
**Textiles — Biaxial tensile properties
of woven fabric — Determination of
maximum force and elongation at
maximum force using the grab method**

*Textile- Propriétés biaxiales des tissus- Détermination de la force
maximale et de l'élongation par la méthode d'arrachement*

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Contents

	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	3
5 Sampling	3
6 Apparatus — Biaxial test machine	4
7 Atmosphere for conditioning and testing	4
8 Preparation of test specimens	4
8.1 General	4
8.2 Dimensions	5
8.3 Preparation of test specimens	5
9 Procedure	5
9.1 Gauge length	5
9.2 Rate of extension	5
9.3 Mounting of test specimens	5
9.4 Operation	5
10 Calculation and expression of results	6
11 Test report	6
Annex A (informative) Locations of test specimens cut from a laboratory sample	8
Annex B (normative) Preparation of test specimens	9
Bibliography	11

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

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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 24, *Conditioning atmospheres and physical tests for textile fabrics*.

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.

Textiles — Biaxial tensile properties of woven fabric — Determination of maximum force and elongation at maximum force using the grab method

1 Scope

This document specifies a procedure to determine the maximum force and elongation at maximum force of textiles woven fabrics using a grab method in the biaxial testing machine.

The method is mainly applicable to woven textile fabrics, including fabrics which exhibit stretch characteristics imparted by the presence of an elastomeric fibre, mechanical, or chemical treatment. It can be applicable to fabrics produced by other techniques. It is not applicable to geotextiles^[4], nonwovens^[3], coated fabrics^[5], textile-glass woven fabrics^[2], and fabrics made from carbon fibres or polyolefin tape yarns.

The method is restricted to the use of constant rate of extension (CRE) testing machines to the same axis.

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 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*

ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13934-2, *Textiles — Tensile properties of fabrics — Part 2: Determination of maximum force using the grab method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13934-1, ISO 13934-2 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

biaxial

related to measurement or application along two axes simultaneously

3.2

constant-rate-of-extension (CRE) biaxial testing machine

tensile-testing machine provided with four clamp moves independently with a constant speed throughout the test, the entire testing system being virtually free from deflection

3.3

grab test

tensile test in which only the centre part of the test specimen is gripped in the jaws of the testing machine

[SOURCE: ISO 13934-2:2014, 3.2]

3.4

maximum force

maximum force recorded when a test specimen is taken to rupture during a test under the specified conditions

[SOURCE: ISO 13934-1:2013, 3.11]

3.5

gauge length

distance between the two effective clamping points of a testing device

Note 1 to entry: the effective clamping points (or lines) of jaws can be checked by clamping the test specimen under defined pretension with carbon copy paper to produce a gripping pattern on the test specimen and/or the jaw faces.

[SOURCE: ISO 13934-1:2013, 3.3]

3.6

extension

increase in length of a test specimen produced by a force

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

[SOURCE: ISO 13934-1:2013, 3.6]

3.7

elongation

ratio of the *extension* (3.6) of the test specimen to its initial length

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

[SOURCE: ISO 13934-1:2013, 3.7]

3.8

pretension

force applied to a test specimen at the beginning of certain tests

Note 1 to entry: Pretension is used to determine the *initial length* (3.9) of the test specimen.

[SOURCE: ISO 13934-1:2013, 3.5]

3.9

initial length

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

Note 1 to entry: See also 3.5.

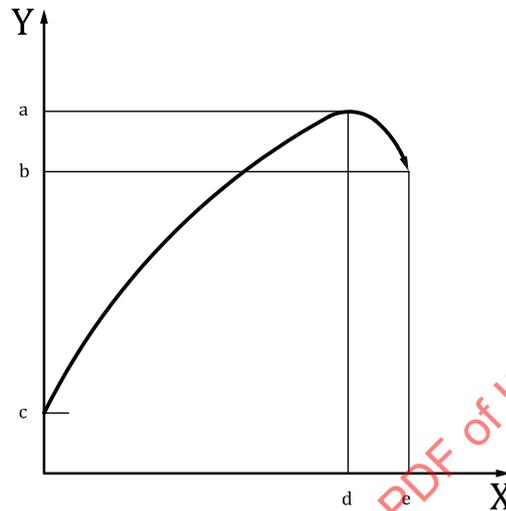
[SOURCE: ISO 13934-1:2013, 3.4]

3.10**elongation at maximum force**

elongation (3.7) of a test specimen produced by the maximum force

Note 1 to entry: See [Figure 1](#).

[SOURCE: ISO 13934-1:2013, 3.8]

**Key**

- X elongation
- Y force
- a Maximum force.
- b Force at rupture.
- c Pretension.
- d Elongation at max. force.
- e Elongation at rupture.

Figure 1 — Example of force-elongation curve

4 Principle

A test specimen of square shape is biaxially loaded in the plane of the fabric. The loads are applied in the warp and weft directions simultaneously. Measurements of maximum force and elongation are used to represent biaxial properties of the fabric.

5 Sampling

Select samples either in accordance with the procedure laid down in the material specification for the fabric or as agreed between the interested parties.

In absence of an appropriate material specification, the example of suitable sampling procedure given in [Annex A](#) may be used.

An example of a suitable pattern for cutting test specimens from the laboratory sample is given in [Annex A](#). Avoid test specimens with folded or creased areas, selvages, and areas not representative of the fabric.

6 Apparatus — Biaxial test machine

The testing apparatus shall be a constant-rate-of-extension (CRE) biaxial testing machine. Metrological confirmation system of the biaxial testing machine shall be in accordance with ISO 10012.

The biaxial test machine shall be capable of simultaneously applying loads to the test specimen with a specified load ration in the warp and weft directions. It shall be capable of measuring loads, strains and/or displacements at suitable locations simultaneously.

The clamping or holding devices shall be capable of holding the test specimen without allowing it to slip and designed so that they minimize damage to the test specimen.

6.1 The biaxial tensile testing machine shall be provided with means for indication or recording the force applied to the test specimen in stretching it to rupture. Under conditions of use, the accuracy of the apparatus shall be class 1 of 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 $\pm 1\%$ and the error of the indicated or recorded jaw separation shall not exceed ± 1 mm.

6.2 The machine shall be capable of a specified constant rate of extension with an accuracy of $\pm 10\%$.

6.3 The machine shall be capable of setting the specified gauge length with in ± 1 mm.

6.4 The machine shall be capable of measuring the distance of the clamp with the warp and weft directions simultaneously.

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

6.6 The faces of the jaws shall be smooth and flat, except that when, even with packing, the test specimen cannot be held satisfactorily with flat-faced jaws, engraved or corrugated jaws can be used to prevent slippage. Other auxiliary materials for use with either smooth or corrugated jaws to improve specimen gripping include paper, leather, plastics, or rubber.

6.7 For the grab test, the dimensional clamping area of the fabric shall be $(50\text{ mm} \pm 1\text{ mm}) \times (60\text{ mm} \pm 1\text{ mm})$.

6.8 The machine shall be capable of constant rate of extension 50 mm/min with an accuracy of $\pm 10\%$.

6.9 The machine shall be capable of setting the gauge length to 200 mm, to within ± 1 mm.

7 Atmosphere for conditioning and testing

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

It is recommended that specimens be conditioned for at least 24 h in the relaxed state.

8 Preparation of test specimens

8.1 General

From each laboratory sample, at least five test specimens shall be cut, no test specimens shall be cut from within 150 mm of either edge of the laboratory sample.

8.2 Dimensions

The length and width of each test specimen shall be 400 mm \pm 2 mm.

8.3 Preparation of test specimens

On each test specimen, a line shall be drawn a distance of 170 mm from one end of the warp and weft direction and drawn the direction of the warp by an arrow. Example of test specimens is illustrated in [Annex B](#).

9 Procedure

9.1 Gauge length

Set the gauge length of the biaxial tensile-testing machine to 200 mm within \pm 1 mm.

9.2 Rate of extension

Set the rate of extension of the biaxial tensile-testing machine to 50 mm/min.

9.3 Mounting of test specimens

Mount the test specimen by aligning one side of the clamp with the two lines drawn parallel to the warp and weft direction and refer to illustrated in [Annex B](#). Zones "4-1" and "4-3" are mounted on the warp direction, and zones "4-2" and "4-4" are mounted on the weft direction.

The extension necessary to reach the pretension shall be added to the gauge length, thus determining the initial length needed for the calculation of the elongation at maximum force.

Apply the appropriate pretension specified as follows:

- for all fabrics with stretch characteristics: 0,5 N;
- for fabrics without stretch characteristics according to mass per unit area:
 - a) \leq 200 g/m²: 2 N;
 - b) $>$ 200 g/m² to 500 g/m²: 5 N;
 - c) $>$ 500 g/m²: 10 N.

9.4 Operation

Engage the device for recording the maximum force and elongation at maximum force. Put the clamp in motion and extend the test specimen to the point of rupture in any direction. Perform the test at least on five specimens. Record the maximum force of each direction in newtons and the extension or the elongation at least to the nearest.

- 0,4 mm or 0,2 % for elongations $<$ 8 %;
- 1 mm or 0,5 % for elongations 8 % to \leq 75 %;
- 2 mm or 1 % for elongations $>$ 75 %.

Record any break which occurs within 5 mm of the clamping line of jaws and report the result as a jaw break. At the end of the five test, examine the results obtained. If any of the jaw break results falls above the lowest "normal" break result, then it can be included. If any of the jaw break results falls below the lowest "normal" break results, then it shall be excluded, and further test should be carried out to obtain five "normal" breaks.

If all the results are jaw breaks, or if five “normal” breaks cannot be obtained, then the individual results shall be reported without the coefficient of variation or confidence limits. Jaw break results shall be indicated as such in the report, and the results discussed between the interested parties.

10 Calculation and expression of results

For each specimen, the average of the two maximum force values calculated for each direction is used as the result in that direction.

Calculate the arithmetic mean of the maximum force of five specimens by two directions, in newtons. Round the results for values.

- < 100 N to the nearest 1 N;
- ≥ 100 N to < 1 000 N to the nearest 10 N;
- ≥ 1 000 N to the nearest 100 N.

For each specimen, the average of the two elongations at maximum force values calculated for each direction is used as the result in that direction.

Calculate the arithmetic mean of the elongation at maximum force of five specimens by two direction and round it to the nearest:

- 0,2 % for elongations < 8 %;
- 0,5 % for elongations 8 % to ≤ 75 %;
- 1 % for elongations > 75 %.

If required, calculate the coefficient of variation to the nearest 0,1 % and the 95 % confidence limits rounded to the same precision as the mean value.

11 Test report

The test report shall include the following information:

- a) reference to this document, i.e. ISO 24281:2021;
- b) date of test;
- c) identification of the test sample and sampling procedure, if required;
- d) number of test specimens, including the number of tests rejected and reasons for this;
- e) gauge length in millimetre;
- f) rate of extension in mm/min;
- g) pretension applied, in newtons;
- h) preconditioning, conditioning and testing atmosphere;
- i) arithmetic mean of the maximum force, in newtons;
- j) arithmetic mean of the elongation at maximum force, in percent;
- k) coefficient of variation of the mean value, in percent, if required;
- l) 95 % confidence limits of the mean value, in newtons, and of the relevant elongation, in percent, if required;

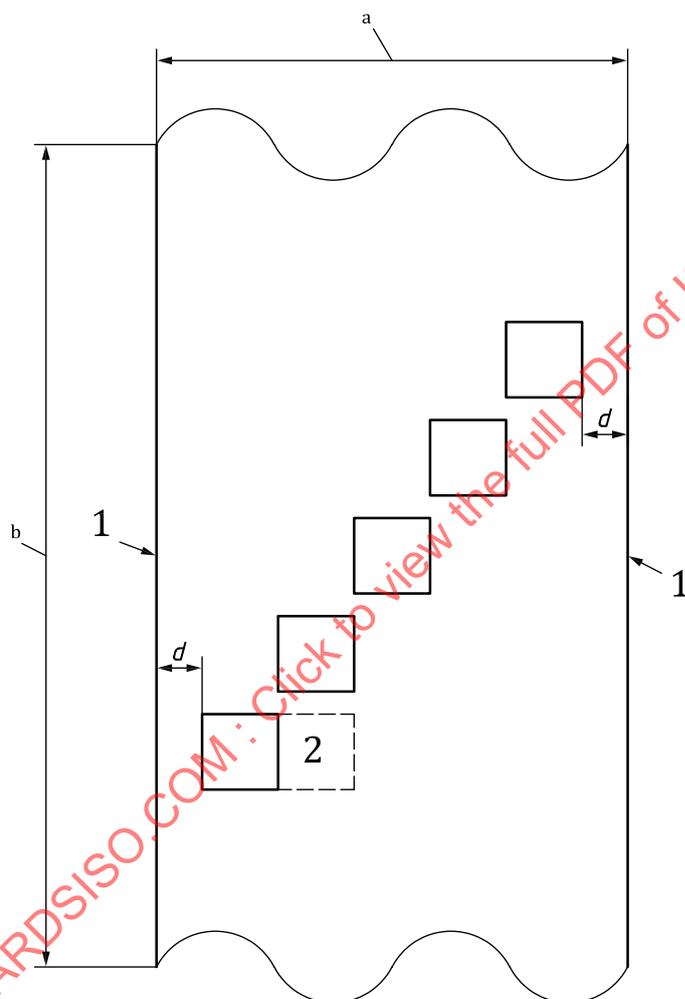
m) any deviation from the given procedure.

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Annex A (informative)

Locations of test specimens cut from a laboratory sample

See [Figure A.1](#)



Key

- 1 edge
- 2 test specimen
- a Width of fabric.
- b Length of fabric.
- d = 150 mm

Figure A.1 — Locations of test specimens cut from a laboratory sample