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Third edition
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Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break

Supports textiles revêtus de caoutchouc ou de plastique — Détermination de la force de rupture et de l'allongement à la rupture

Reference number
ISO 1421:2016(E)

International Organization for Standardization

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This third edition cancels and replaces the second edition (ISO 1421:1998), which has been technically revised. The changes are as follows.

— In Clause 3, gauge length and reference points have been added and Figures 1, 2, and 3 have been moved to clarify the definitions.

— The title of Clause 5 has been changed.

— Clause 6 has been subdivided in two subclauses and conditions have been clarified respectively by referring to the particulars specified in ISO 2231:1989.

— A new clause has been added to specify the time-interval between manufacture and testing.

— In 8.1, two narrower widths of 10 mm and 30 mm have been added for test piece and the pre-tension forces have been revised accordingly. The procedure for the test pieces with reference mark has been incorporated.

— In 8.2, the procedure for handling abnormal test results has been modified.

Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This International Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard specifies two methods for the determination of the tensile strength of fabrics coated with rubber or plastics.

— Method 1 — the strip test method, which is a method for the determination of tensile strength and elongation at break.

— Method 2 — the grab test method, which is a method for the determination of tensile strength only.

The methods apply to test pieces in equilibrium with specific standard atmospheres for testing and to wet test pieces. Both methods require the use of a constant rate of extension (CRE) tensile-testing machine.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2231:1989, *Rubber- or plastics-coated fabrics — Standard atmospheres for conditioning and testing*

ISO 2286-2, *Rubber- or plastics-coated fabrics — Determination of roll characteristics — Part 2: Methods for determination of total mass per unit area, mass per unit area of coating and mass per unit area of substrate*

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.*

3 Terms and definitions

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

3.1
constant rate of extension
CRE
means of conducting a tensile test in which the rate of increase in the length of the test piece is uniform with time

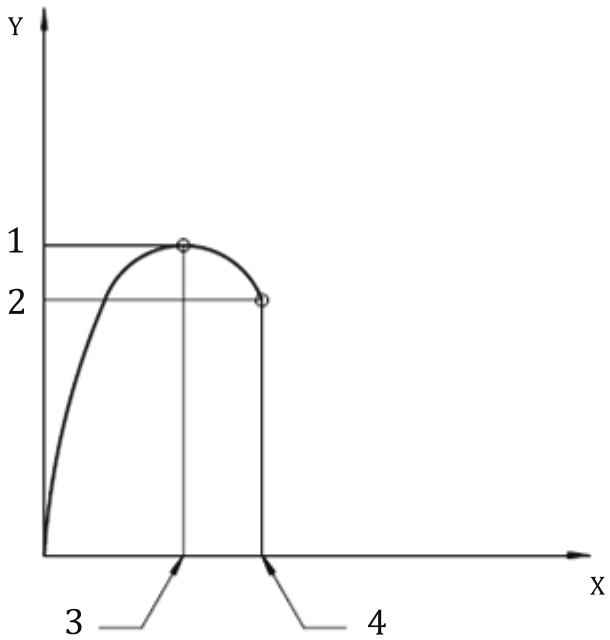
Note 1 to entry: The rate of increase of the force is dependent upon the extension characteristics of the test piece.

3.2
elongation
extension
E
increase in length of a test piece

Note 1 to entry: It is expressed in units of length, e.g. cm or mm.

3.3
elongation at break
elongation (3.2) of a test piece corresponding to the force at the breaking point

Note 1 to entry: See Figure 1. It is usually expressed as a percentage of the *nominal gauge length* (3.9).



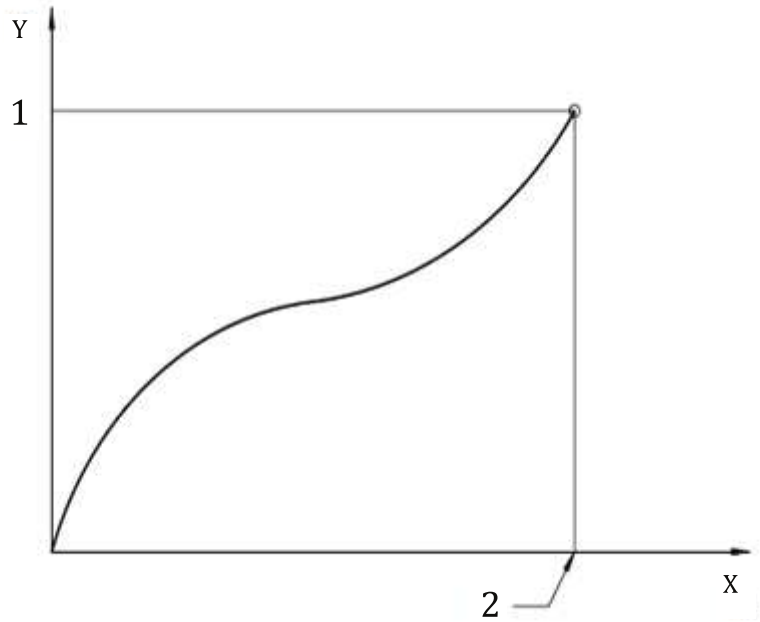
Key

X	elongation, *E*
Y	force
1	maximum force
2	force at break
3	elongation at maximum force
4	elongation at break

Figure 1 — Tensile force at break

3.4
elongation at maximum force
elongation (3.2) of a test piece produced by the maximum force

Note 1 to entry: See Figure 1, Figure 2 and Figure 3.



Key

X elongation, *E*

Y force

1 maximum force

2 elongation at maximum force

Figure 2 — Maximum force at break

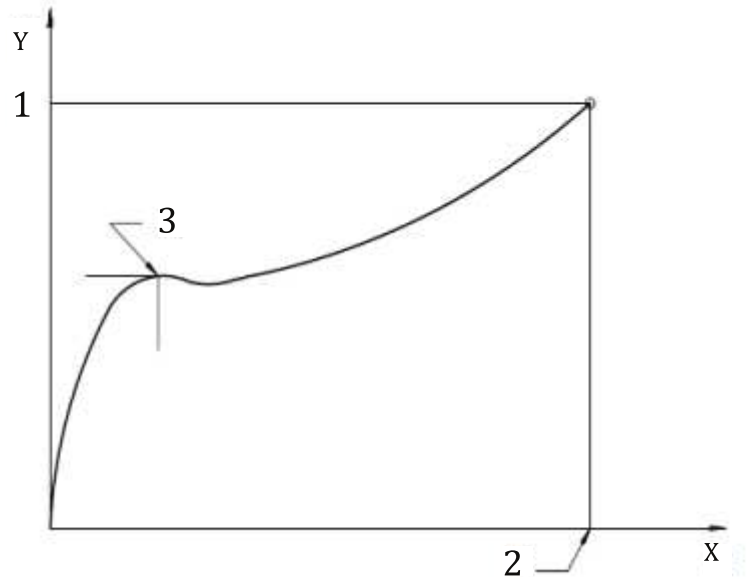
3.5
force at break
tensile force recorded at the moment of break

Note 1 to entry: See Figure 1.

Note 2 to entry: Figure 3 corresponds to the rupture of one of the elements constituting the coated fabric. Typical examples are:

a) a “rigid” polymer layer on an extensible fabric: rupture of the polymer layer;

b) a very extensible, thick polymer layer on a weak, less extensible fabric or nonwoven: rupture of the woven fabric or of the nonwoven.



Key

X elongation, *E*
Y force
1 maximum force
2 elongation at maximum force
3 rupture of one element

Figure 3 — Rupture of one element of a coated fabric

3.6
gauge length
length at a test piece prior to the addition of the pre-tension loaded, measured either from nip to nip of the jaws of the holding clamps or between the *reference points* (3.11)

3.7
grab test
tensile strength test in which only the central part of the width of the test piece is gripped in the jaws

3.8
maximum force
maximum force recorded in extending the test piece to breaking point

Note 1 to entry: See Figure 1, Figure 2 and Figure 3.

3.9
nominal gauge length
length of a test piece under a specified pre-tension, measured either from nip to nip of the jaws of the holding clamps with the clamps or between the *reference points* (3.11) in their starting position

3.10
percentage elongation
elongation (3.2) expressed as a percentage of the *nominal gauge length* (3.9)

3.11
reference points
two marks which are usually lines perpendicularly across the width of 100 mm apart marked on the surface of a test piece equidistantly from the middle point

3.12
strip test
tensile strength test in which the full width of the test piece is gripped in the jaws

4 Principle

A test piece is extended at a constant rate of extension until it breaks. For Method 1 (see Clause 8), the maximum force and the elongation at maximum force and, if required, the force at break and the elongation at break are determined. For Method 2 (see Clause 9), only the maximum force is determined.

5 Apparatus and reagents

5.1 Constant rate of extension (CRE) tensile testing machine, having the following general characteristics.

The machine shall be provided with means for reading and recording both the force applied to the test piece in stretching it to the breaking point and the corresponding extension of the test piece. It shall be provided with a strength indicator having several scales in order to ensure that the rupture of each test piece is obtained with a strength of 15 % to 85 % of the maximum of the scale used. Under conditions of use, the accuracy of the apparatus shall be class 1 as defined in 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. After the first 2 s of the test, the rate of increase in the distance between the clamps shall be uniform to within 5 %. If the force and elongation are recorded by means of data acquisition boards and software, the frequency of data collection shall be at least 8 s^{-1}.

5.2 Clamping device, with the central point of the two jaws of the machine in the line of pull, the front edges at right angles to the line of pull and their clamping faces in the same plane. The jaws shall be capable of holding the test piece without allowing it to slip. They shall be designed so that they do not damage the test piece or reduce its strength. Smooth, flat or engraved corrugated jaws can be used for clamping. Using suitable packing materials in the jaws, e.g. paper, leather, plastics or rubber, avoids difficulties in clamping in many cases.

When tests are carried out and the test pieces either break at the jaws or tend to slip, the results may often be discarded. In order to obtain legitimate results by avoiding jaw breaks and the effect of slippage, the use of capstan jaws or any other self-locking device can be a suitable alternative to ordinary flat jaws. When information on strain is required, elongation measurements are made by means of an extensometer which follows the movements of two reference points on the test piece. The use of such jaws and an extensometer shall be reported in the test report; see 9.4 h).

For the strip test method, the jaws shall be not less than the width of the test piece and should preferably have a width of at least 60 mm.

For the grab test method, the dimensions of one of the jaws of each clamp shall be 25 mm ± 0,5 mm by 25 mm ± 0,5 mm. The other jaw of each clamp shall be at least as wide as the one to which it is attached and should preferably be 50 mm wide.

5.3 Equipment for cutting test pieces and fraying them down to the required width.

5.4 Equipment in which the test pieces can be immersed in water prior to wet testing.

5.5 Distilled or deionized water, for wetting out the test pieces.

5.6 Wetting agent or surfactant.

6 Atmosphere for conditioning and testing

6.1 For conditioning

The atmosphere shall be the method of conditioning “1” specified in ISO 2231:1989.

For fabrics coated on one side only, a minimum of 16 h exposure is recommended.

For fabrics coated on both sides, a minimum of 24 h is recommended.

6.2 For testing

The atmosphere shall be selected from A to E as specified in ISO 2231:1989. If it is necessary to control both temperature and humidity, select the atmosphere from A to C.

NOTE The temperature 23 °C is normally the testing atmosphere in temperate countries and 27 °C is normally in tropical and subtropical countries.

7 Time-interval between manufacture and testing

For all test purposes, the minimum time between manufacture and testing shall be 16 h. For non-product tests, the maximum time between manufacture and testing shall be 4 weeks, and for evaluations intended to be comparable, the tests, as far as possible, shall be carried out after the same time-interval.

For products, unless otherwise agreed between the interested parties, the time between manufacture and testing shall not exceed 3 months.

8 Method 1: Strip test method

8.1 Sampling and preparation of test pieces

From each sample, cut two sets of test pieces, one set in the longitudinal direction and the other in the transverse direction. Each set shall consist of not less than five test pieces. If, by agreement between the interested parties, a higher degree of precision is required, test more test pieces.

Select the test pieces from the full usable width and length of the sample in accordance with ISO 2286-2. An example of how test pieces may be cut out is given in Figure 4.

Each test piece shall be 10 mm ± 0,5 mm, 30 mm ± 0,5 mm or 50 mm ± 0,5 mm wide and of sufficient length to allow a distance of 200 mm ± 1 mm between the jaws of the test machine. If the elongation exceeds 75 %, reduce the distance to 100 mm ± 1 mm. When a reference mark is applied, the distance between the reference points shall be 100 mm ± 1 mm and the distance between the jaws shall be 150 mm ± 1 mm or 200 mm ± 1 mm. The length of the parts of test piece clamped in the jaws is not less than the width of the test piece. If there is a woven support, take a wider strip and reduce the width to 50 mm ± 0,5 mm by fraying, if possible. Should fraying not be possible, cut the test pieces in the direction of testing as exactly as possible along a thread.

If it is not possible to cut exactly along a thread because of distortion of the threads or the presence of an invisible support, use another test method, for example, Method 2.

If there is a knitted support, cut the test pieces to their final dimensions by following a wale or course. If it is not possible to cut a suitable test piece because of distortion of the threads or the presence of an invisible support, use another test method, for example, Method 2.

If there is a nonwoven support such as felt, cut rectangular test pieces in the longitudinal and transverse directions with tidy edges.

When it is required to determine the properties of wet material, immerse the test pieces for 24 h in water (5.5), or water containing no more than 0,1 % wetting agent or surfactant (5.6), of about 20 times the total volume of the test pieces at the room temperature. Immediately after removal from the water, rinse thoroughly in water and proceed to test within 1 min.

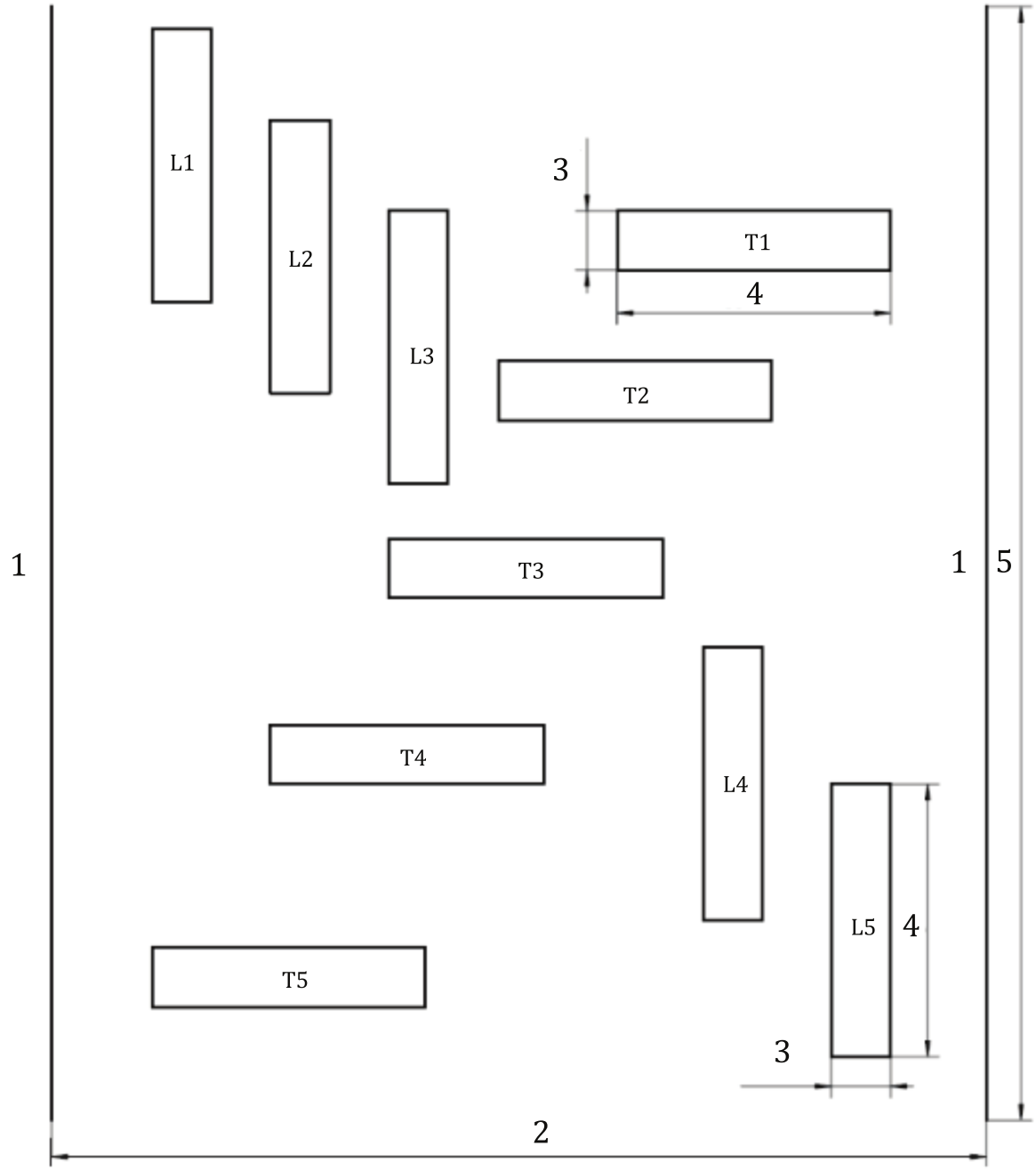
8.2 Procedure

8.2.1 Mounting the test piece in place

8.2.1.1 General

Set the jaws of the test machine 200 mm ± 1 mm apart, 150 mm ± 1 mm or 100 mm ± 1 mm apart if more appropriate. Clamp a test piece in the stationary jaws so that its longitudinal axis passes through the centre of the front edge of each jaw.

Test pieces can be mounted under pre-tension or in the slack condition. When test pieces are mounted under pre-tension, check that the pre-tension does not produce an elongation greater than 5 %. If these conditions cannot be met, mount the test piece in the slack condition.



Key

L test pieces cut in the longitudinal direction
T test pieces cut in the transverse direction
1 selvedge
2 usable width
3 width
4 length
5 about 1 m

Figure 4 — Example showing how test pieces may be cut out

8.2.1.2 Pre-tension setting

Apply the appropriate pre-tension from the values given in Table 1.

Table 1 — Pre-tension force of each test piece width

Mass of the test piece	Test piece width		
	10 mm	30 mm	50 mm
Less than 200 g/m^2	0,4 N	1,2 N	2,0 N
Equal to or more than 200 g/m^2 and less than 500 g/m^2	1,0 N	3,0 N	5,0 N
Equal to or more than 500 g/m^2	2,0 N	6,0 N	10,0 N

8.2.1.3 Slack mounting

When test pieces are mounted in the slack condition, the starting point of the curve corresponds to the required pre-tension force. Add the corresponding elongation to the gauge length and use it as the nominal gauge length.

Table 2 — Pre-tension force of slack condition

Test piece width	10 mm	30 mm	50 mm
Pre-tension	0,1 N	0,3 N	0,5 N

8.2.2 Operation

Engage any device for reading the breaking strength and elongation. Set the moving clamp in motion at a constant rate of 100 mm/min ± 10 mm/min, unless otherwise agreed between the interested parties, and extend the test piece to the breaking point. Repeat the procedure for each test piece.

8.2.3 Slippage

Disregard any test results where the test piece slips asymmetrically or slips by more than 2 mm, or record them in the report when they are useful information.

When results are discarded, repeat the test on a replacement test piece taken, if practicable, from the same part of the sample as the discarded test piece.

8.2.4 Jaw breaks and the breaks outside the reference marks

Disregard any test results where the test piece breaks within 5 mm of the face of a jaw or outside the reference marks on the test piece (outside the test length of 100 mm). When the results are judged to be useful information at the user's discretion, record them in the test report.

When results are discarded, repeat the test on a replacement test piece taken, if practicable, from the same part of the sample as the discarded test piece.

If, in spite of taking care, all breaks are within 5 mm of the face of a jaw or outside the reference marks, use Method 2.

8.2.5 Test on wet test pieces

Remove the test piece from the water (see 8.1, last paragraph), press it lightly between two sheets of blotting paper and immediately carry out the test as described in 8.2.1 to 8.2.4, except that, for the wet test, apply half the normal pre-tension.

8.3 Calculation and expression of results

Record the maximum force and the force at break (this has to be recorded to ascertain whether it differs from the maximum force or not) for each of the five test pieces in both the longitudinal and the transverse directions and calculate the mean value of the maximum force and the mean value of the force at break in each direction. Round both the mean maximum force and the mean force at break to the nearest 1 N or to 1 % of the calculated value. Calculate the coefficient of variation in each case and, if required, the confidence limits of the mean.

Record, to the nearest 1 mm, the elongation at maximum force (and, if different, the elongation at break) of each of the five test pieces in each direction. Express the elongation at maximum force and elongation at break values as a percentage elongation (see 3.10).

Calculate the mean values of the elongation at maximum force and elongation at break. Round these mean values to the nearest 0,2 % when the mean elongation does not exceed 8 %, to the nearest 0,5 % when it is 8 % to 50 % and to the nearest 1 % when it is greater than 50 %. Calculate the coefficient of variation in each case and, if required, the confidence limits of the mean.

8.4 Test report

The test report shall include the following particulars:

a) a reference to this International Standard, i.e. ISO 1421;

b) the method used (Method 1: Strip test method);

c) the sampling scheme used;

d) the number of test pieces tested from each sample;

e) the conditioning and test atmosphere used;

f) the gauge length and the way in which the test pieces were mounted (pre-tension or slack);

g) the state of the test pieces (conditioned or wet) and the time of conditioning or immersion;

h) the type of tensile testing machine used and its load capacity;

i) the values of the maximum force and, if different, the force at break, for each test piece and the mean maximum force and force at break, in newtons, and the width of the test piece tested, for each sample, for the longitudinal and transverse directions separately, as well as the coefficient of variation for each force and each direction and, if required, the confidence limits of the mean;

j) the values of the elongation at maximum force and, if different, the elongation at break of each test piece and the mean elongation at maximum force and elongation at break, in millimetres, for each sample, for the longitudinal and transverse directions separately, as well as the coefficient of variation and, if required, the confidence limits of the mean;

k) details of any deviation from the specified procedure;

l) the date of the test.

9 Method 2: Grab test method

9.1 Sampling and preparation of test pieces

From each sample, cut two sets of test pieces, one set in the longitudinal direction and the other in the transverse direction. Each set shall consist of not less than five test pieces. If, by agreement between the interested parties, a higher degree of precision is required, test more test pieces.

Select the test pieces from the full usable width of the sample. The width of each test piece shall be 100 mm ± 2 mm and its length shall not be less than 150 mm.

On each test piece, draw a line 37 mm from one of the long edges, parallel to the edge, along the full length of the test piece (see Figure 5).

When it is required to determine the properties of wet material, immerse the test pieces for 24 h in water (5.5), or water containing no more than 0,1 % wetting agent or surfactant (5.6), of about 20 times the total volume of the test pieces at the room temperature. Immediately after removal from the water, rinse thoroughly in water and proceed to test within 1 min.

9.2 Procedure

9.2.1 Mounting the test piece in place

Set the jaws of the test machine either 100 mm ± 1 mm or 75 mm ± 1 mm apart, by agreement between the interested parties. Clamp a test piece in the stationary jaws (5.2) so that its longitudinal axis passes through the centre of the front edge of each jaw and is perpendicular to the edges of the jaws, and so that the line drawn on the test piece coincides with the appropriate edge of each jaw (see Figure 5).

9.2.2 Operation

Engage any device for reading the maximum force. Set the moving clamp in motion at a constant rate of 100 mm/min ± 10 mm/min, unless otherwise agreed between the interested parties, and extend the test piece to the breaking point. Repeat the procedure for each test piece.

9.2.3 Slippage

Discard the test results where the test piece slips asymmetrically or slips by more than 2 mm. Record the test results in the report when they are judged to be useful information at the user's discretion.

When results are discarded, repeat the test on a replacement test piece taken, if practicable, from the same part of the sample as the discarded test piece.

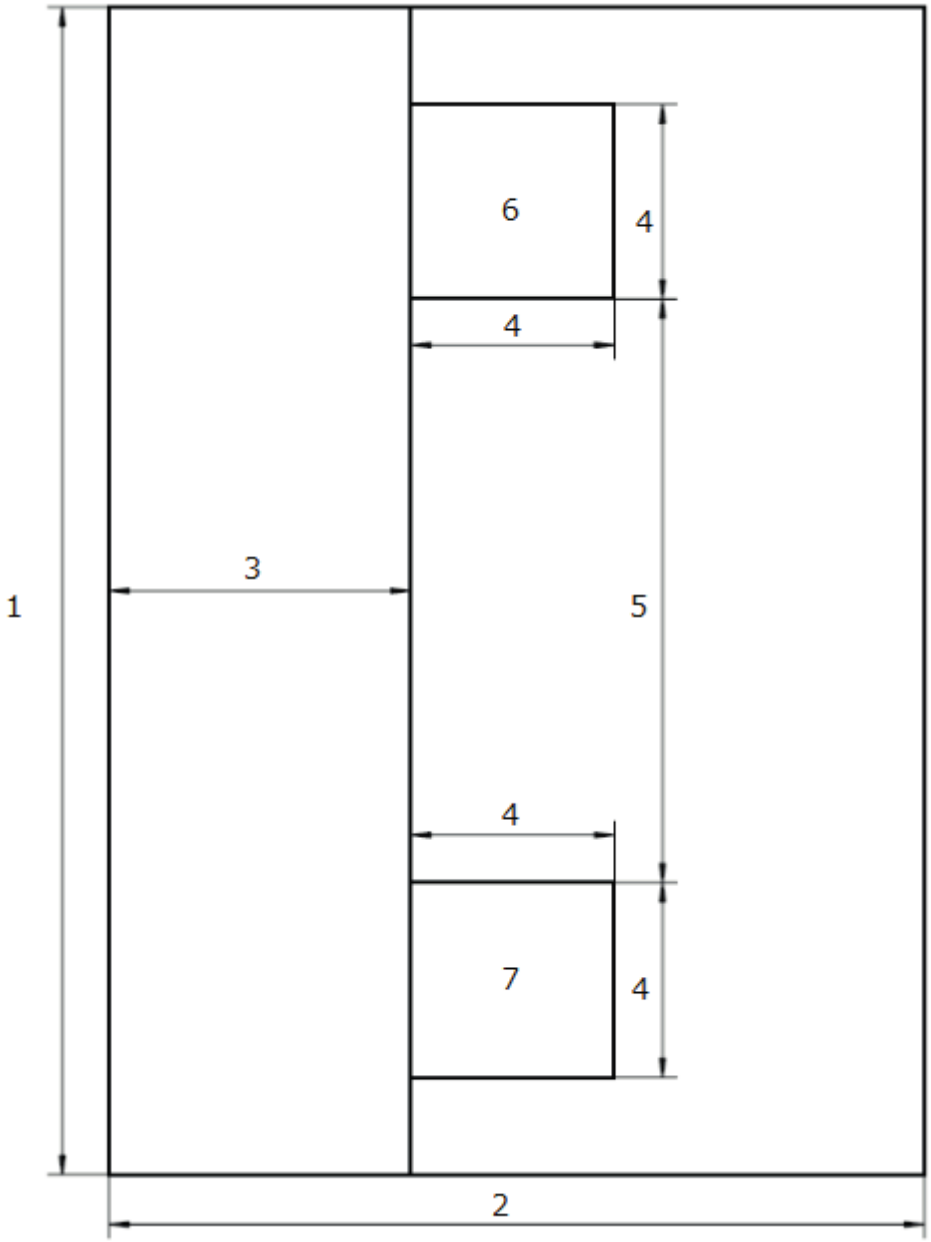
9.2.4 Jaw breaks

Discard the test results where the test piece breaks within 5 mm of the face of a jaw. Record the test results in the test report when they are judged to be useful information at the user's discretion.

When results are discarded, repeat the test on a replacement test piece taken, if practicable, from the same part of the sample as the discarded test piece.

9.2.5 Test on wet test pieces

Remove the test piece from the water (see 9.1, last paragraph), press it lightly between two sheets of blotting paper and immediately carry out the test as described in 9.2.1 to 9.2.4.



Key

1 ≥150 mm
2 100 mm
3 37 mm
4 25 mm
5 100 mm or 75 mm
6 top jaw
7 bottom jaw

Figure 5 — Test piece for grab test method

9.3 Calculation and expression of results

Record the maximum force for each of the five test pieces in both the longitudinal and the transverse directions and calculate the mean value in each direction. Round the mean maximum force to the nearest 1 N or to 1 % of the calculated value. Calculate the coefficient of variation and, if required, the confidence limits of the mean.

9.4 Test report

The test report shall include the following particulars:

a) a reference to this International Standard, i.e. ISO 1421;

b) the method used (Method 2: Grab test method);

c) the sampling scheme used;

d) the number of test pieces tested from each sample;

e) the conditioning and test atmosphere used;

f) the gauge length;

g) the state of the test pieces (conditioned or wet) and the time of conditioning or immersion;

h) the type of tensile testing machine used and its load capacity;

i) the values of the maximum force for each test piece and the mean maximum force, in newtons, for each sample, for the longitudinal and transverse directions separately, as well as the coefficient of variation and, if required, the confidence limits of the mean;

j) details of any deviation from the specified procedure;

k) the date of the test.

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