISO 3060 and IWTO 32-82).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 and vibroscope method*

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

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

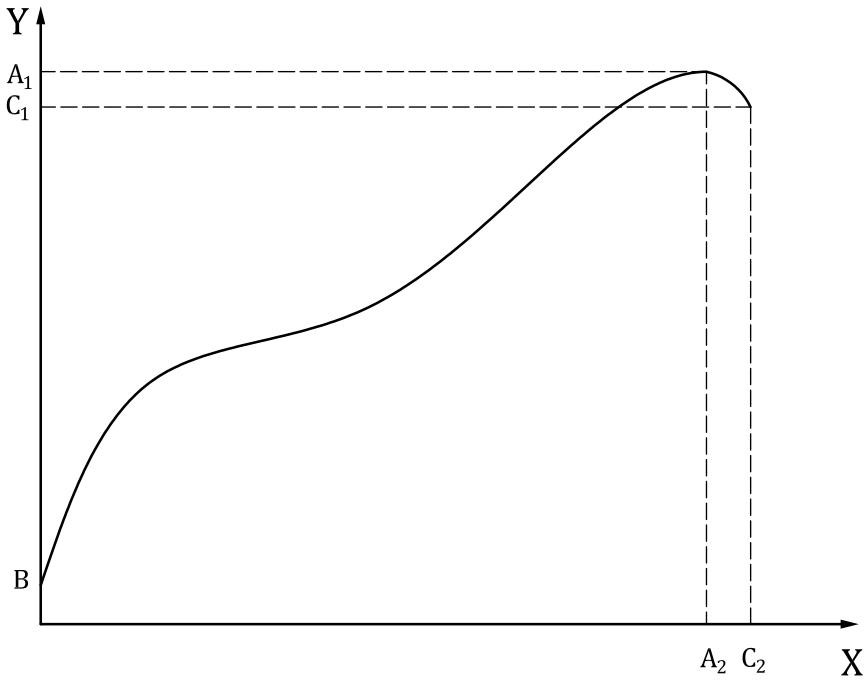
— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
breaking force
maximum force appearing during a test specimen carried to rupture in a tensile test under specified conditions

EXAMPLE See A_1 in Figure 1.

Note 1 to entry: For fibres, breaking force is preferably expressed in centinewtons.



Key

Y force, expressed in centinewtons

X *elongation* (3.4), expressed as a percentage

A_1 *breaking force* (3.1)

A_2 *elongation at break* (3.5)

B *pretension* (3.9)

C_1 *force at rupture* (3.2)

C_2 *elongation at rupture* (3.6)

Figure 1 — Typical force/elongation curve

3.2
force at rupture
force at the point of rupture of the test specimen during a tensile test

EXAMPLE See C_1 in Figure 1.

3.3
extension
increase in length of a test specimen during a tensile test

Note 1 to entry: Extension is expressed in units of length.

3.4
elongation
ratio of the *extension* (3.3) of a test specimen to its *initial length* (3.8)

Note 1 to entry: Elongation is expressed as a percentage.

3.5
elongation at break
elongation (3.4) of a test specimen at the *breaking force* (3.1)

EXAMPLE See A_2 in Figure 1.

3.6
elongation at rupture
elongation (3.4) of a test specimen at the *force at rupture* (3.2)

EXAMPLE See C_2 in Figure 1.

3.7
gauge length
distance between the two effective clamping points of a testing device

Note 1 to entry: With guide groove or wrap bollard clamps, it is the distance between their effective clamping points, measured along the path of the specimen.

3.8
initial length
length of a test specimen (between the two effective clamping points) under specified *pretension* (3.9) at the beginning of a test

3.9
pretension
tension applied to a test specimen at the beginning of a tensile test

EXAMPLE See B in Figure 1.

Note 1 to entry: For fibres, pretension is preferably expressed in centinewtons.

3.10
constant-rate-of-extension testing machine
CRE testing machine
tensile testing machine provided with one clamp, which is stationary, and another clamp, which moves with a constant speed throughout the test, the entire testing system being virtually free from deflection

[SOURCE: ISO 20932-1:2018, 3.3]

3.11
breaking tenacity
breaking force (3.1) divided by the linear density

Note 1 to entry: For fibres, breaking force is preferably expressed in centinewtons per decitex.

4 Principle

An individual fibre is extended at a constant rate until rupture occurs. The breaking force and elongation at break are recorded.

If the breaking tenacity is to be calculated, the linear density of the individual fibres or the mean linear density of the laboratory sample is also required.

NOTE If required, the force and elongation at rupture is recorded.

5 Apparatus and reagents

5.1 Tensile testing machine.

5.1.1 Metrological confirmation system of the tensile testing machine shall be in accordance with ISO 10012.

5.1.2 The machine shall be equipped with suitable clamps for gripping individual fibres at the required gauge length, a means for stretching the fibre to rupture at constant rate of extension by

moving one of the clamps, and a means for recording the extension (elongation) of the fibre and the corresponding force.

Visualization of the individual force/extension (or tenacity/elongation) curves is helpful for detection of fibre slippage in the clamps. Advice on mounting of test specimens is given in Annex A.

5.1.3 The machine shall be capable of operating at various constant rates of extension between at least 5 mm/min and 40 mm/min.

5.1.4 Under conditions of use, the accuracy of the testing machine shall be at least class 1 of ISO 7500-1, and meet the following requirements.

a) the error of the indicated or recorded force at any point in the range in which the testing machine is used shall not exceed ± 1 %;

b) the error of the indicated or recorded extension shall not exceed ± 0,1 mm;

c) the gauge length shall be with an accuracy of ± 0,2 mm;

d) the constant rate of displacement of the moving clamp shall be with an accuracy of ± 5 %.

5.1.5 The clamps of the machine shall be capable of adjustment, and the surface of the clamp jaws in contact with the specimen shall be of a material to provide the correct gripping force without damage to the fibre, thereby avoiding slippage and jaw breaks (see 8.7).

5.2 Tweezers.

5.3 Wetting solution.

If wet testing is to be carried out, distilled water or grade 3 water in according with ISO 3696 at a temperature of (20 ± 2) °C, to which a non-ionic wetting agent to a maximum concentration of 0,1 % has been added, shall be used.

6 Conditioning and testing atmospheres

The atmospheres for preconditioning, conditioning and testing shall be as specified in ISO 139.

7 Sampling and preparation of test specimen

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

For staple fibres, the length shall be sufficient to allow tests at the selected gauge length.

For filaments, cut the specimen into short segments allowing a gauge length of 20 mm. Carefully remove the required number of test specimens from the segments by grasping the individual filament segments at one end with tweezers. The effective part of the fibre under test shall not be damaged during preparing the test specimen.

8 Procedure

8.1 Condition the test specimens and carry out the tests in the standard atmosphere as specified in Clause 6.

8.2 Adjust the machine to extend the test specimen using a speed of the moving clamp of

a) 50 % gauge length per minute, for test specimens with a mean elongation at break lower than 8 %,

b) 100 % gauge length per minute, for test specimens with a mean elongation at break equal to or greater than 8 % and lower than 50 %, or

c) 200 % gauge length per minute, for test specimens with a mean elongation at break equal to or greater than 50 %.

In case of fibres with extreme high-extension or low-extension, different rates of extension may be applied upon agreement by the interested parties.

If the nominal elongation at break is not known, establish an approximate value by preliminary tests. In cases where the breaking elongation found in the preliminary test lies around 8 % or 50 %, one of the above testing speeds shall be agreed upon by the interested parties.

If the final results vary slightly from those obtained in the preliminary test, a repetition of the test at a different speed are not necessary.

If both linear density and breaking force for the same fibre are required, then the linear density of the fibre shall be determined in accordance with ISO 1973 before the tensile test is performed.

8.3 The pretension used for the tensile test in the conditioned or wet state is specified as follows.

a) In the conditioned tests of staple fibres, use a pretension per unit linear density of (0,10 ± 0,01) cN/dtex. For the fibres listed in Table 1, use the pretension per unit linear density indicated.

A higher pretension, for example to remove crimp, may be applied upon agreement between the interested parties.

Table 1 — Pretension per unit linear density for the conditioned test of staple fibres

Fibre	Pretension per unit linear density cN/dtex
Cellulose man-made fibres	0,060 ± 0,006
Polyester fibres	
linear density < 2 dtex	0,20 ± 0,02
linear density ≥ 2 dtex	0,10 ± 0,01
Meta-aramid fibres and polylactide fibres	0,12 ± 0,03
Polyimide fibres	0,15 ± 0,03

b) In the conditioned tests of filaments, use a pretension per unit linear density of (0,050 ± 0,005) cN/dtex.

c) In the wet tests of staple fibres and filaments, use a pretension per unit linear density of (0,025 ± 0,003) cN/dtex for cellulose man-made fibres, and use a pretension which is half of that specified in the conditioned test for other fibres.

Calculate the mass necessary to obtain the required pretension on the basis of the nominal linear density of the fibre.

8.4 Use a gauge length of 20 mm.

Where it is impossible to use the 20 mm gauge length because of short fibre length, a gauge length of 10 mm may be used. In this case, the accuracy of results is reduced.