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**Textiles — Determination of the  
elasticity of fabrics —**

**Part 2:  
Multiaxial tests**

*Textiles — Détermination de l'élasticité des étoffes —  
Partie 2: Essais multiaxiaux*

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ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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## 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](http://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](http://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 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 the following URL: [www.iso.org/iso/foreword.html](http://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](http://www.iso.org/members.html).

A list of all parts in the ISO 20932 series can be found on the ISO website.

## Introduction

This document was developed as a result of technical advancements in yarn and fabric structures and properties, which increase product range and developments.

This document is based on EN 14704-2<sup>[1]</sup>.

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# Textiles — Determination of the elasticity of fabrics —

## Part 2: Multiaxial tests

### 1 Scope

This document specifies the test methods which can be used to measure elasticity and related properties of fabrics when they undergo a deformation of their surface. Two methods are specified: a dynamic method (method A) and a static method (method B). This document does not apply to narrow fabrics.

The results obtained cannot be compared. The choice of test method are agreed between parties and indicated in the test report.

### 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 20932-1, *Textiles — Determination of the elasticity of fabrics — Part 1: Strip tests*

### 3 Terms and definitions

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

ISO and IEC maintain terminological 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

##### **narrow fabric**

woven or knitted construction intended for use as a trim, binding, edging, strapping or harness, and designed to be used in its full width

[SOURCE: ISO 20932-1:2018, 3.1]

#### 3.2

##### **elasticity**

<material> ability to recover original size and shape immediately after the removal of the force causing deformation

[SOURCE: ISO 20932-1:2018, 3.2]

**3.3**  
**constant-rate-of-extension testing machine**  
**CRE testing machine**

tensile testing machine provided with one clamp, which is stationary and another clamp, which moves with a constant speed throughout the test, the entire testing system being virtually free from deflection

[SOURCE: ISO 20932-1:2018, 3.3]

**3.4**  
**bagging**

*residual deformation* (3.6) between the original state and the state of the surface when it has undergone a multidirectional force, which by repetition creates a “bag”

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

**3.5**  
**maximum deformation**

deformation developed when a specified force is applied to the surface of the test specimen compared to the original state of a test specimen

Note 1 to entry: Maximum deformation is expressed in units of the length.

**3.6**  
**residual deformation**

deformation after the removal of the hemispherical probe and an agreed recovery time

Note 1 to entry: Residual deformation is expressed in units of the length.

**3.7**  
**maximum force**

force at the position when a test specimen is taken to a fixed distension

Note 1 to entry: Maximum force is expressed in newtons.

**3.8**  
**modulus**

force measured at a given distension on either the load or unload curves

**3.9**  
**cycle**

process whereby a fabric is taken from the original position to a fixed load or fixed distension and returned to the original position

## 4 Principle

A fabric test specimen of specified dimensions is distended at a constant rate to either a specified force or distension for an agreed number of cycles, and its elasticity determined by measuring certain characteristics.

## 5 Sampling

Fabric samples shall be selected in accordance with the product specification. In the absence of a product specification for the fabric, the sampling method given in [Annex B](#) may be used.

## 6 Atmosphere for conditioning and testing

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

The fabric samples shall be conditioned for a minimum of 20 h in a tension-free state. The prepared test specimens shall be conditioned in a tension-free state for a further 4 h after preparation, to minimize the effects of handling during preparation.

## 7 Preparation of test specimens

From each laboratory sample, prepare a minimum of five test specimens. For Method A, no test specimens shall be cut from within 150 mm of either edge of the laboratory sample. No test specimen taken from the sample shall contain the same ends and picks or wales and courses.

NOTE An example of a suitable pattern for cutting test specimens from the laboratory sample is given in [Figure C.1](#).

Avoid selecting test specimens from folded or creased areas, selvages and areas not representative of the fabric.

## 8 Method A — Dynamic test

### 8.1 Apparatus

#### 8.1.1 CRE testing machine.

Metrological confirmation system of the tensile testing machine shall be in accordance with ISO 10012.

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 deformation values when cycling between the original position and either a fixed load or fixed deformation. Under conditions of use, the accuracy of the apparatus shall be at least 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 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 distension including 20 mm/min to 500 mm/min, with an accuracy of  $\pm 10$  %.
- d) The machine shall be capable of variable gauge length settings including 0 mm to 100 mm, to an accuracy of  $\pm 1$  mm.
- e) The clamping ring and probe shall be positioned with the centre in line with the applied force. The machine shall be calibrated with the clamp and probe in position.

The clamping ring shall be capable of holding the test specimen without allowing it to slip and designed so that it does not cut or otherwise weaken the test specimen (see [Annex D](#), [Figures D.1](#) to [D.3](#)).

#### 8.1.2 Equipment for cutting circular test specimens to the required dimensions.

#### 8.1.3 Calibrated metal rule graduated in millimetres.

### 8.2 Test specimen preparation

Each test specimen shall be cut  $(145 \pm 2)$  mm in diameter (see [Annex C](#)).

### 8.3 Procedure for loading test specimen in clamping ring

**8.3.1** Position the clamping ring (key 2 in [Figure D.1](#)) onto loading base (key 7 in [Figure D.1](#)), place the test specimen face down into the ring, the face of the fabric will be visible to the operator during the test. Next locate holding ring (key 4 in [Figure D.1](#)) onto the specimen and finally locking ring (key 5 in [Figure D.1](#)) and screw down on the specimen.

**8.3.2** Set the distension rate of the specimen at 200 mm/min for woven and nonwoven fabrics and 500 mm/min for knitted.

**8.3.3** Fix a suitable load cell to the moving crosshead of the testing machine and then connect the probe.

**8.3.4** Set the required cycling limits to cycle between the original position and 10 N (knitted and nonwoven), 50 N (woven) or 100 N (upholstery). Other loading limits can be used as agreed between parties.

**8.3.5** Invert the loaded clamping ring with specimen in place onto the base unit (key 6 in [Figure D.1](#)) which has been attached onto the base of the testing machine (see [Figure D.2](#)).

**8.3.6** Position the probe to give a distance of between 2 mm and 5 mm between the fabric surface and the bottom of the probe.

**8.3.7** Engage the device for recording the force and deformation measurements required. Put the crosshead in motion and cycle the test specimen between the original position and the required maximum force for five cycles. During the first cycle determine the deformation at a force of 0,2 N.

If it is required to determine the unrecovered deformation, wait for 60 s after completion of the fifth cycle. Take the crosshead down for a further sixth cycle and record the deformation after cycling and recovery at a force of 0,2 N.

Many of the parameters measured can be determined by manual analysis of graphs and by software data collection procedures. It is recommended that assessment of the individual software is carried out to establish accuracy of the data collected.

### 8.4 Recording

**8.4.1** Record the maximum deformation in millimetres at the maximum force during the fifth cycle, from the curves or data generated in the test, as agreed between the relevant parties.

**8.4.2** Record the modulus at any deformation point along the load or unload curves as agreed between relevant parties.

### 8.5 Expressions and calculations of test results

The following values shall, where applicable, be calculated from the data recorded during the test.

Maximum deformation,  $S$ , expressed in millimetres, as shown in [Formula \(1\)](#).

$$S = E - L \quad (1)$$

where

$E$  is the deformation (mm) at maximum force on the fifth cycle;

$L$  is the original deformation at 0,2 N (mm).

Unrecovered deformation (bagging),  $C$ , expressed in mm, as shown in [Formula \(2\)](#).

$$C = Q - P \quad (2)$$

where

$Q$  is the deformation at 0,2 N (mm) after a specified recovery period at the original position;

$P$  is the original deformation take during the first cycle at 0,2 N.

## 8.6 Test report

The test report shall include the following information:

- a) a reference to this document (i.e. ISO 20932-2:2018) and the date of test;
- b) identification of test sample and sampling procedure, if required;
- c) force used to record the deformation before and after cycling;
- d) rate of extension used in millimetres per minute;
- e) state or condition of test specimens (original, washed, aged);
- f) number of test specimens, particularly if less than five;
- g) diameter of test ring and probe;
- h) any deviation from this procedure;
- i) maximum cycling force;
- j) arithmetic mean of maximum deformation in millimetres, whichever is required and for which cycle;
- k) arithmetic mean of modulus, the deformation point in millimetres and cycle, when required;
- l) arithmetic mean of unrecovered deformation, when required;
- m) if required, the coefficient of variation for the relevant measured and calculated values;
- n) if required, the 95 % confidence limits of the relevant measured and calculated values.

## 9 Method B – Static test

### 9.1 Preliminary test

#### 9.1.1 Apparatus

**CRE testing machine**, as described in ISO 20932-1:2018, Method A.

#### 9.1.2 Preparation of test specimens

Cut two specimens ( $50 \pm 1$ ) mm by ( $300 \pm 1$ ) mm, one with the longer dimension in the length direction of the fabric, and one with the longer dimension in the width direction of the fabric.

#### 9.1.3 Procedure

Determine the maximum percentage elongation of the fabric in each direction at ( $30 \pm 1$ ) N, according to ISO 20932-1:2018, Method A, and record to the nearest 5 %, noting which direction has the "higher" elongation and which has the "lower" elongation.

## 9.2 Actual static test

### 9.2.1 Apparatus

Static testing rig, (see [Annex E, Figures E.1 to E.3](#)).

### 9.2.2 Selection of testing parameters

**9.2.2.1** Using [Table 1](#) and the higher and lower elongations of the fabric obtained in [9.1.3](#), read off the length to which the frame should be set,  $L_f$  (mm).

The width of the frame is fixed at 100 mm. For a fabric that has the same elongation in both directions the length of the frame should also be set to 100 mm. For fabrics with a lower elongation in one direction than the other, the direction of lower elongation is mounted lengthwise on the frame, and the length to be used is set correspondingly longer so that the fabric is distended as uniformly as possible in both directions during the test.

**9.2.2.1** Using [Table 2](#) and the higher elongation of the fabric obtained in [9.1.3](#), read off the deformation,  $L_d$  (mm), to be applied during the test.

### 9.2.3 Preparation of test specimens

Cut two specimens of width  $(130 \pm 1)$  mm and length  $(30 + L_f)$  mm, with the width of the sample parallel to the direction of the higher elongation of the fabric.

### 9.2.4 Procedure

Remove the hemispherical shape and support (keys 3 and 4 in [Figure E.1](#)) from the frame.

Adjust the position of the removable small sides of the upper and lower frames to the length setting  $L_f$  established from [Table 1](#).

Raise the upper frame, key 11 in [Figure E.1](#), to the vertical position, ensuring that the zero of the scale is at the top.

Place the back of the fabric (or the face which should be in contact with the hemispherical shape) of the test specimen against the upper frame and secure it (with adhesive tape or the other means). The test specimen is retained in place under its own mass.

Fix the lower frame against the upper frame by means of the locking device.

Lower the frame onto its feet with the test specimen in a horizontal position.

### 9.2.5 Setting of the hemispherical shape

Replace the hemispherical shape on the upper frame. Centre the hemispherical shape so that it is set in the middle of the length of the test specimen.

Lock the hemispherical shape in this position and then lower it to the deformation depth  $L_d$  as defined in [Table 2](#).

Maintain the pressure applied by the hemispherical shape for  $5 \text{ h} \pm 5 \text{ min}$ .

After 5 h raise and remove the hemispherical shape in order to measure the residual deformation.

**One-way stretch fabrics:** If one of the two directions has less than 3 % elongation, proceed as follows. Position the test specimen with its stretch direction along the frame. Fix the test specimen between the longitudinal bars of the 2 frames, but not between the transverse bars, with  $(200 \pm 1)$  mm. Use the

value of deformation which relates to the percentage elongation of the stretch direction of the fabric (see Table 2).

### 9.2.6 Measurement of the residual deformation

Let the test specimen relax in the frame once the hemispherical shape has been removed for  $(30 \pm 2)$  min. Attach the measuring probe (see Figure E.3) onto the frame in the same position as the removed hemispherical shape. Lower this probe using the knurled knob (key 1) in Figure E.1 until it just touches the fabric, and record in millimetres the deformation from the graduated scale on the side of the measuring device (key 2) in Figure E.1.

Table 1 — Length of the frame,  $L_f$  in mm

Lower % elongation obtained in 9.1.3	Higher % elongation obtained in 9.1.3					
	30	25	20	15	10	5
30	100					
25	110	100				
20	121	110	100			
15	139	127	114	100		
10	169	154	139	121	100	
5	238	217	191	169	139	100

Table 2 — Deformation to be applied,  $L_d$  in mm

Higher % elongation obtained in 9.1.3	30	25	20	15	10	5
Deformation to apply (mm)	38	34	31	26	22	15

### 9.2.7 Recording

Record the residual deformation in millimetres for each specimen after the  $(30 \pm 2)$  min recovery period for both specimens.

### 9.2.8 Expressions and calculations of test results

Express the individual values in millimetres obtained for both specimens.

Calculate the average, in millimetres.

### 9.2.9 Test report

The test report shall include the following information:

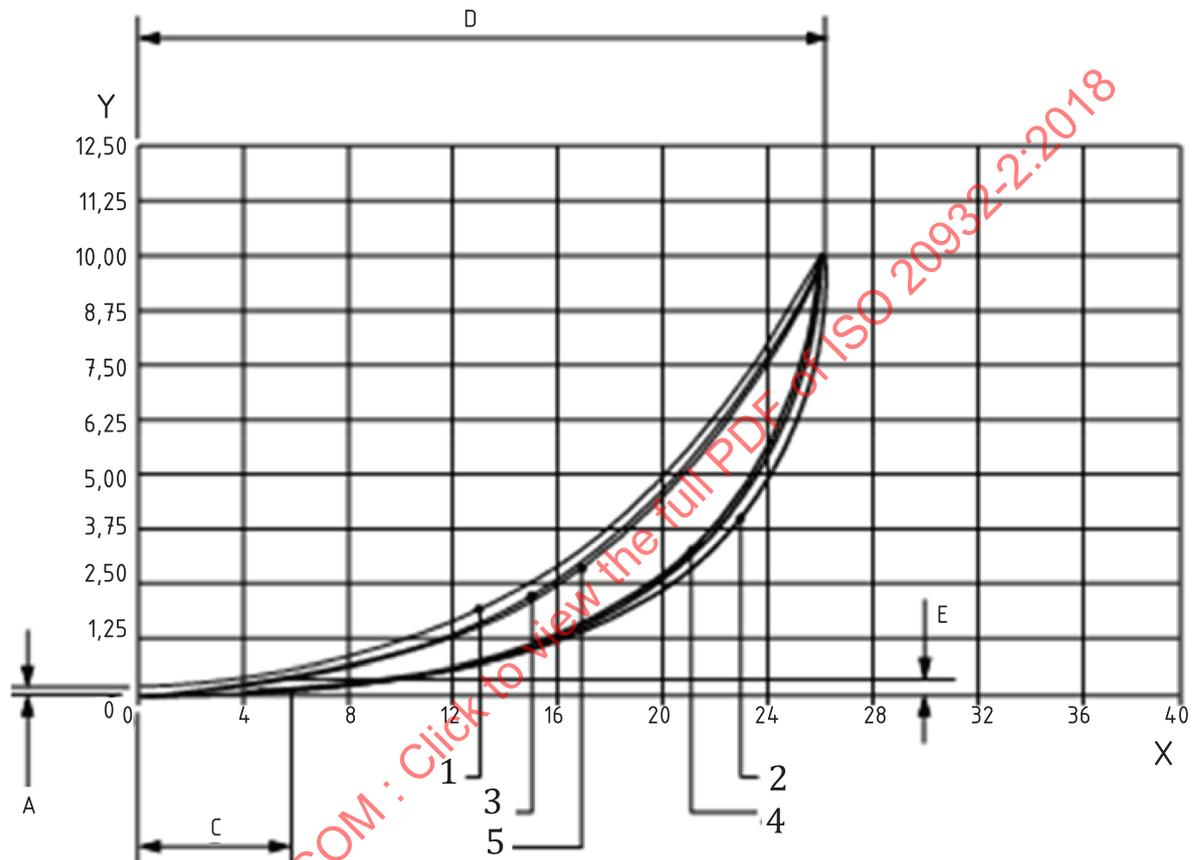
- a reference to this document (i.e. ISO 20932-2:2018) and the date of test;
- identification of test sample and sampling procedure, if required;
- the dimensions of the test specimens;
- type of equipment used;
- state or condition of test specimens (original, washed, aged);
- number of test specimens, particularly if less than two;
- percentage elongation used to calculate the deformation required for each direction;
- the applied deformation,  $L_d$ , in mm, relative to the determined elongation;

- i) the length  $L_f$  of the frames, in mm (calculated from [Table 1](#));
- j) any deviation from this procedure;
- k) the individual results of residual deformation for each test specimen, and the mean;
- l) if required, the standard deviation, coefficient of variation for the relevant measured and calculated values;
- m) if required, the 95 % confidence limits of the relevant measured and calculated values.

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## Annex A (informative)

### Example of a typical cycling graph



#### Key

- X deformation axis (in mm, in this example)
- Y force axis (in N, in this example)
- A 0,2 N force on first cycle
- C unrecovered deformation
- D maximum deformation
- E deformation at 0,2 N after specified recovery period
- 1 pre-cycle
- 2 fifth unload cycle
- 3 second load cycle
- 4 second unload cycle
- 5 fifth load cycle

Figure A.1 — Example of a typical cycling graph

## Annex B (informative)

### Procedure for sampling

#### B.1 Bulk sample (number of pieces from a shipment or lot)

The appropriate number of pieces should be taken at random from the shipment or lot as specified in [Table B.1](#) to form the bulk sample (number of pieces from a shipment or lot). No piece that shows signs of damage or dampness incurred during transit should be included in the sample.

**Table B.1 — Bulk sample**

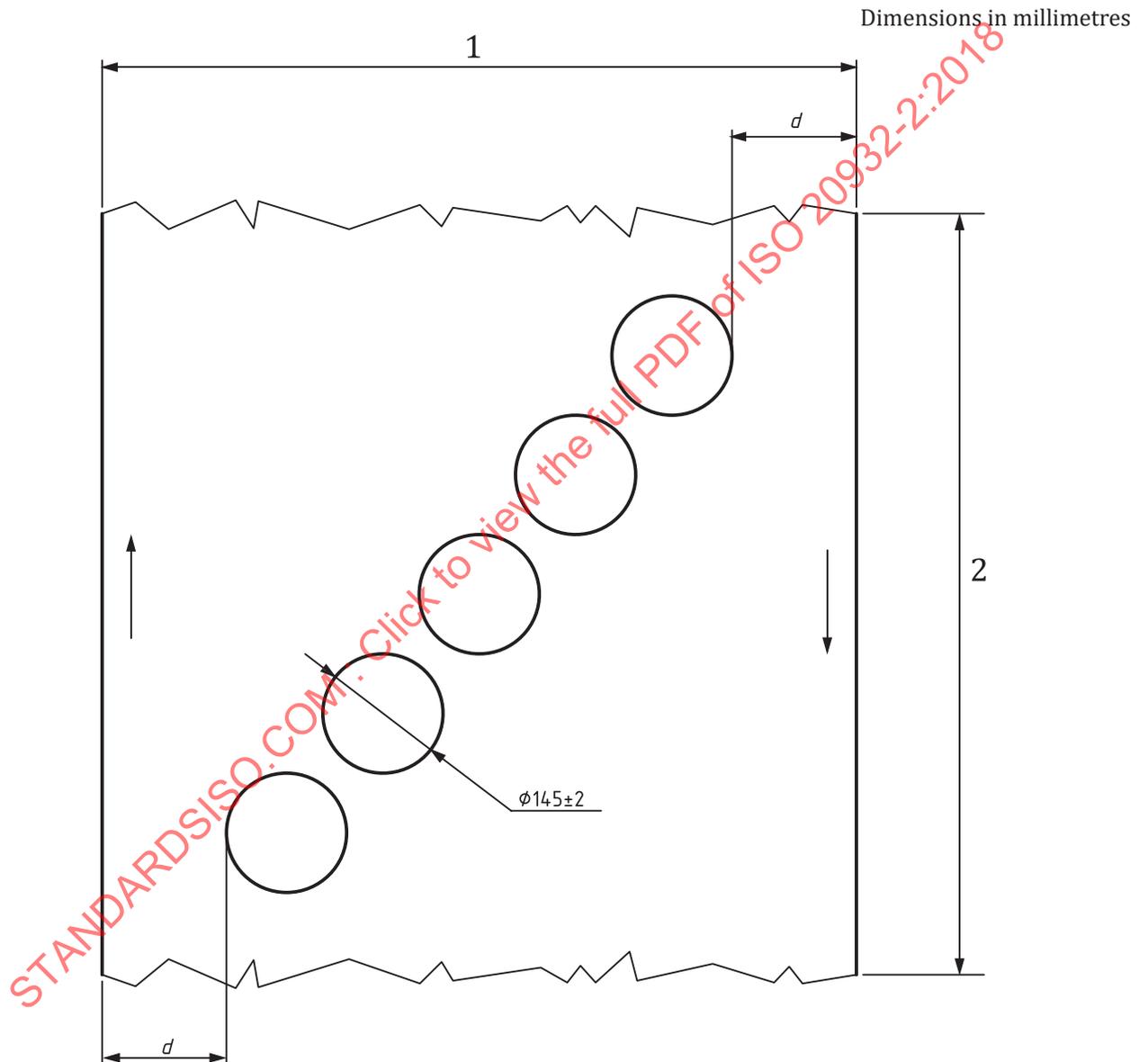
Number of pieces in shipment or lot	Number of pieces in bulk sample, minimum
3 or less	1
4 to 10	2
11 to 30	3
31 to 75	4
76 or more	5

#### B.2 Number of laboratory samples

From each piece in the bulk sample, a laboratory sample should be cut from a position taken at random, but at least 3 m from an end of the piece. The laboratory sample should be cut to include the full width of the piece and should have a length of at least 1 m. Areas that are creased or that have a visible fault should not be included in the sample.

## Annex C (informative)

### Example of a pattern for cutting test specimens from a laboratory sample



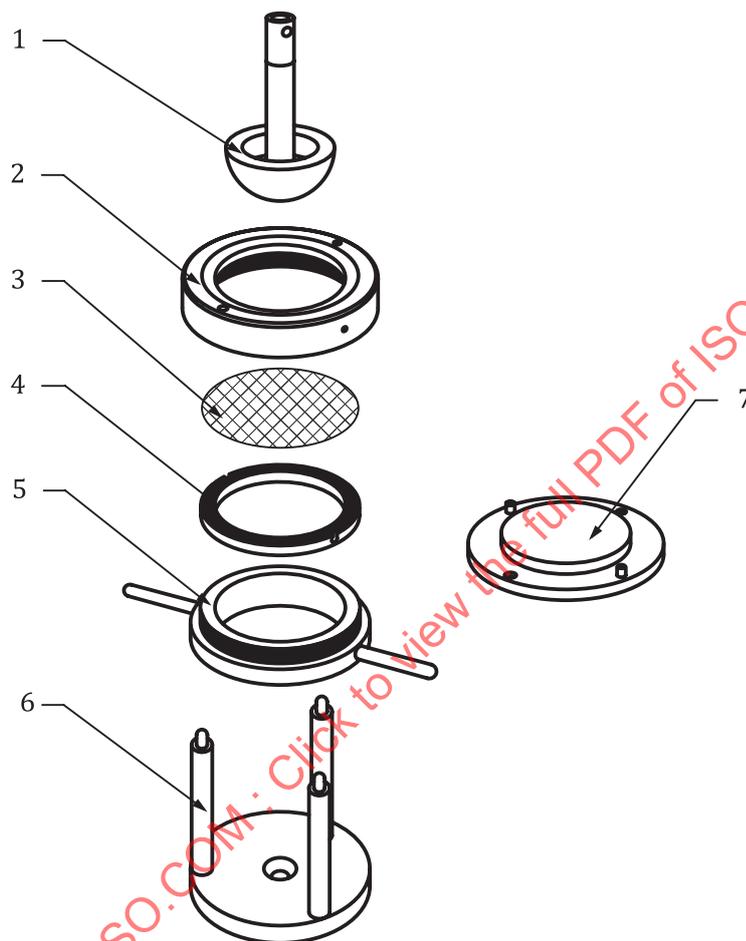
#### Key

- 1 fabric width
- 2 fabric length
- ↑ ↓ selvages
- d 150

Figure C.1 — Example of a pattern

## Annex D (informative)

### Method A — Dynamic test equipment



**Key**

- 1 probe (acetal polymer, smooth polished surface)
- 2 clamping ring (rubber surface on clamping face)
- 3 specimen
- 4 holding ring (rubber surface on clamping face)
- 5 locking ring
- 6 base unit
- 7 loading base

**Figure D.1 — Dynamic test equipment: Exploded view**

Dimensions in millimetres

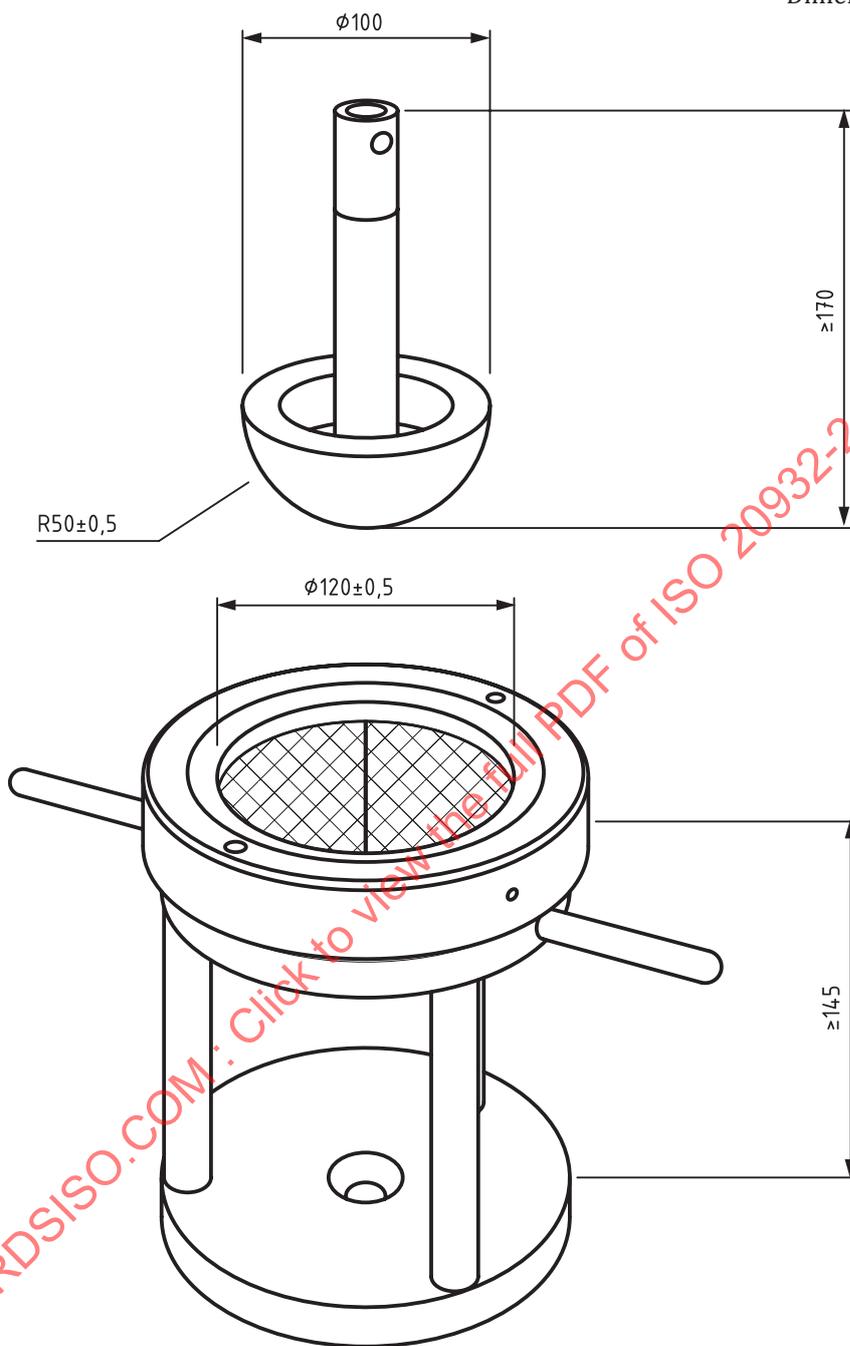


Figure D.2 — Dynamic test equipment: Critical dimensions