INTERNATIONAL STANDARD

ISO 2062

Third edition
2009-12-01

Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester

Textiles — Fils sur enroulements — Détermination de la force de rupture et de l'allongement à la rupture des fils individuels à l'aide d'un appareil d'essai à vitesse constante d'allongement

Reference number
ISO 2062:2009(E)

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Published in Switzerland

Foreword

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The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2062 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns*.

This third edition cancels and replaces the second edition (ISO 2062:1993), which has been technically revised.

Introduction

In the 1950s and 1960s when this International Standard was first prepared, three types of tensile testers were in wide use: constant rate of specimen extension (CRE), constant rate of travel (CRT) and constant rate of loading (CRL). It was therefore advisable to state the rate of operation in a way which would be common to all three types of tester. In addition, the best possible agreement was sought between the test results of the three types of tester. Consequently, the principle of constant time to break was adopted, and 20 s to break was chosen for this International Standard and also for a number of national standards.

In the early 1990s, CRE testers were recognized as the best type. As CRT and CRL testers were still in use internationally, the procedure for using them was included in an informative annex. There is no assurance that the results from the three types of tester will agree. This International Standard considers CRE testers only, so the time-to-break principle was no longer needed and a simpler statement of rate of extension was used. The rate of extension of 100 % per minute has been adopted as standard, but higher rates were permitted by agreement for automatic testers.

CRT and CRL testers are now considered to be obsolete. The methods of using them are deprecated and their inclusion in informative Annex A does not have an influence on the status of this International Standard.

Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester

1 Scope

1.1 This International Standard specifies methods for the determination of the breaking force and elongation at break of textile yarns taken from packages.

Four methods are given:

— A: manual; specimens are taken directly from conditioned packages;

— B: automatic; specimens are taken directly from conditioned packages;

— C: manual; relaxed test skeins are used after conditioning;

— D: manual; specimens are used after wetting.

1.2 Method C is used in cases of dispute regarding elongation at break of the yarn.

NOTE Methods A, B and C are expected to give the same results for yarn strength, but Method C might give somewhat truer (and higher) values of elongation than A or B. Method D is likely to give results differing, for both breaking force and elongation at break, from those obtained by methods A, B or C.

1.3 This International Standard specifies methods using constant rate of specimen extension (CRE) tensile testers. Testing on the now obsolete constant rate of travel (CRT) and constant rate of loading (CRL) instruments is covered, for information, in Annex A, in recognition of the fact that these instruments are still in use and can be used by agreement.

1.4 This International Standard applies to all types of yarns, except glass, elastomeric, aramid, high molecular polyethylene (HMPE), ultra high molecular polyethylene (UHMPE), ceramic and carbon yarns and polyolefin tape.

NOTE A method for the testing of glass yarns is given in ISO 3341.

1.5 This International Standard is applicable to yarns from packages but can be applied to yarns extracted from fabrics, subject to agreement between the interested parties.

1.6 This International Standard is intended for the single-end (single-strand) testing of yarns.

NOTE The skein method of testing is given in ISO 6939.

2 Normative references

The following referenced documents are indispensable for the application 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 2060, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method*

3 Terms and definitions

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

3.1
breaking force
maximum force applied to a specimen in a tensile test carried to rupture

NOTE For yarns, the breaking force or load is preferably expressed in centinewtons.

3.2
elongation at break
increase in length of a specimen corresponding to the breaking force

NOTE For yarns, elongation at break is expressed as a percentage of the initial length.

3.3
breaking tenacity
ratio of a yarn's breaking force to its linear density

NOTE For yarns, breaking tenacity is expressed in centinewtons per tex.

3.4
constant rate of specimen extension (CRE) tester
testing machine in which one end of the specimen is held in a virtually stationary clamp and the other end is gripped in a clamp that is driven at a constant speed

NOTE A suitable system is provided for detecting and recording the force applied and the elongation.

3.5
clamp
that part of a tensile testing machine used to grip the specimen by means of suitable jaws

3.6
jaws
those elements of a clamp which grip the specimen

3.7
gauge length
nominal length
distance between the clamping points of the tester

NOTE With bollard or capstan clamps, it is the distance between their gripping points, measured along the path of the yarn.

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

3.9
package
length of yarn in a form suitable for use, handling, storing, etc.

NOTE Packages can be supported (e.g. cones, bobbins) or unsupported (e.g. skeins, balls).

4 Principle

A specimen of yarn is extended until rupture by a suitable mechanical device, and the breaking force and elongation at break are recorded. A constant rate of extension of 100 % per minute (based on the gauge length) is used, but higher or lower rates are permitted by agreement. Two gauge lengths are permitted: usually 500 mm (with a rate of extension of 500 mm/min), and exceptionally 250 mm (with a rate of extension of 250 mm/min).

5 Apparatus and reagents

5.1 Constant rate of specimen extension (CRE) tester, which complies with the following requirements.

The tester shall be capable of being set at gauge lengths of 500 mm ± 2 mm or 250 mm ± 1 mm, or preferably both.

The constant rate of extension of the moving clamp shall be 500 mm/min ± 10 mm/min or 250 mm/min ± 5 mm/min, to an accuracy of ± 2 %, with lower or, for automatic testers, higher rates being permitted by agreement.

The maximum error of the indicated force shall not exceed 2 % of the true force.

The tester may be of the manual or automatic type.

The clamps for gripping the specimens shall prevent slipping or cutting of the specimens and breaks at the jaws. Flat-faced unlined jaws shall be the normal type but, if these cannot prevent slippage, then other types of clamps may be used on agreement, such as lined jaws, bollard clamps or other types of snubbing devices. As the type of clamp may influence the reading of the elongation, all interested parties shall use the same type.

The tester shall be equipped with an autographic force/elongation recording device of sufficiently fast response, or with a system directly recording the breaking force and elongation at break.

The tester shall be capable of setting a pretension either by means of a set of pretensioning weights or by using the force-measuring device.

5.2 Reel, for preparing test skeins from the laboratory sample (for methods C and D).

5.3 Swift or **similar device**, for holding the test skein under zero tension and permitting easy transfer of the yarn to the tensile tester (for Method C).

5.4 Receptacles, for immersing the sample or the specimens in water (for Method D).

5.5 Tap water, at room temperature (for Method D).

5.6 Non-ionic surfactant, 0,1 % (volumetric) aqueous solution (for Method D).

6 Sampling

6.1 Samples shall be taken in accordance with

a) the directions given in the material specification when available, or

b) the procedures described in 6.2 to 6.7.

6.2 A bulk sample shall be taken of one or more cases, as representative of the lot to be tested as shown in Table 1.

Table 1 — Sampling frequency

Number of cases	Number of cases selected at random
3 or less	1
4 to 10	2
11 to 30	3
31 to 75	4
76 or more	5

6.3 If only mean values are required, then 10 packages shall be taken from the bulk sample, distributed as evenly as possible among the cases and among the levels in each case.

6.4 Except for the provisions of 6.5, the minimum number of specimens to be tested shall be 50 for single-spun yarns and 20 for other yarns. The specimens shall be distributed as evenly as possible among the 10 packages.

6.5 If the variability of the test is known and only mean values are required, then the number of specimens shall be calculated as $0{,}17\ CV^2$, where CV is the coefficient of variation of the individual breaks (expressed as a percentage) obtained from experience on similar material.

NOTE This number of specimens will give a precision (1,96 times the standard error of the mean) of ± 4 % at a probability level of 90 %.

Strength testing is a “one-tail” test; that is “yarn shall not be weaker than…” but “may be stronger than…”. When specifying 90 % probability, one tail of the distribution is 5 %, or exactly the same as the two tails together or the more common 95 % probability appropriate for a “two-tail” test.

6.6 If the coefficient of variation is to be determined in addition to the mean, then 20 packages shall be taken from the bulk sample and at least 200 specimens shall be tested for single-spun yarns and at least 100 specimens for all other types of yarn.

6.7 If specimens are to be extracted from fabrics [not suitable for automatic testers (Method B)], then the fabric sample shall be large enough to furnish a sufficient number and length of specimens. The test specimens shall be taken so that the twist in the yarn is not changed during sampling. In woven fabrics, warp specimens shall be taken from different ends and weft specimens shall be taken at random from several sections of the sample to be as representative of the yarn as possible. In knitted fabrics, specimens shall represent as many different yarns as possible.

7 Preconditioning and conditioning

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

7.2 For methods A to C, the sample packages or test skeins shall be preconditioned for a minimum of 4 h.

NOTE Preconditioning can often be dispensed with if the samples are conditioned directly “from the dry side”.

7.3 After preconditioning, the sample shall be brought to moisture equilibrium under the conditioning atmosphere. For skeins, overnight conditioning is usually sufficient, but for tightly wound packages a minimum of 48 h is necessary.

7.4 Preconditioning and conditioning are not required for wet tests (Method D).

8 Procedure

8.1 General

8.1.1 If more than one condition of testing is permitted, usually by agreement, then all parties interested in the test results shall perform the test under the same conditions (i.e. gauge length, rate of extension, type of clamp, temperature, pretension).

8.1.2 Two gauge lengths are permitted: the usual length of 500 mm, and a length of 250 mm which can be used only if

a) the extension of the instrument is insufficient to accommodate a 500 mm specimen, or

b) by agreement between the interested parties.

8.1.3 If a calculation of breaking tenacity is required, determine the linear density of the yarn in accordance with ISO 2060.

8.1.4 Use a rate of extension of 500 mm/min or 250 mm/min at the gauge length of 500 mm or 250 mm. In addition, for automatic testers only (Method B), higher rates are permitted by agreement; 2 000 mm/min and 5 000 mm/min are recommended. Lower extension rates may be used on agreement; e.g. 50 %/min or 20 %/min.

8.1.5 Unwind the yarn from the package as is done in normal use.

8.1.6 Before clamping the specimen, check that the jaws are correctly aligned and parallel, so that the force applied produces no angular deviation.

8.1.7 Insert the specimen in the clamps with a pretension of 0,5 cN/tex ± 0,1 cN/tex for conditioned specimens, or 0,25 cN/tex ± 0,05 cN/tex for wet specimens. If the specimen is inserted under unknown tension, the tester must be able to determine its initial length (under specified pretension).

For untwisted technical and industrial multifilament yarns, to ensure that all filaments have the same tension at the beginning of the test and to prevent slippage of individual filaments in the clamps during the test, a twist should be applied prior to the test. A twist of 60 ± 1 turns/m for yarns below 2 200 dtex and a twist of 30 ± 1 turns/m for yarns above 2 200 dtex are recommended. Other twist amounts may be allowed on agreement of the interested parties.

8.1.8 For textured yarns, use a pretension which will remove the crimp but not stretch the yarn. The following pretensions are recommended (unless otherwise agreed), calculated on the nominal linear density of the yarn:

— 2,0 cN/tex ± 0,2 cN/tex, for polyester and polyamide yarns;

— 1,0 cN/tex ± 0,1 cN/tex, for acetate, triacetate and viscose yarns;

— 0,5 cN/tex ± 0,05 cN/tex, for bi-shrinkage and jet-bulked yarns, except for carpet yarns heavier than 50 tex.

8.1.9 Finally, secure the specimen in the clamps.

8.1.10 Perform the test under the standard atmosphere for testing, as specified in 7.1.

8.1.11 During the test, check that the specimen does not slip between the jaws by more than 2 mm. If it does so repeatedly, change the clamps or jaw lining. Discard the results of the tests where slippage occurs. Also discard results involving jaw breaks where breaks occur 5 mm from the jaws or closer, but record the number of specimens for which the results were discarded.

8.1.12 Record the breaking force and elongation at break (done automatically in Method B). For fancy yarns, record values for the first component that breaks. The values recorded for fancy yarns may be lower than those defined in 3.1 and 3.2.

8.1.13 With bollard or capstan clamps, measurement of the elongation is not accurate and is discouraged.

8.2 Method A — Manual

Take specimens directly from the conditioned packages. Follow the procedures given in 8.1.1 to 8.1.13. Insert the test specimens manually into the clamps to perform the tensile test.

8.3 Method B — Automatic

Take specimens directly from the conditioned packages. Follow the procedures given in 8.1.1 to 8.1.6 and 8.1.9 to 8.1.13. Set the instrument to take specimens from the 10 or 20 packages of the sample (see 6.3 and 6.6). The test will be performed automatically.

8.4 Method C — Manual for conditioned specimens

8.4.1 Using the reel (5.2), take one test skein from each package of the sample. The test skeins shall be of sufficient length to give the required number and length of test specimens.

8.4.2 Using the swift (5.3), allow the test skeins to relax under minimal tension in the preconditioning and conditioning atmospheres (see 7.1).

8.4.3 Follow the procedures given in 8.1.1 to 8.1.13. When taking a specimen from the test skein for insertion between the clamps, make sure that its length is at least 100 mm greater than the selected gauge length; an excess of 500 mm is recommended. Be careful not to change the twist.

NOTE With suitable modifications (see 6.7), this method can also be used for yarns from fabrics.

8.5 Method D — Manual for wet specimens

8.5.1 Take test skeins as described in 8.4.1.

8.5.2 Before removing the test skein from the reel, wrap two or three turns of a strong thread (e.g. sewing thread) tightly around the skein at two places about 2 cm apart and securely tie the ends of the thread. Cut the skein midway between the two places. Fill a receptacle (5.4) with tap water (5.5). Then lay the cut skein flat on the surface of the water and leave it until it sinks below the surface under its own weight.

8.5.3 If the skein will not sink in the water, then hold the yarn under the surface, e.g. by means of weights attached to the ends, until the yarn is thoroughly saturated (e.g. for 30 min). When the yarns are normally resistant to wetting, use a non-ionic wetting agent (5.6). Rinse out the wetting agent thoroughly with water before testing the yarn.

8.5.4 Remove the specimens individually from the water and test them within 60 s thereafter, following the procedures given in 8.1.1 to 8.1.13.

9 Test report

9.1 General information

The test report shall include the following information:

a) a reference to this International Standard (ISO 2062);

b) lot number or other identification of the sample;

c) type of package (cone, bobbin, etc.), its condition (dyed, bleached, etc.), and the manner in which the yarn was withdrawn from the package (over-end or from the side);

d) conditioning atmosphere and testing atmosphere used;

e) sampling scheme used, the number of specimens tested, and if applicable, the number of specimens discarded (see 8.1.11);

f) make and model of tester used;

g) test method used (A to D);

h) gauge length, rate of extension and pretension used;

NOTE If untwisted technical or industrial multifilament yarns are tested, report the twist amount and direction ("S" or "Z") used.

i) type of clamp and jaws used;

j) date of the testing.

9.2 Test results

The following test results shall be given:

a) mean breaking force, in centinewtons (to two significant figures);

b) mean elongation at break, as a percentage (to two significant figures);

c) coefficient of variation of the breaking force, if required (to the nearest 0,1 %);

d) coefficient of variation of percent elongation at break, if required (to the nearest 0,1 %);

e) linear density of the yarn, if determined, in tex (to two significant figures);

f) breaking tenacity, if required, in centinewtons per tex (to the nearest 0,1 %).

Annex A
(informative)

Alternative methods using constant rate of travel (CRT) and constant rate of loading (CRL) testers

A.1 Scope

This annex describes seven methods: these methods are given for information only and can be used by agreement between the interested parties. They do not have an influence on the status of this International Standard.

— E: CRT testers, manual: specimens are taken directly from conditioned packages;

— F: CRT testers, manual: relaxed test skeins are used after conditioning;

— G: CRT testers, manual: relaxed test skeins are used after wetting;

— H: CRL testers, manual: specimens are taken directly from conditioned packages;

— J: CRL testers, automatic: specimens are taken directly from conditioned packages;

— K: CRL testers, manual: relaxed test skeins are used after conditioning;

— L: CRL testers, manual: relaxed test skeins are used after wetting.

A.2 Procedure

A.2.1 General

Follow 8.1.2, 8.1.3, 8.1.5, 8.1.6, if possible 8.1.7, and also 8.1.8 to 8.1.13 and Clause 9.

A.2.2 Method E: CRT testers, manual

A.2.2.1 Use the pendulum tester which complies with the following requirement. After the first 2 s of the test, the average rate of travel for the pulling clamp in any 2 s interval shall not differ by more than 5 % from the average rate of travel over the whole period of the test.

Adjust the instrument so that the average time-to-break shall be 20 s ± 3 s. Also adjust the tester so that the recorded breaking force lies between 15 % and 85 % of the instrument's scale.

A.2.2.2 Follow the procedure given in Method A (8.2), omitting 8.1.4.

A.2.3 Method F: CRT testers, manual

Follow the procedure given in A.2.2.1 and then follow the procedure given in Method C (8.4), omitting 8.1.4.

A.2.4 Method G: CRT testers, manual

Follow the procedure given in A.2.2.1 and then follow the procedure given in Method D (8.5), omitting 8.1.4.