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Fibres — Elasticity of fibres — Test methods

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The UK participation in its preparation was entrusted to Technical Committee TCI/24, Physical testing of textiles.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 15930:2010) has been prepared by Technical Committee CEN/TC 248 “Textiles and textile products”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2011, and conflicting national standards shall be withdrawn at the latest by March 2011.

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1 Scope

This test method covers the determination of the elasticity of fibres and may lead to classification of the fibre as elastic fibre (see Annex A).

It is applicable to single man-made crimped and uncrimped fibres.

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.

EN 12751, *Textiles — Sampling of fibres, yarns and fabrics for testing*

EN ISO 139, *Textiles — Standard atmospheres for conditioning and testing (ISO 139:2005)*

EN ISO 1973, *Textile fibres — Determination of linear density — Gravimetric method and vibroscope method (ISO 1973:1995)*

EN ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

3 Terms and definitions

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

3.1
elasticity
property of a fibre by virtue of which it tends to recover its original size and shape immediately after the removal of the force causing deformation

3.2
linear density
mass per unit length of an essentially linear structure

3.3
constant-rate-of-extension (CRE) testing machine
tensile testing machine provided with one clamp, which is virtually stationary, and another clamp, which moves with a constant speed throughout the test, the entire testing system being virtually free from deflection

3.4
gauge length
distance between the two effective clamping or holding points of a testing device

3.5
initial length
length of the test specimen between the two effective clamping or holding points at the required pretension, before testing

3.6
extension
increase in length of a test specimen expressed in units of length e.g. millimetres

3.7
elongation
ratio of the extension of the test specimen to its initial length, expressed as a percentage

3.8
maximum force
force recorded in Newton at the position when a test specimen is taken to a fixed extension

3.9
cycle
process whereby a fibre is taken from the gauge length to fixed extension or elongation and returned to gauge length

3.10
elastic recovery
recovered elongation expressed as a percentage of the specified elongation

3.11
permanent deformation
ratio of un-recovered extension of the test specimen after cycling to its initial length, expressed as a percentage

3.12
force decay
loss of force measured over time when a test specimen is stretched to a specified elongation or extension and held at this position for a given time period

4 Principle

The measurements are performed on an individual fibre.

A fibre is cycled between the gauge length and a specified elongation at a constant rate for an agreed number of cycles. The fibre can be maintained at the specified elongation or at the gauge length – for a specific period of time. Its elasticity is determined by measuring certain physical characteristics.

5 Apparatus

5.1 Pretension device

Pretension device able to apply (0,010 ± 0,005) cN/tex on the individual test specimen.

NOTE Pretension may be applied using masses with discontinuous values (e.g. adhesive paper or clips) or using a high-resolution load cells.

5.2 Tensile testing machine

The constant-rate-of-extension (CRE) testing machine shall conform to the following.

a) The tensile testing machine shall be provided with the means for indicating or recording the force and elongation values when cycling between gauge length and either a fixed load or fixed extension. Under conditions of use, the accuracy of the apparatus shall be at least class 1 of EN ISO 7500-1. The error of

the indicated or recorded maximum force at any point in the range in which the machine is used shall not exceed 1 %, and the error of the indicated or recorded jaw separation shall not exceed 1 mm.

b) If recording of force or elongation is obtained by means of data acquisition boards and software, the frequency of data collection shall be at least eight per second.

c) The machine shall be capable of constant rates of extension from (20,0 ± 0,5) mm/min to (50,0 ± 0,5) mm/min.

d) The machine shall be capable of variable gauge length settings from (20,0 ± 0,5) mm to (50,0 ± 0,5) mm.

e) The clamping or holding devices shall be positioned with the centre in line with the applied force.

The jaws shall be capable of holding the test specimen without allowing it to slip and designed so that they do not cut or otherwise weaken the test specimen.

6 Atmosphere of conditioning and testing

Samples shall be conditioned in a tension free state for at least 16 h in the standard atmosphere according to EN ISO 139.

Testing shall be performed in this standard atmosphere.

7 Sampling

The sampling of the fibres to be tested from staple fibres, from yarns or from fabrics shall be according to EN 12751.

8 Preparation of the test specimens

8.1 Preparation from staples

In order to isolate one fibre first open very carefully the sample in a direction perpendicular to the local fibre orientation, taking care to apply the force at two points sufficiently distant to allow free fibre movements necessary to disentangle the fibre mass.

In the middle of the small web thus created extract one fibre by using tweezers. There shall be no resistance.

If there is any entanglement, first open this entanglement by pulling the fibres sideways before extracting.

Avoid stretching a fibre, even lightly, by drawing it by one of its ends.

Once separated, the fibre can be pinched at one of its ends for handling.

8.2 Preparation from yarns

For all types of yarns (e.g. monofilament or fused multifilament alone, fused multifilament in core spun – e.g. elastane -, multifilament, etc.), take randomly at least five lengths (approx. 20 cm) from the yarn package.

8.3 Preparation from fabrics

For all types of fabric, remove at least five threads (approx. 20 cm) in the production direction (i.e. warp direction for woven fabric, wales' direction for knitted fabric) and/or in the perpendicular production direction (i.e. weft direction for woven fabric and courses' direction for knitted fabric).

9 Procedure

9.1 Determination of the linear density

Determine the linear density testing according to EN ISO 1973 using only the gravimetric method.

NOTE In the case of crimped fibres, the crimp should be removed in order to determine the length.

9.2 Number of results for determination of the elasticity properties

Determine at least five results.

9.3 Determination of the pretension

Based on the determination of the linear density, calculate the pretension force to be applied using a pretension of 0,01 cN/tex.

When applicable (in the case of the use of discontinuous values of pretension masses), choose the nearest pretension mass to fix onto the fibre in vertical position.

9.4 Determination of the elasticity

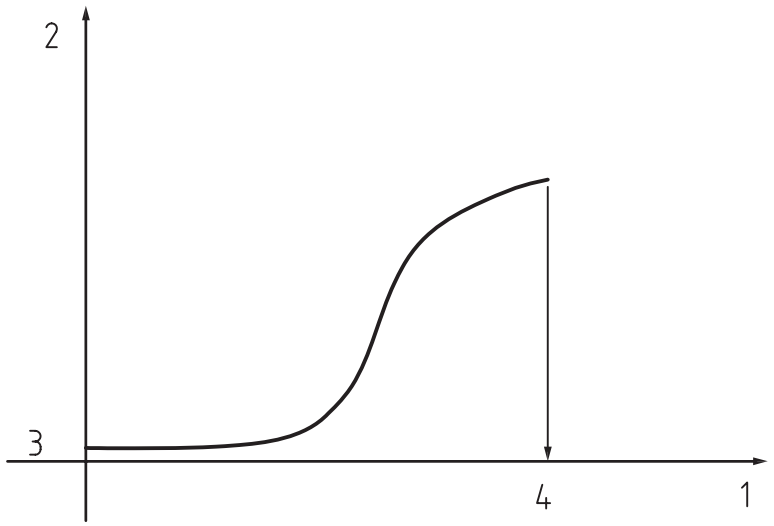
9.4.1 General

Set the gauge length to 50 mm. If it cannot be achieved, then set to 20 mm.

Set the testing speed at 100 % of the gauge length/minute (i.e. 50 mm/min for gauge length 50 mm).

Zero the load cell with the grips in position and the jaw faces closed, prior to testing.

NOTE See Figure 1 for illustration of the elongation-force curve and the position of the pretension point.



Key

1 extension (mm) axis

2 force (cN) axis

3 pretension (cN)

4 E_{spec}

Figure 1 — Example of force/elongation curve

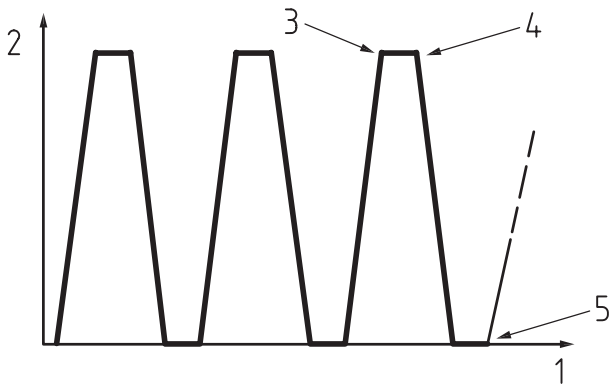
9.4.2 Determination of the elasticity with exercising

9.4.2.1 Description of the cycles

The fibre is extended at a constant rate to a specified elongation and is maintained for a specified time, then the fibre is relaxed to the initial length and maintained for the same specified time.
This cycle is applied again 2 times (Figure 2 illustrates the cycles by the curve extension in function of time).

A 4^{th} load cycle is applied past the specified pretension in order to determine the recovery extension E_{rec} (Figure 3 illustrates this point).

If the force decay is required, the 3^{rd} cycle is taken into account for the calculation (Figure 4 illustrates this determination).



Key

1 time (s) axis

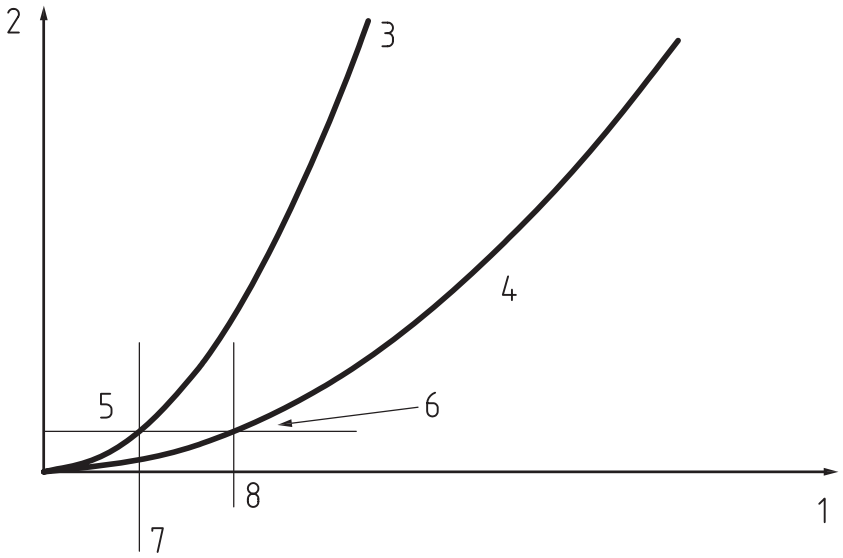
2 extension (mm) axis

3 F_1

4 F_2

5 point "P"

Figure 2 — Curve extension in function of the time



Key

1 extension (mm) axis

2 force (cN) axis

3 1st cycle (beginning)

4 4th cycle (beginning)

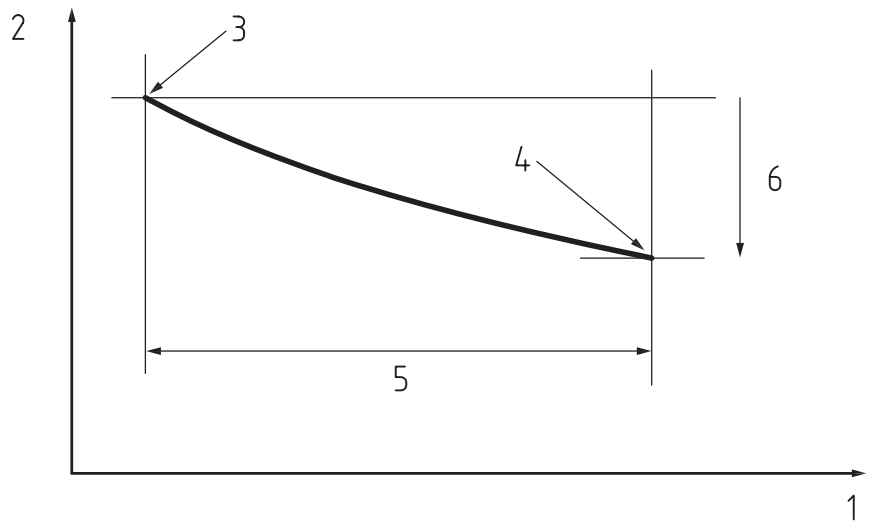
5 pretension

6 point "P"

7 initial length

8 E_{rec}

Figure 3 — Determination of the extension (regarding Point "P" at the pretension force) on the 4th cycle



Key

1 time (s) axis

2 force (cN) axis

3 F_1

4 F_2

5 specified times (s)

6 force decay

Figure 4 — Determination of the force decay at the 3rd cycle

9.4.2.2 Setting of the testing parameters

Set the following testing parameters:

- specified elongation at 50 % (i.e. for a gauge length of 50 mm, specified elongation of 50 % represents 25 mm);
- specified time at 60 s;
- specified pretension at 0,01 cN/tex.

10 Calculation and expression of the results

10.1 Calculation of the elastic recovery

Elastic recovery is calculated according to the following formula:

$$\text{Elastic Recovery} = \frac{E_{spec} - E_{rec}}{E_{spec}} \times 100\,,\ \text{expressed in percentage,}$$

where

E_{spec} is the specified extension of the fibre, expressed in mm,

E_{rec} is the extension determined at the specified pretension on the 4th cycle (recovery extension), expressed in mm.

Based on the individual values, calculate the arithmetic mean value and the standard deviation.

10.2 Calculation of the permanent deformation

Permanent deformation is calculated according to the following formula:

$$\text{Permanent Deformation} = \frac{E_{rec}}{L_{init}} \times 100\ \text{, expressed in percentage,}$$

where,

E_{rec} is the extension determined at the specified pretension on the 4th cycle (recovery extension), expressed in mm,

L_{init} is the initial length at the specified pretension on the 1st cycle, expressed in mm.

Based on the individual values, calculate the arithmetic mean value and the standard deviation.

10.3 Calculation of the force decay (optional)

Force decay is calculated according to the following formula:

$$\text{Force Decay} = \frac{F_1 - F_2}{F_1} \times 100\ \text{, expressed in percentage,}$$

where,

F_1 is the first force at the maximum extension on the 3rd cycle (measured at 1 s after the beginning of the 3rd cycle), expressed in cN,

F_2 is the last force at the maximum extension on the 3rd cycle (measured at 1s before the end of the specified time of the 3rd cycle), expressed in cN.

Based on the individual values, calculate the arithmetic mean value and the standard deviation.

11 Test report

The test report shall include the following information:

a) Reference to this standard;

b) All details necessary for complete identification of the sample tested;

c) Description of the sampling procedure;

d) Testing parameters applied;

e) Pretension used;

f) Elastic recovery: individual, mean and standard deviation values;

g) Permanent deformation: individual, mean and standard deviation values;

h) If required, Force decay: individual, mean and standard deviation values;

i) Any deviation by agreement or otherwise from the procedure specified.

Annex A
(normative)

"Elastic" qualification of fibres

Based on the testing results, the tested fibre can be qualified as an "elastic" fibre, when it is extended under a tensile force until reaching 1,5 times its initial length (i.e. elongation of 50 %), comes back quickly and substantially to its initial length as soon as the tensile force ceases being applied.

"Substantially" means that the elastic recovery, $E_{rec,}$ shall be more than 80 %.

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[3] EN ISO 5079, *Textiles — Fibres — Determination of breaking force and elongation at break of individual fibres (ISO 5079:1995)*

[4] EN 14704-1, *Determination of the elasticity of fabrics — Part 1: Strip tests*

[5] EN 14704-2, *Determination of the elasticity of fabrics — Part 2: Multiaxial tests*

[6] EN 14704-3, *Determination of the elasticity of fabrics — Part 3: Narrow fabrics*

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