
Textiles — Tear properties of fabrics —

Part 2:

**Determination of tear force of trouser-
shaped test specimens (Single tear
method)**

Textiles — Propriétés de déchirement des étoffes —

*Partie 2: Détermination de la force de déchirure des éprouvettes pantalons
(Méthode de la déchirure unique)*



Reference number
ISO 13937-2:2000(E)

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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 13937-2 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)*

Annex D forms a normative part of this part of ISO 13937. Annexes A, B and C are for information only.

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Foreword

The text of EN ISO 13937-2:2000 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 Octobre 2000, and conflicting national standards shall be withdrawn at the latest by Octobre 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 as a part 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. Annex E lists test methods standardized in this context.

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

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1 Scope

This part of EN ISO 13937 describes a single-tear method to determine fabric tear force, known as the trouser test, using a test specimen cut to form trouser-shaped legs. The tear force measured is the force required to propagate a previously started single tear when the force is applied parallel to the cut and the fabric tears in the direction of applied force.

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

In general the method 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.

The method only allows the use of constant-rate-of-extension (CRE) testing machines.

NOTE 1: For other tear test methods using tensile-testing machines part 3 of EN ISO 13937 describes a method known as the wing test and part 4 the tongue test method. Part 1 of EN ISO 13937 describes the ballistic pendulum (Elmendorf) method.

NOTE 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 which, 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 7500-1	Metallic materials - Verification of static uniaxial testing machines - Part 1 - Tensile testing machines
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 constant-rate-of-extension (CRE) testing machine: Tensile-testing machine where one clamp is stationary whilst the other is moving with a constant speed throughout the test and where the entire testing system is virtually free from deflection.

3.2 gauge length: Distance between the two effective clamping points of a testing device.

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

3.3 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 threads (weft threads are torn) respectively.

3.4 peak: Point on a force/extension curve where the gradient, relative to the force values recorded, changes from positive to negative.

NOTE: For tear recordings, the peak to be used for calculation is defined by rising and falling of force of at least 10 % of the last decreasing or increasing force values respectively.

3.5 length of tear: Measured distance propagated by a tearing force from the initiation of the force until its termination.

3.6 Trouser shaped test specimen: Rectangular test specimen having a single cut of defined length made in the centre of the shorter edge to form two trouser legs for clamping (see figures 1 and 2).

4 Principle

A rectangular test specimen is cut in the centre of the shorter edge to form a trouser shape. The legs of the trouser are gripped in the clamps of a recording tensile testing machine to form a straight line and pulled in the direction of the cut to tear the fabric. The force to continue the tear over a specified distance is recorded. The tear force is calculated from the force peaks of the autographic trace, or on-line by electronic means.

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 A.

An example of a pattern for cutting test specimens from the laboratory sample is given in annex B. 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 tensile-testing machine shall be in accordance with ISO 10012-1.

6.2 CRE machine, having the following characteristics:

- a) Capable of operating at a constant-rate-of-extension of (100 ± 10) mm/min;
- b) capable of gauge length to be set to (100 ± 1) mm;
- c) provided with means for recording the force applied to the test specimen during the tear test;
- d) 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;
- e) if recording of force and extension is obtained by means of data acquisition boards and software, the frequency of data collection shall be at least 8 per second.

If a class 2 tensile testing machine has to be used, this shall be stated in the test report.

6.3 Clamping device, comprising the two jaws of the machine, the central points of which are in the line of pull, the front edges at right angles to the line of pull and the clamping faces in the same plane.

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.

The width of the jaws shall preferably be 75 mm, but shall not be less than the width of the test specimen.

6.4 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.

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

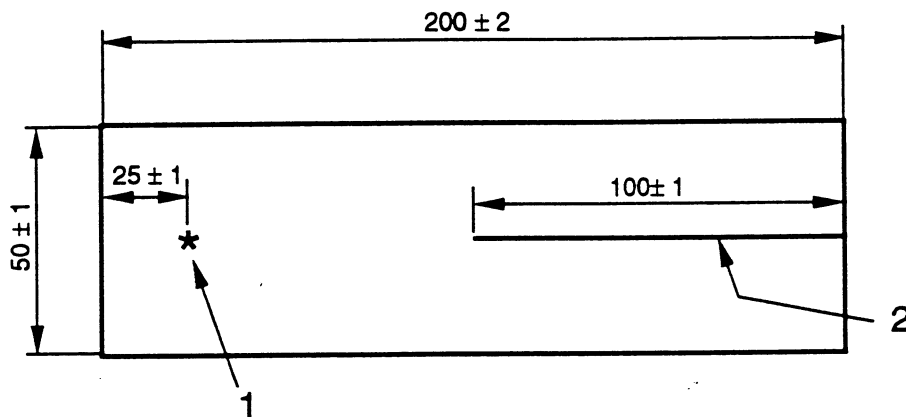
Each set shall consist of at least five test specimens, or more if agreed. In accordance with clause 5 and annex B, no two test specimens shall contain the same longitudinal or transverse threads, and no specimen shall be cut within 150 mm of the edge of the fabric.

8.2 Dimensions

8.2.1 Test specimens 50 mm wide

The test specimen (see figure 1) shall be a rectangular strip 200 mm ± 2 mm long by 50 mm ± 1 mm wide; in it shall be made, a longitudinal slit 100 mm ± 1 mm in length beginning from the centre of the width. Mark the end of tear (25 ± 1) mm from the uncut end of the strip to indicate the position of the tear at the completion of the test.

Dimensions in millimetres



- 1 Mark for end of tear length
- 2 Cut

Figure 1 - Trouser-shaped test specimen

8.2.2 Wide-width test specimens 200 mm wide

Test specimens having a width of 200 mm may be tested if agreed by the interested parties. This is recommended for samples where the narrow-width test specimens are considered unsuitable (see 9.4) or for special tear-resistant fabrics. The method for use of wide-width test specimens is described in annex D.

8.3 Cutting out of test specimens

For woven fabrics, each test specimen shall be cut out with its length parallel to the warp or the weft of the fabric. For test specimens where the longer side is parallel to the warp, the direction of the tear is qualified as "across weft" and for test specimens where the longer side of the test specimen is parallel to the direction of the weft, the tear is qualified "across warp" (see 3.3 and annex B).

9 Procedure

9.1 Gauge length

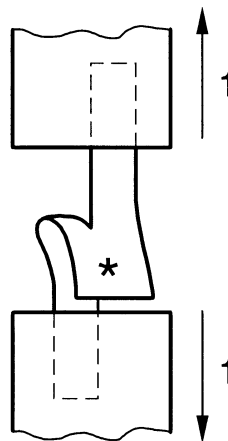
Set the gauge length of the tensile-testing machine to 100 mm.

9.2 Rate of extension

Set the rate of extension of the tensile-testing machine to 100 mm/min.

9.3 Mounting of test specimens

Clamp the test specimen in the jaws, with one leg in each of the jaws and the cut aligned along the centrelines of the jaws. The uncut end of the test specimen remains free. The clamping arrangement is shown in figure 2. Take care to ensure that each leg is positioned in a jaw so that the beginning of the tear is parallel to the cut and in the direction in which the tear force is applied. Avoid pretension when the test is started.



1 Jaw

Figure 2 - Clamping arrangement

9.4 Operation

Engage any device for recording of the tear force. Put the moving clamp in motion at 100 mm/min and continue the tear to the point marked near the end of the strip.

Record the tear force in newtons, and if a tear trace is wanted record the accompanying jaw separation (tear length) for each of the test specimens in each fabric direction, using recording or electronic devices (6.2).

If the evaluation of the peaks derived from dense fabrics with large numbers of threads per centimetre are to be taken from the chart recording manually (see 10.1), the speed of the chart paper has to be set to 2:1 in relation to the rate of extension.

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 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 proceeded along the direction of application of the force. Other results shall be discarded.

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If the 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.

Annex D describes a method using enlarged test specimens (8.2.2) which may be acceptable to samples considered untearable by the test using small-width test specimens or for special tear-resistant fabrics.

NOTE: If both methods are not satisfactory other methods of test such as the double tongue tear or wing tear may be considered (see annex E).

10 Calculation and expression of results

Two methods of calculation are specified, manual and electronic. They may not lead to the same result and results calculated by different methods are not to be compared.

10.1 Evaluation of tear forces from the chart recording

For a sample of calculation, see annex C.

10.1.1 Divide the peak trace, beginning with the first peak and ending with the last peak, into four equal parts (see annex C). The first part shall not be used for the calculation of the mean value. From each of the three remaining subsections, select and note the two highest and the two lowest peaks. A peak suitable for calculation is characterized by a 10 % min. rising and falling of force (see 3.4).

10.1.2 For each test specimen, calculate the arithmetic mean in newtons of the 12 peak values obtained according to 10.1.1.

NOTE: For manual evaluations a limited number of selected peaks is chosen to keep calculation time acceptable. For calculation including all peaks, electronic evaluation is recommended.

10.1.3 From the mean calculated for each test specimen (see 10.1.2), calculate the overall arithmetic mean of the tear force in newtons for each fabric direction tested, and round it to two significant figures.

10.1.4 If required, calculate the coefficient of variation to the nearest 0,1 % and the 95% confidence limits in newtons rounded to two significant figures, using the mean test specimen values as calculated according to 10.1.2.

10.1.5 If required, calculate the mean of the six highest peak values for each test specimen in newtons.

10.1.6 If required, note the highest and the lowest peak value (maximum peak distance) for each test specimen, in newtons.

10.2 Calculation using electronic devices

For a sample of calculation, see annex C.

10.2.1 Divide the tearing length between the first and last peak recorded into four equal parts (see annex C). Ignoring the first part of the tearing length, all peaks of the remaining distance are recorded. A peak suitable for calculation is characterized by a 10 % min. rising and falling of force (see 3.4).

10.2.2 The arithmetic mean in newtons for the test specimen is calculated using all peaks recorded according to 10.2.1.

10.2.3 From the mean calculated for each test specimen (see 10.2.2) calculate the overall arithmetic mean of the tear force in newtons for each direction tested and round it to two significant figures.

10.2.4 If required, calculate the coefficient of variation to the nearest 0,1 % and the 95% confidence limits in newtons rounded to two significant figures, using the specimen mean values as calculated according to 10.2.2.

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) number of test specimens and number of tests rejected and reasons for this;
- d) observations on unusual tear behaviour;
- e) whether mean values are calculated manually (see 10.1) or by electronic device (see 10.2).
- f) any deviation from the given procedure, specifically if a wide-width test specimen was used (see 8.2.2).

11.2 Test results

- a) The overall mean tear force across-warp and across-weft, in newtons. If only 3 or 4 test specimens are torn correctly, state the results for the individual test specimens only;
- b) if required, the coefficient of variation, in percent;
- c) if required, the 95% confidence limits, in newtons;
- d) if required, in case of manual evaluation (see 10.1), the mean of the highest peak force values for each test specimen (see 10.1.5), in newtons;
- e) if required, in case of manual evaluation (see 10.1), the lowest and highest peak force value recorded for each test specimen (see 10.1.6), in newtons.

Annex A
(informative)

Suggested procedure for sampling

A.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 A.1. Ensure that no piece that shows signs of damage or dampness incurred during transit is included in the bulk sample.

Table A.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

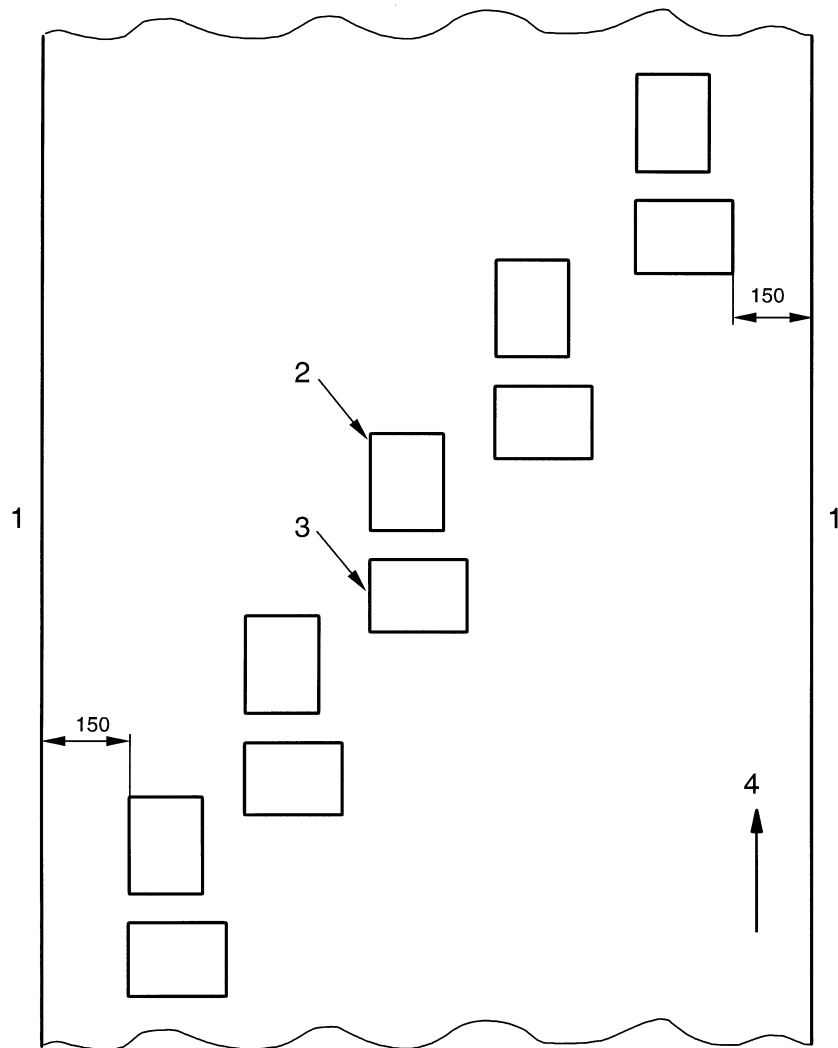
A.2 Number of laboratory samples

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 B

(informative)

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

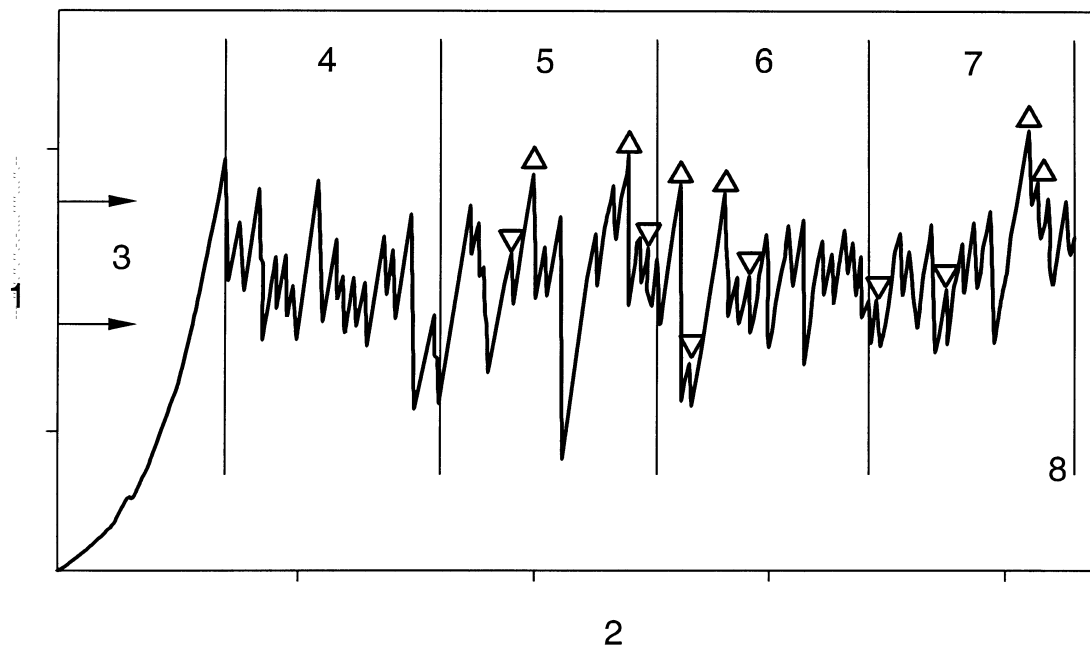


- 1 Edge
- 2 Specimen for tear "accross weft"
- 3 Specimen for tear "accross warp"
- 4 Warp

Figure B.1

Annex C
(informative)

Sample calculation of tear force



- 1 Force
- 2 Direction of tear (trace length)
- 3 Approx. medium peak range
- 4 Ignore
- 5 Subsection 1
- 6 Subsection 2
- 7 Subsection 3
- 8 End of tear

Figure C.1

Approximation of a peak (see 3.4)

For ease of handling manual evaluations, it is suggested to approximate the peak force level for medium height peaks in the tear trace of a test specimen. One-tenth of this value, rounded to within about $\pm 10\%$, indicates the rising and falling of force required for characterization of a peak.

Example	Medium-height peaks	85 N to 90 N (approximate level)
	10 % of this	8,5 N to 9 N
	peaks usable for calculation are characterized by	
	rising and falling of force	> 8 N

Annex D

(normative)

Wide-width trouser test specimens

General

- a) In accordance with 9.4, test specimens are discarded if threads to be torn slip unbroken, the tear is incomplete or does not proceed along the direction of force. If three or more out of five test specimens are rejected, the method is considered unsuitable. In these cases it is recommended to proceed the test with wide-width trouser test specimens (see figure D.1).
- b) For special tear-resistant fabrics, above mentioned criteria are not suitable, e.g. for loose fabrics, rip-stop fabrics, man-made-fibre tear-resistant fabrics for technical applications (fabrics for coating or air bags etc.). In these cases it is recommended to perform the test with specimens of enlarged width (see figure D.1). Other widths may be agreed by the interested parties.

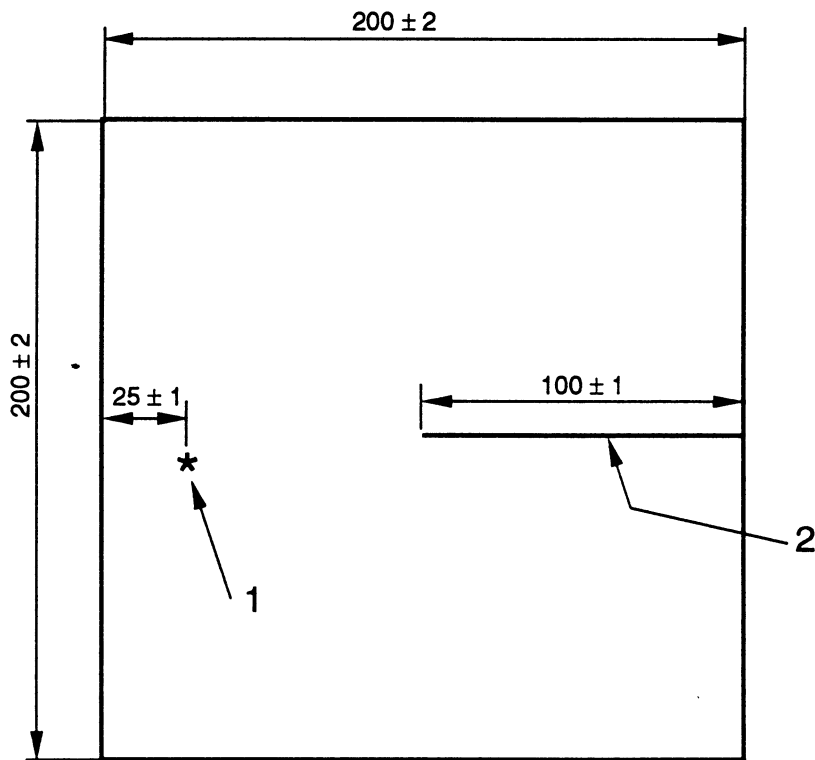
Procedure

For clamping, each trouser leg is to be folded from the outside parallel and toward the cut so that the clamped width of each trouser leg is half of the cut width (see figure D.2).

All other test conditions shall be as specified in this part of EN ISO 13937 except the width of the jaws shall be at least half the width of the test specimen.

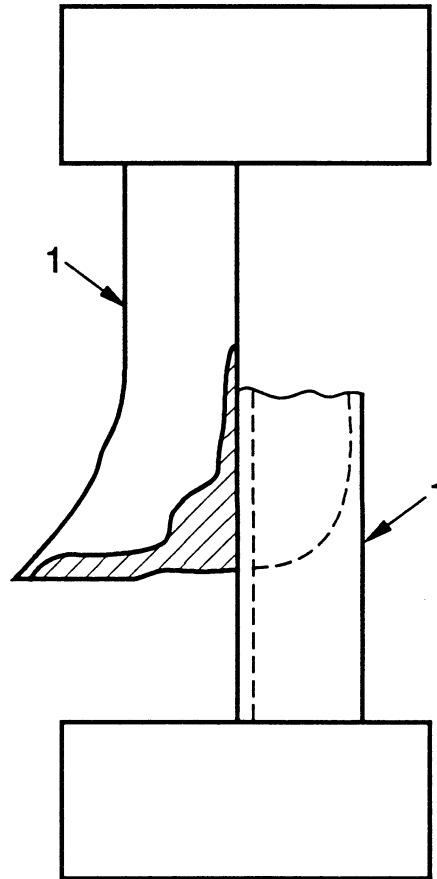
For special tear-resistant fabrics the evaluation of all peaks in accordance with 10.2 is necessary. The specific design of a tear-resistant fabric may result in "unusual" tear traces, which are often the specific characteristic of those fabrics and it is recommended to agree to the evaluation which seems adequate and to include a recorded tear trace.

Dimensions in millimetres



- 1 Mark for end of tear length
- 2 Cut

Figure D.1 - Wide-width trouser test specimens



1 Folded edge

Figure D.2 - Clamping test specimens in the jaws

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ISO 4674:1977, *Fabrics coated with rubber or plastics - Determination of tear resistance*

ISO 9073-4:1997, *Textiles - Test methods for nonwovens - Part 4: Determination of tear resistance*

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