
Textiles — Tear properties of fabrics —

Part 1:

**Determination of tear force using ballistic
pendulum method (Elmendorf)**

Textiles — Propriétés de déchirement des étoffes —

*Partie 1: Détermination de la force de déchirure à l'aide de la méthode
ballistique au pendule (Elmendorf)*



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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 13937 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 13937-1 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 38, *Textiles*, Subcommittee SC 24, *Conditioning atmospheres and physical tests for textile fabrics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

ISO 13937 consists of the following parts, under the general title *Textiles — Tear properties of fabrics*:

- *Part 1: Determination of tear force using ballistic pendulum method (Elmendorf)*
- *Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method)*
- *Part 3: Determination of tear force of wing-shaped test specimens (Single tear method)*
- *Part 4: Determination of tear force of tongue-shaped test specimens (Double tear test)*

Annexes A, B and C of this part of ISO 13937 are for information only.

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Foreword

The text of EN ISO 13937-1:2000 has been prepared by Technical Committee CEN/TC 248 "Textiles and textile products", the secretariat of which is held by BSI, in collaboration with Technical Committee ISO/TC 38 "Textiles".

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of an identical text or by endorsement, at the latest by October 2000, and conflicting national standards shall be withdrawn at the latest by October 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

EN ISO 13937 has been prepared in the context of several test methods for the determination of certain mechanical properties of textiles using mainly tensile-testing machines, e.g. tensile properties, seam tensile properties, tear properties, seam slippage. Test requirements for these standards agree where appropriate. The results obtained by one of the methods should not be compared with those obtained by other methods.

EN ISO 13937 specifies methods for the determination of tear force of fabrics. Part 1 describes a ballistic pendulum method and parts 2 to 4 describe methods using tensile-testing machines.

1 Scope

This part of EN ISO 13937 describes a method known as the ballistic pendulum (Elmendorf) method for the determination of tear force of textile fabrics. The method describes the measurement of the tear force required to propagate a single-rip tear of defined length from a cut in a fabric when a sudden force is applied.

The test is mainly applicable to woven textile fabrics. It may be applicable to fabrics produced by other techniques, e.g. to nonwovens (with the same under-mentioned restrictions as for the woven fabrics).

In general the test is not applicable to knitted fabrics and woven elastic fabrics. It is not suitable for highly anisotropic fabrics or loose fabrics where tear transfer from one direction to another direction of the fabric during the tear test is likely to occur.

NOTE 1: For tests using tensile-testing machines part 2 of EN ISO 13937 describes a single tear method known as the trouser test, part 3 the wing test and part 4 the tongue test method.

NOTE 2: For the ballistic pendulum method for coated fabrics see ISO 4674-2. For the trapezoidal test method, see ISO 9073-4 for nonwovens or ISO 4674 for coated fabrics.

2 Normative references

The following normative documents contain provisions through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 139	Textiles - Standard atmospheres for conditioning and testing
ISO 1974:1990	Paper - Determination of tearing resistance (Elmendorf method)
ISO 10012-1	Quality assurance requirements for measuring equipment - Part 1: Metrological confirmation system for measuring equipment

3 Terms and definitions

For the purposes of this part of EN ISO 13937 the following terms and definitions apply:

3.1 tear force

Force required to propagate a tear initiated under the specified conditions.

NOTE: The tear force is qualified as "across warp" or "across weft" according to whether the tear is made across the warp (warp threads are torn) or weft (weft threads are torn) respectively.

3.2 length of tear

Measured from the beginning of the tear to the termination point.

4 Principle

The force required to continue a slit previously cut in a fabric is determined by measuring the work done in tearing the fabric through a fixed distance. The apparatus consists of a pendulum carrying a clamp which is in alignment with a fixed clamp when the pendulum is in the raised, starting position with maximum potential energy.

The specimen is fastened in the clamps and the tear is started by cutting a slit in the specimen between the clamps. The pendulum is then released and the specimen is torn completely as the moving jaw moves away from the fixed one. The tear force is measured.

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 the absence of an appropriate material specification, an example of a suitable sampling procedure is given in annex B.

An example of a pattern for cutting test specimens from the laboratory sample is given in annex C. Avoid test areas with folded or creased places, selvages and areas not representative of the fabric.

6 Apparatus

6.1 General

The system for metrological confirmation of the pendulum testing machine shall be in accordance with ISO 10012-1. For calibration of the apparatus, follow directions given in annex B of ISO 1974:1990

6.2 Pendulum testing machine, in which the test specimen is held between two jaws, one movable and the other fixed to the frame. The moving jaw is attached to a pendulum which can fall under the influence of gravity. The pendulum shall provide for the test specimen to be torn without coming in contact with the pendulum during the test.

The apparatus is made up of the following parts:

6.2.1 A rigid framework, supporting the pendulum and a fixed jaw, as well as a knife to cut a slit, and a measuring device. It is fitted with a level and positioned to prevent any movement during test.

6.2.2 A pendulum, that is free to swing about a horizontal axis on a bearing, with means for holding the pendulum in the raised starting position (pendulum stop) and releasing it instantly.

The mass of the pendulum shall be alterable by adding masses or by exchanging pendulums.

6.2.3 A mechanical or electronic device for determining the maximum amplitude of the first swing, and thus the energy used to tear the test specimen. The reading may be given directly in terms of tear force. Means for providing zero setting of the instrument.

6.2.4 A movable jaw integral with the pendulum **and a fixed jaw** integral with the framework. These jaws shall be $3 \text{ mm} \pm 0,5 \text{ mm}$ apart in order to permit the passage of the knife. The clamps are so aligned that the specimen clamped in them lies in a plane parallel to the axis of the pendulum, the plane making an angle of $27,5^\circ \pm 0,5^\circ$ with the perpendicular line joining the axis and the horizontal line formed by the top edges of the clamping jaws. The distance between the axis and the top edges of the clamping jaws is $104 \text{ mm} \pm 1 \text{ mm}$.

The dimensions of the clamping faces of the jaws are not critical. A width of 30 mm to 40 mm and a height of preferably 20 mm but not less than 15 mm have been found to be suitable.

When the pendulum is in the raised starting position, the clamping faces of both jaws shall be in the same plane perpendicular to the plane of swing of the pendulum. The surface state of the clamping faces and the force applied to the jaws applied shall permit the test specimens to be held without slipping.

6.2.5 A sharp knife to begin the tear of the test specimen by cutting a slit of $20 \text{ mm} \pm 0,5 \text{ mm}$ mid-way between the two jaws.

6.3 Equipment for cutting out test specimens, preferably a hollow punch or template to give test specimens of the dimensions shown in figure 1.

7 Atmosphere for conditioning and testing

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

8 Preparation of test specimens

8.1 General

From each laboratory sample two sets of test specimens shall be cut, one set in the warp direction and the other in the weft direction. Align the short side of the test specimens exactly parallel to warp or weft direction to assure that the tear will propagate within the notch.

For other than woven fabrics use the relevant designation for direction e.g. length and transverse.

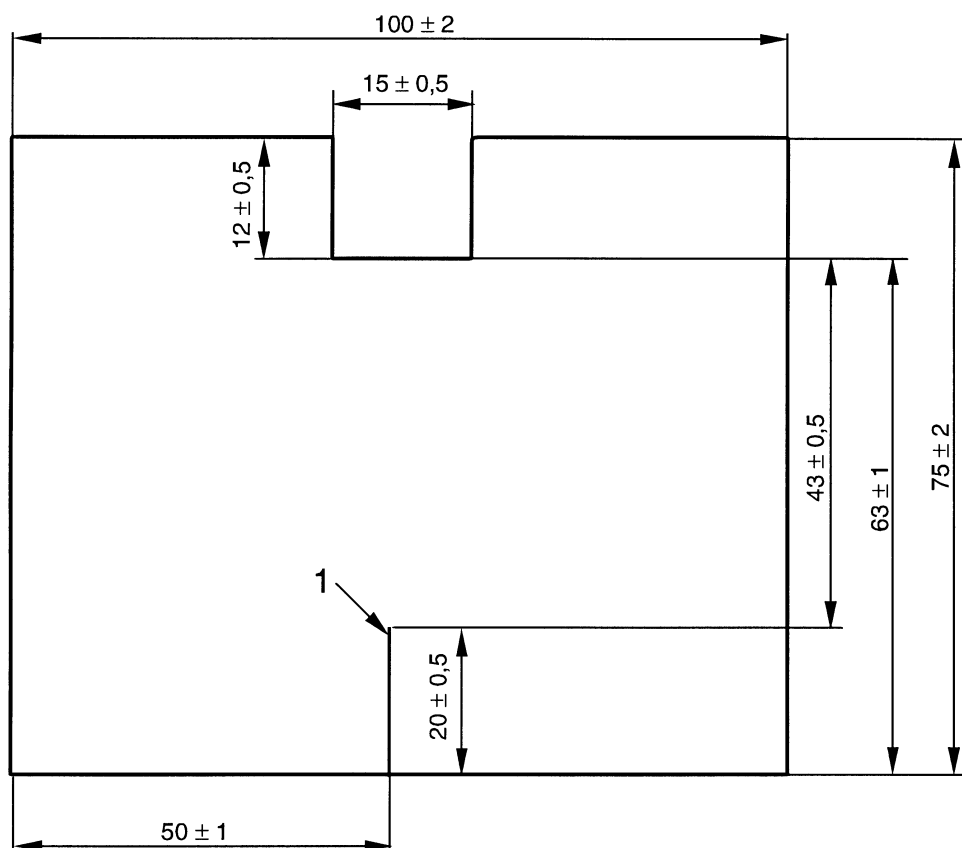
Each set shall consist of at least five test specimens, or more if agreed. In accordance with clause 5 and annex C, no two test specimens shall contain the same longitudinal or transverse threads, and no specimen shall be cut within 150 mm of the edge of the fabric.

8.2 Shape and dimensions

The test specimen shall be cut out according to the design shown in figure 1.

Slightly different shapes (e.g. with rounded edges, positioning aids for jaw alignment) are acceptable provided the tearing length remains $43 \text{ mm} \pm 0,5 \text{ mm}$.

All dimensions in mm



1 Slit

Figure 1 - Dimensions of test specimen

8.3 Cutting out of test specimens

For woven fabrics, each test specimen shall be cut out with its short side parallel to the warp or the weft of the fabric. For test specimens where the short side is parallel to the warp, the direction of the tear is qualified as "across weft" and for test specimens where the short side of the test specimen is parallel to the direction of the weft, the tear is qualified as "across warp" (see 3.1 and annex C).

9 Procedure

9.1 General

Select the mass of the pendulum (6.2.2) so that the measurements taken from the test specimens give results between 15 % and 85 % of the full scale range of the corresponding measuring scale.

Check that the apparatus is set at zero. Move the pendulum to the raised position.

9.2 Mounting of test specimens

Position the test specimen in the jaws (6.2.4) so that the long side of the test specimen is parallel to the upper edge of the jaws. Clamp the test specimen centrally and with the bottom edges of the test specimen carefully set against the bottom stop of the jaws. Using the knife (6.2.5), cut a slit of $20 \text{ mm} \pm 0,5 \text{ mm}$ in the side opposite the notch, leaving a tear length of $43 \text{ mm} \pm 0,5 \text{ mm}$.

9.3 Operation

Release the pendulum by depressing the pendulum stop (6.2.2). Restrain the pendulum on the return swing without disturbing the position of the pointer. Read the tear force in newtons off the measuring device to the nearest scale division or off the digital display. Depending on the type of apparatus used, the scale reading obtained may have to be multiplied by an appropriate factor as specified by the manufacturer of the test apparatus to obtain the result in newtons (see 10 and A.5). Check that the result is in fact within the zone between 15 % and 85 % of the full scale used. Repeat the test on at least five test specimens for each fabric direction.

Observe whether the tear proceeds along the direction of force and whether any threads slip out from the fabric rather than being torn. The test is considered correct if there is a) no slippage of threads out of the fabric, b) no slippage in the jaws, c) the tear is completed and remains within the 15-mm wide notched area. Other results shall be discarded.

If the test results from three or more out of the five test specimens have to be rejected, the method is unsuitable.

If agreed, test additional test specimens, preferably doubling the number of test specimens. In such cases, the reporting of the results shall also be agreed.

10 Calculation and expression of results

The ballistic pendulum measures energy directly. In current practice, it is preferred to express tear resistance as a force which is usually indicated directly in newtons. Results indicated in other units shall be converted to newtons (see A.5).

Calculate the arithmetic mean of the tear force, in newtons, for each direction tested and round it to two significant figures.

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If required, calculate the coefficient of variation to the nearest 0,1 % and the 95% confidence limits, in newtons and round it to two significant figures.

If required, note minimum and maximum tear force values for the test specimens for each fabric direction of a sample.

11 Test report

The test report shall include the following information:

11.1 General information

- a) Reference to this part of EN ISO 13937 and the date of test;
- b) identification of test sample and if required, sampling procedure;
- c) measuring range used;
- d) number of test specimens and number of tests rejected and reasons for this;
- e) observations on unusual tear behaviour;
- f) any deviation from given procedure.

11.2 Test results

- a) Mean tear force across warp and across weft, in newtons. If only 3 or 4 test specimens are torn correctly, state the results of the individual correctly torn test specimens in addition;
- b) if required, the coefficient of variation of tear force, in percent;
- c) if required, the 95% confidence limits of tear force, in newtons;
- d) if required, the minimum and maximum tear force values for each test specimen and each fabric direction of a sample, in newtons.

Annex A

(informative)

Adjustment and verification of apparatus

If necessary adjust functional parts of the apparatus to conform with the requirements according to clause 6 and by following the manufacturers instructions. Checks recommended before performing the test are:

A.1 With the pendulum in the raised, starting position, check the alignment of the clamps. Verify that the knife is centred between the clamps and the distance between the jaws is $3 \text{ mm} \pm 0,5 \text{ mm}$. Check the sharpness of the knife. A dull knife will adversely effect the result.

A.2 The tear length of the test specimens may be checked by cutting a specimen from a paper. Make a $20 \text{ mm} \pm 0,5 \text{ mm}$ incision with the knife after the paper specimen has been clamped properly. The height of the knife shall be such that the notched test specimen has a length to be torn of $43 \text{ mm} \pm 0,5 \text{ mm}$.

A.3 The levelness of the apparatus is essential. Movement of the instrument during the swinging of the pendulum is a significant source of error. Securely anchor the apparatus that it is sufficiently rigid and that there will be no perceptible movement of the apparatus during the swing of the pendulum. Adjust the apparatus according to the built-in level.

A.4 Check the friction of the main bearing, the zero pointer stop or zero reading of the display by operating the levelled apparatus several times without a test specimen, the movable clamp being closed. The apparatus is considered to have been properly adjusted when zero has been obtained within a tolerance $\pm 1 \%$ of the scale on three consecutive occasions.

A.5 For apparatus' with scales calibrated other than in newtons, use conversion factors provided by the manufacturer of the equipment.

Annex B

(informative)

Suggested procedure for sampling

B.1 Bulk sampling (Number of pieces taken from a shipment or lot)

Take at random from the shipment or lot the appropriate number of pieces shown in table B.1. Ensure that no piece that shows signs of damage or dampness incurred during transit is included in the bulk sample.

Table B.1 - Bulk sampling

Number of pieces in shipment or lot	Number of pieces comprising bulk sample, minimum
3 or less	1
4 to 10	2
11 to 30	3
31 to 75	4
76 or more	5

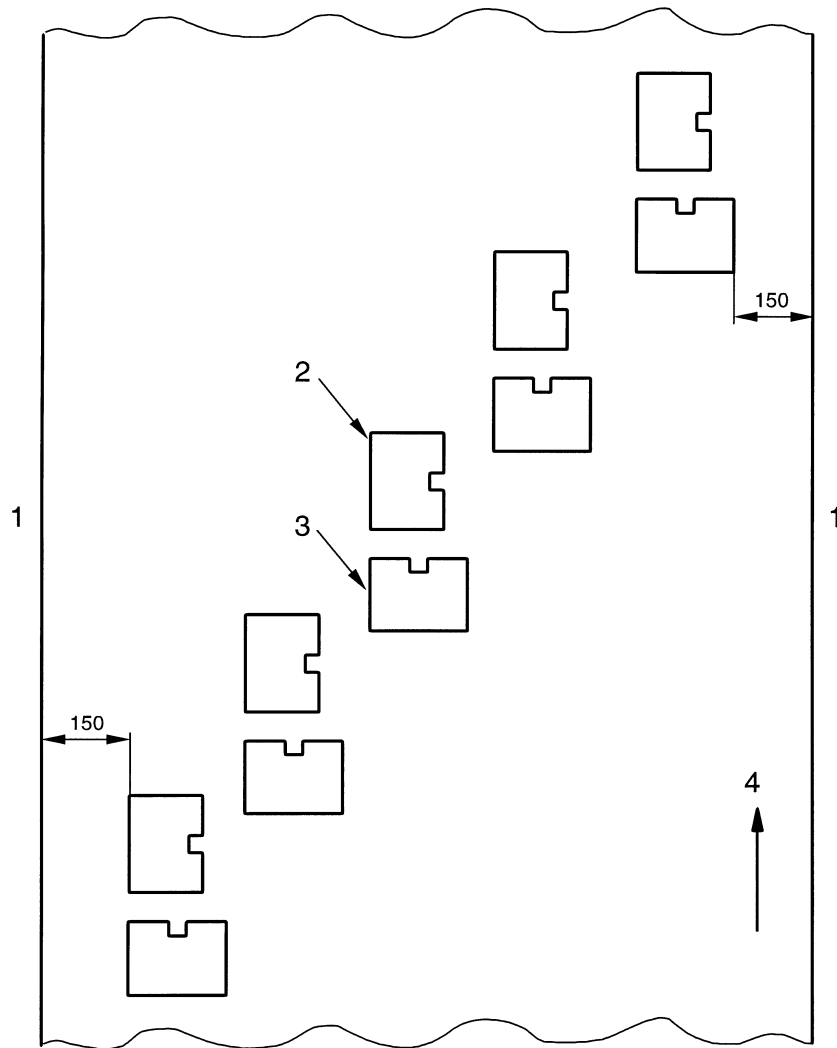
B.2 Number of laboratory samples

From each piece in the bulk sample, cut (from a position taken at random but at least 3 m from an end of the piece) a laboratory sample of length at least 1 m and of full width. Ensure that areas that are creased or that have a visible fault, or faults, are not included in the laboratory sample.

Annex C

(informative)

Example of pattern for cutting out test specimens from the laboratory sample



- 1 Edge
- 2 Specimen for tear "across wrap"
- 3 Specimen for tear "across weft"
- 4 Wrap

Figure C.1

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