

Determination of the elasticity of fabrics —

Part 2: Multiaxial tests

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National foreword

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Foreword

This document (EN 14704-2:2007) has been prepared by Technical Committee CEN/TC 248 "Textiles and textile products", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by August 2007, and conflicting national standards shall be withdrawn at the latest by August 2007.

The reasons for the development of this European Standard are because of technical advancements in yarn and fabric structures and properties, which increase product range and developments.

EN 14704 *Determination of the elasticity of fabrics* consists of the following parts:

Part 1: Strip tests

Part 2: Multiaxial tests

Part 3: Narrow fabrics

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

1 Scope

This European Standard specifies the methods of test, which can be used to measure elasticity and related properties of fabrics, when they undergo a deformation of their surface, excluding narrow fabrics. Two methods are specified, one a dynamic method (method A) and the other a static method (method B).

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

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 14704-1, *Determination of the elasticity of fabrics — Part 1: Strip tests*

EN ISO 139, *Textiles — Standard atmospheres for conditioning and testing (ISO 139:2005)*

EN ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

EN ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment (ISO 10012:2003)*

3 Terms and definitions

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

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

3.2 elasticity
property of a material by virtue of which it tends to recover its original size and shape immediately after the removal of the force causing deformation

3.3 constant-rate-of-extension (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

3.4 bagging
residual deformation, expressed in millimetres, between the original state and the state of the surface when it has undergone a multidirectional force, which by repetition creates a "bag"

3.5 maximum deformation
maximum deformation, expressed in millimetres, developed when a specified force is applied to the surface of the test specimen compared to the original state of a test specimen

3.6**residual deformation**

deformation, expressed in millimetres, after the removal of the hemispherical probe and an agreed recovery time

3.7**maximum force**

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

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

3.10**force decay due to time**

loss of force measured over time when a test specimen is stretched to a specified distension or force and held at this position for a given time period

NOTE The decay in force is expressed as a percentage of the original force recorded at the specified position. See Annex A.

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 EN ISO 139.

The fabric samples shall be conditioned for a minimum of 20 h in a tension free state. The prepared specimens shall be conditioned in a tension free state for a further 4 h after preparation, to minimise 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 Annex C.

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 EN ISO 10012.

The constant-rate-of-extension 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 EN 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 ± 10 %.
- d) The machine shall be capable of variable gauge length settings including 0 to 100 mm, to an accuracy of ± 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).

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 ± 2) mm in diameter (see Annex C).

8.3 Procedure for loading test specimen in clamping ring (see Figures D.1 and D.2)

8.3.1 Position the clamping ring (2) onto loading base (7), 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 (4) onto the specimen and finally locking ring (5) and screw down on the specimen.

8.3.2 Set the distension rate of the specimen at 100 mm/min for woven and non-woven 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 non-woven) or 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 (6) 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 5 cycles. During the first cycle determine the deformation at a force of 0,2 N.

For the determination of force decay, due to time, on the final cycle set the CRE testing machine to 'hold' at the maximum force for a 60 s period.

If it is required to determine the un-recovered 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.

NOTE 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

$$S = E - L$$

where

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

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

Force decay due to time, A , expressed as a percentage.

$$A = \frac{V - W}{V} \times 100$$

where

V is the maximum force from the final cycle;

W is the maximum force on the final cycle, after a specified holding period.

Un-recovered deformation (bagging), C , expressed in mm

$$C = Q - P$$

where

Q is the deformation at 0,2 N in millimetres 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) reference to this European Standard, i.e. EN 14704-2 and 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 5;
- 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 which ever is required and for which cycle;
- k) arithmetic mean of modulus, the deformation point in millimetres and cycle, when required;
- l) arithmetic mean of force decay – due to time and relevant cycles, when required;
- m) arithmetic mean of un-recovered deformation, when required;
- n) if required, the coefficient of variation for the relevant measured and calculated values;
- o) if required, the 95 % confidence limits of the relevant measured and calculated values;
- p) any deviations from the procedure.

9 Method B – Static test

9.1 Preliminary test

9.1.1 Apparatus

CRE testing machine as described in EN 14704-1, Method A.

9.1.2 Preparation of test specimens

Cut two specimens (50 ± 1) mm by (300 ± 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 ± 1) N, according to EN 14704-1, 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).

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.

9.2.2.2 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 ± 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 (items 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, item 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 $(200 \pm 1)\text{ mm}$. Use the value of deformation which relates to the % 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 $(30 \pm 2)\text{ min}$. 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 (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 (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 ± 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.

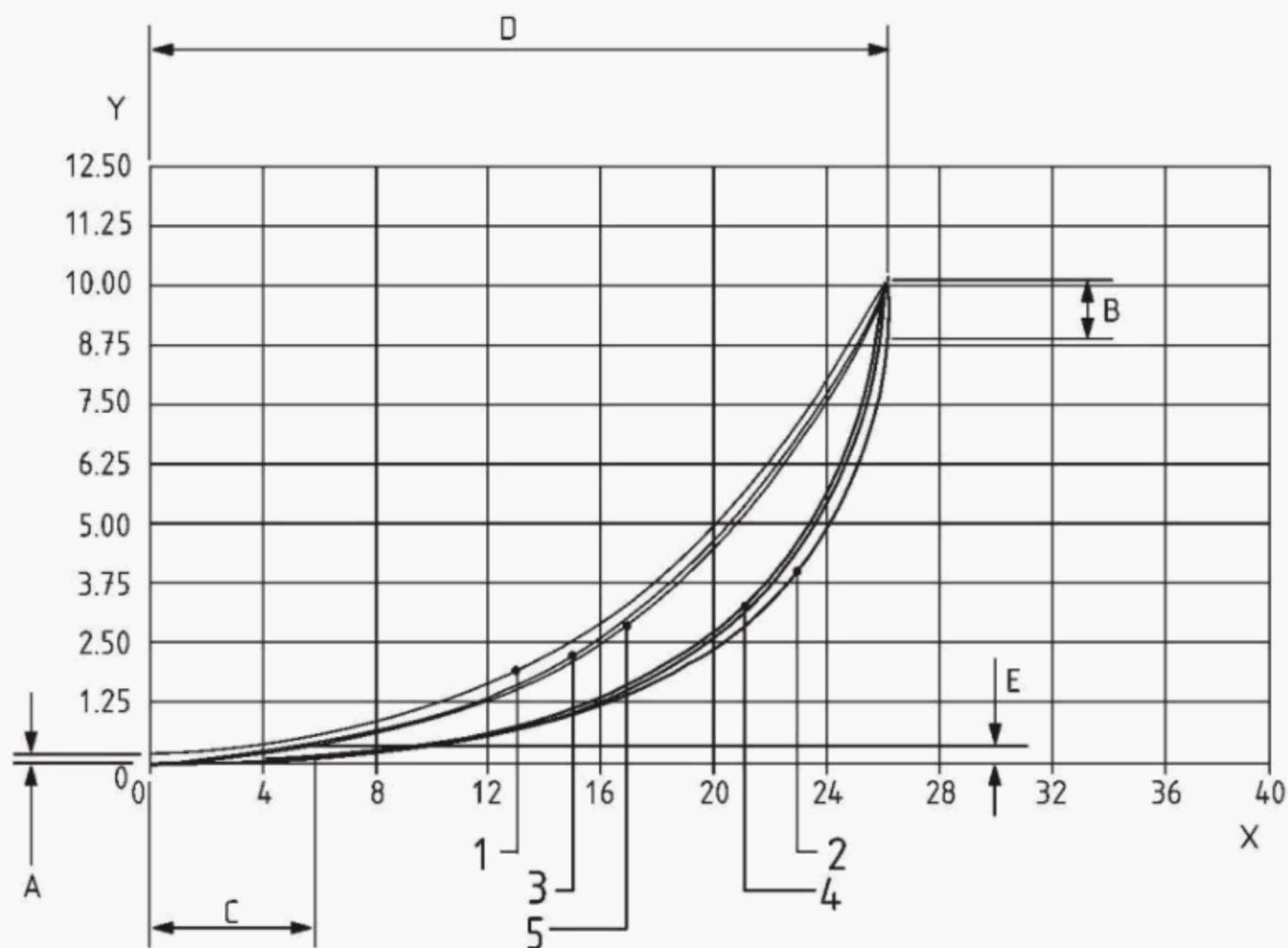
9.2.9 Test report

The test report shall include the following information:

- a) reference to this European Standard, i.e. EN 14704-2 and date of test;
- b) identification of test sample and sampling procedure, if required;
- c) the dimensions of the test specimens;
- d) type of equipment used;
- e) state or condition of test specimens (original, washed, aged);
- f) number of test specimens particularly if less than 2;
- g) % elongation used to calculate the deformation required for each direction;
- h) 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.

Annex A
(informative)

Example of a typical cycling graph



Key

- A 0,2 N force on first cycle
- B force decay due to time
- C un-recovered deformation
- D maximum deformation
- E deformation at 0,2 N after specified recovery period
- 1 pre-cycle
- 2 fifth un-load cycle
- 3 second load cycle
- 4 second un-load cycle
- 5 fifth load cycle

Figure A.1

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

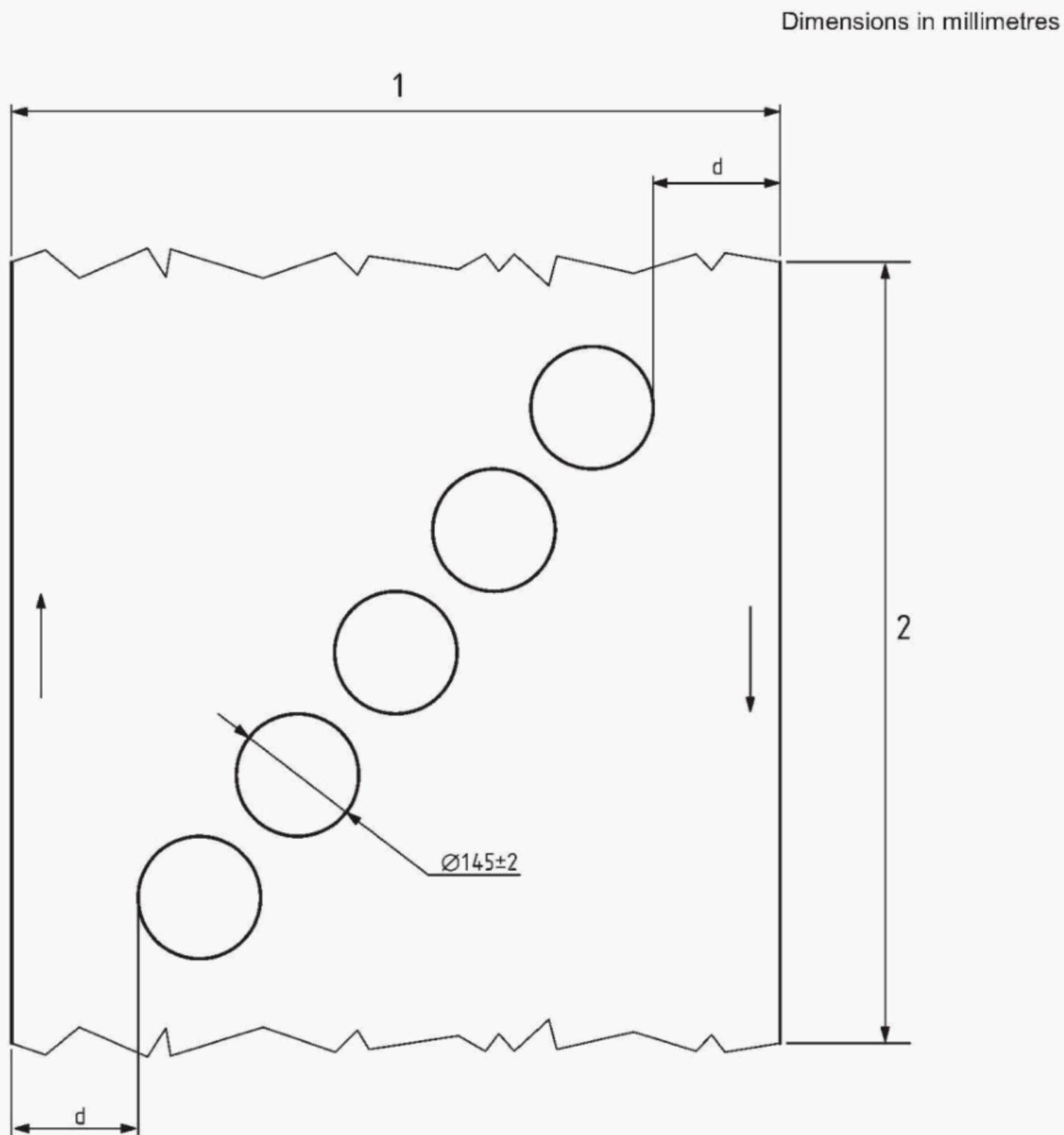
Number of pieces in shipment or lot	Number of pieces in bulk sample, minimum
3 or less	1
4 to 10	2
11 to 30	3
31 to 75	4
76 or more	5

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

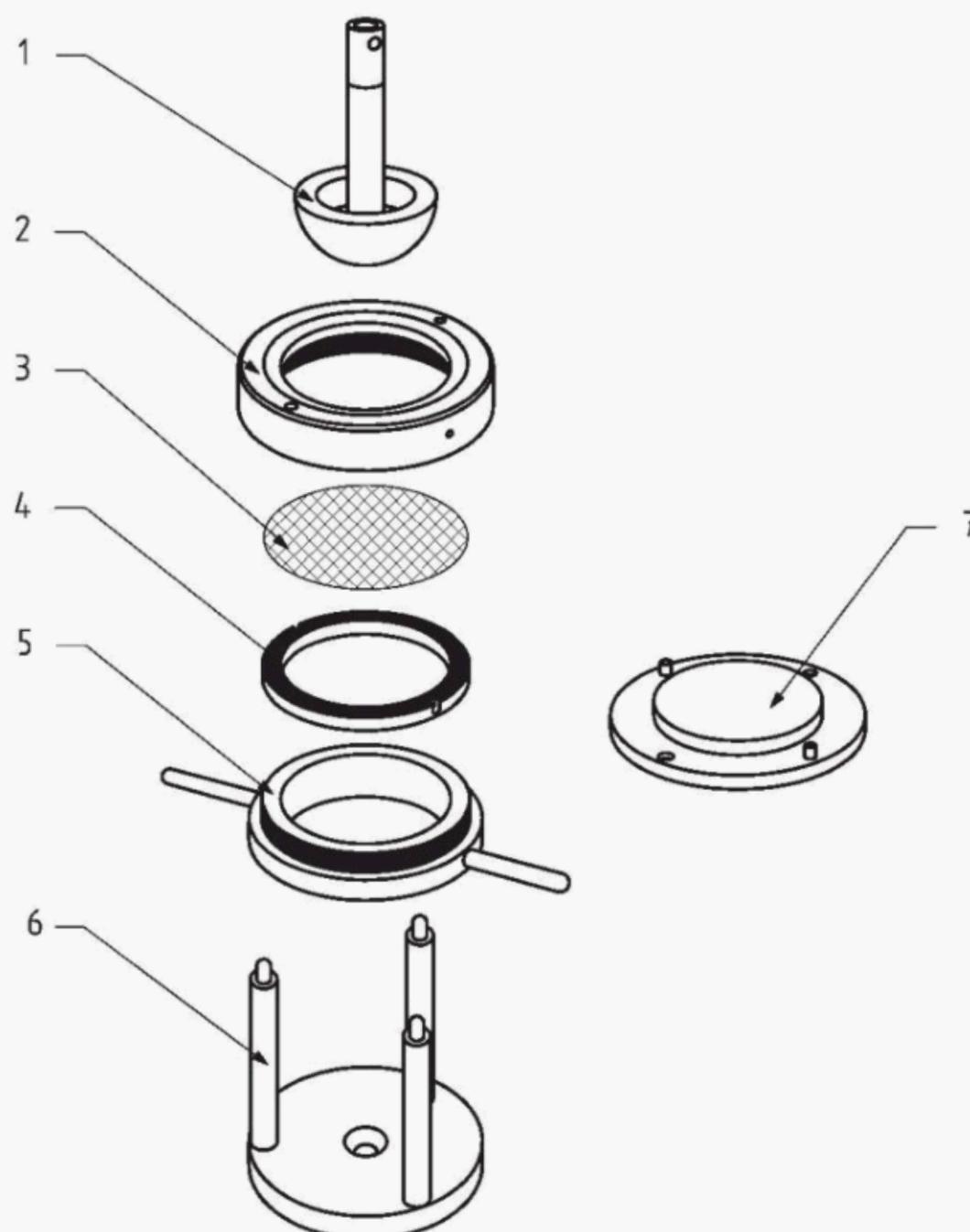


- Key**
1 fabric width
2 fabric length
↑ ↓ selvages
 $d = 150$ mm

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

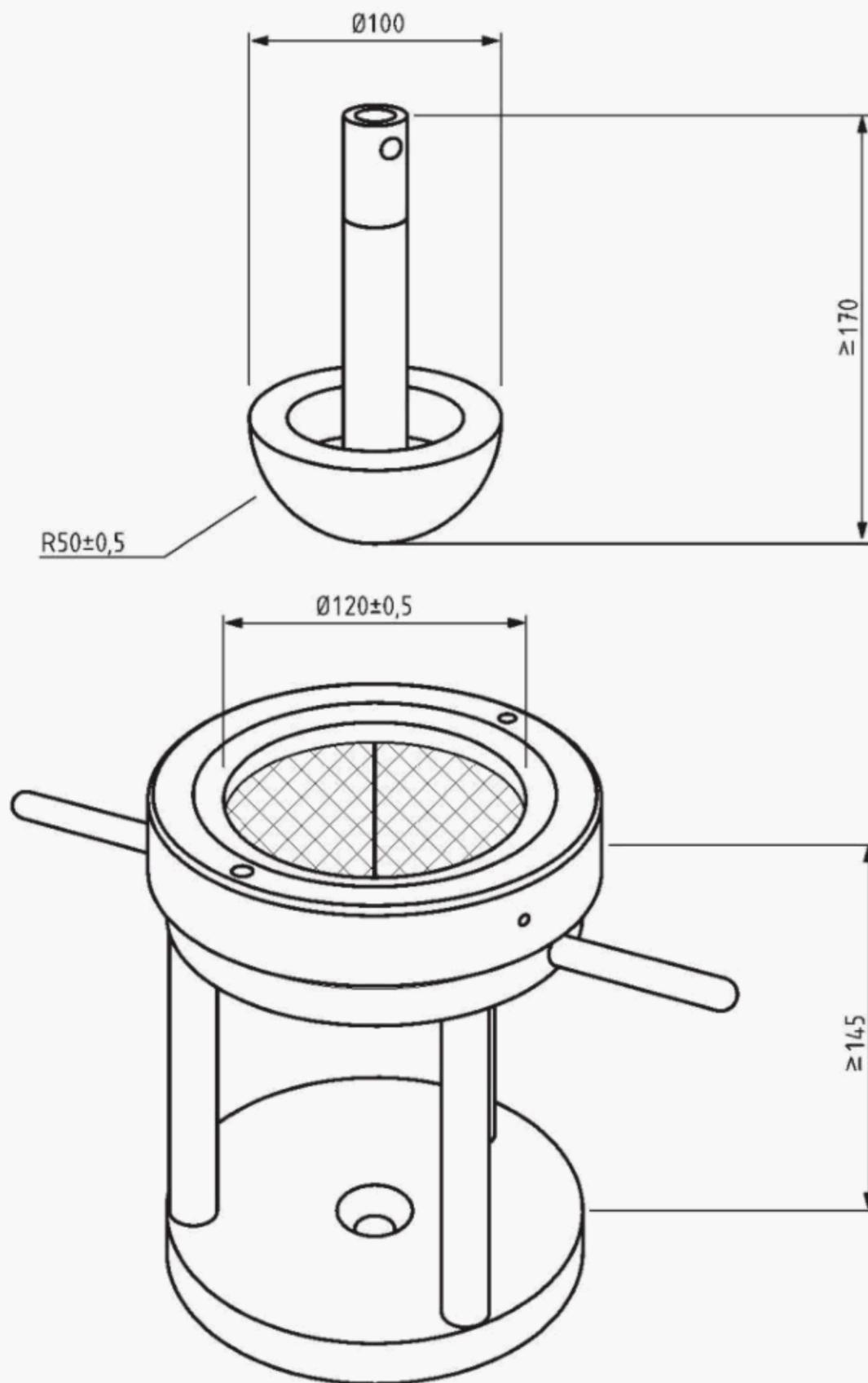


Figure D.2 — Dynamic test equipment – Critical dimensions

Dimensions in millimetres

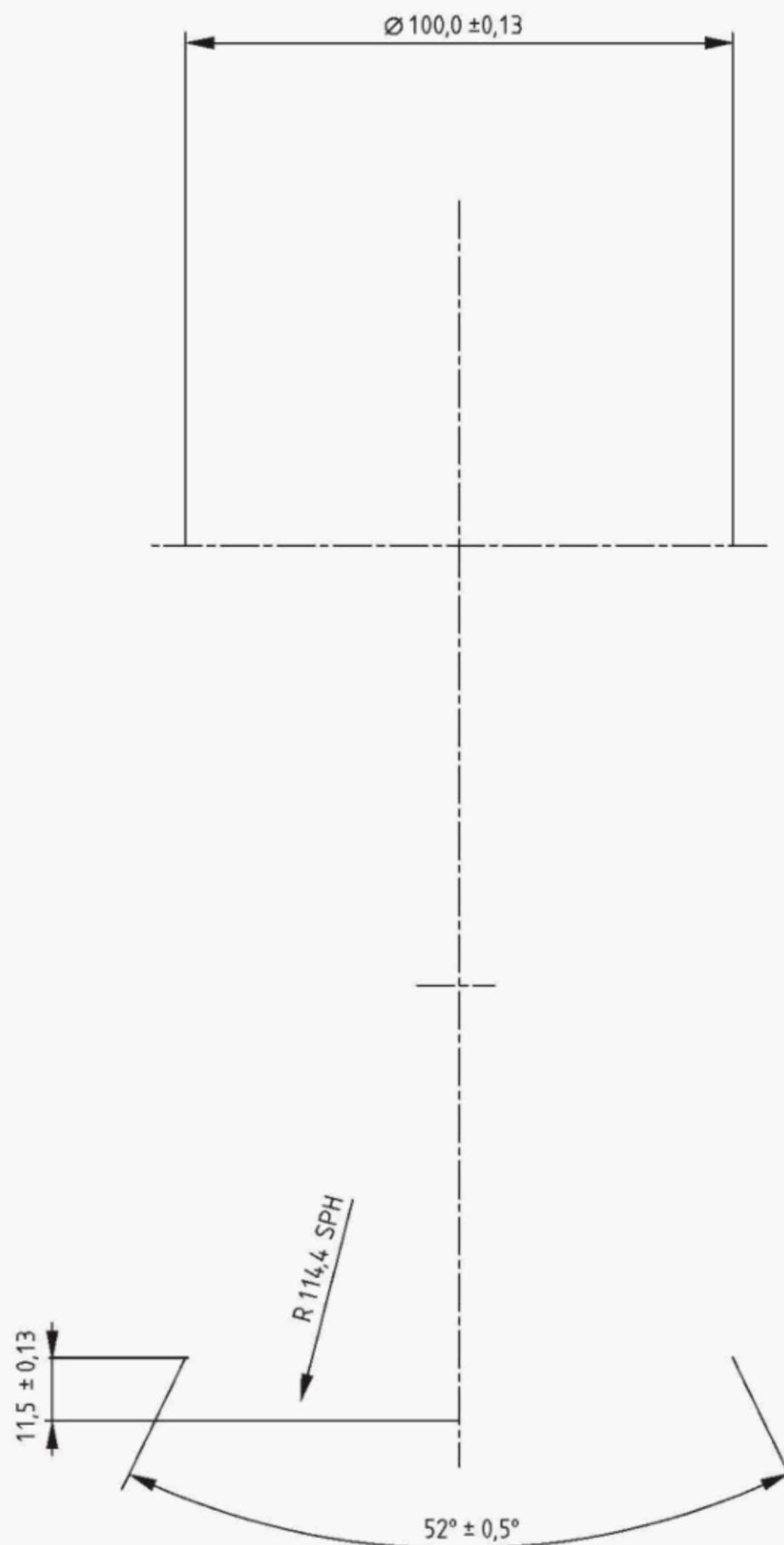
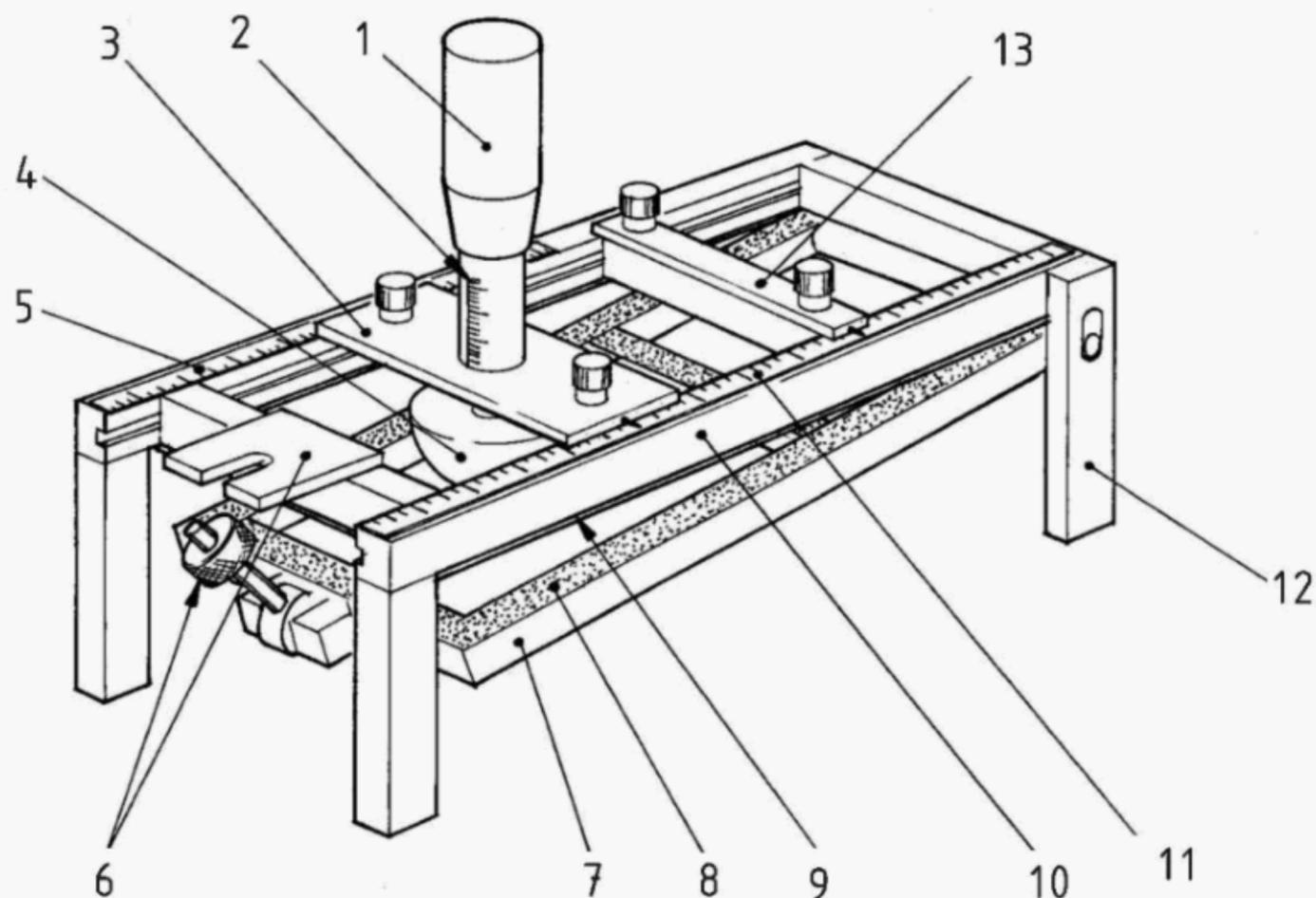


Figure D.3 — Dynamic test equipment – Critical dimensions for alternative upholstery probe

Annex E
(informative)

Method B - Static test equipment



Key

- 1 knurled knob for adjusting hemispherical shape depth
- 2 gauge to measure deformation (mm scale) including the residual deformation probe (see Figure E.3)
- 3 support for hemispherical shape
- 4 removable hemispherical shape (see Figure E.3)
- 5 ruler to position hemispherical shape
- 6 locking device
- 7 lower part of the frame (long side)
- 8 coarse sandpaper surface
- 9 thin cork bonded to surface
- 11 upper part of the frame (long side)
- 12 leg
- 13 removable part (small side) of the frame

Figure E.1 — Static test equipment

Dimensions in millimetres

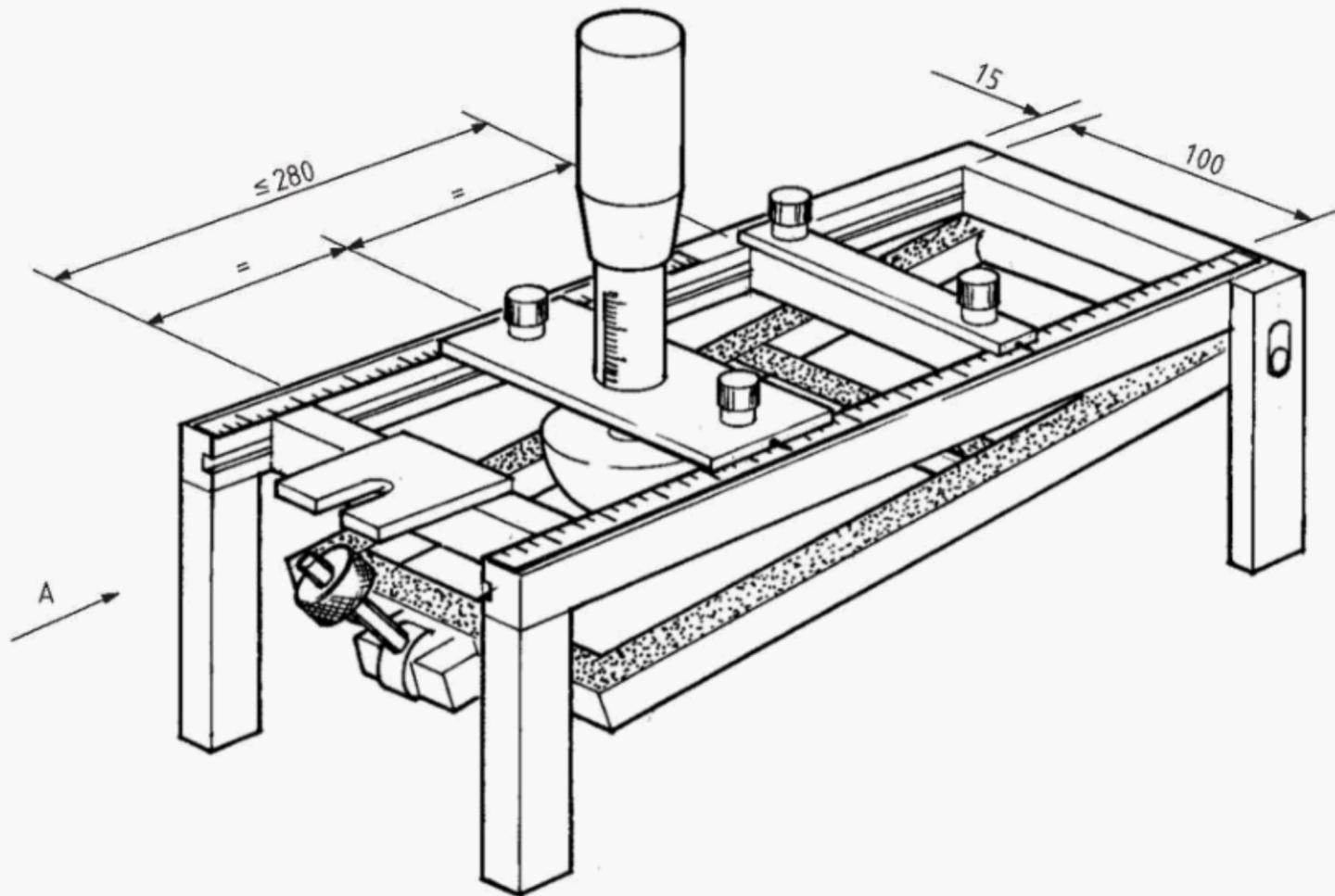


Figure E.2 — Static test equipment - Critical dimensions

Dimensions in millimetres

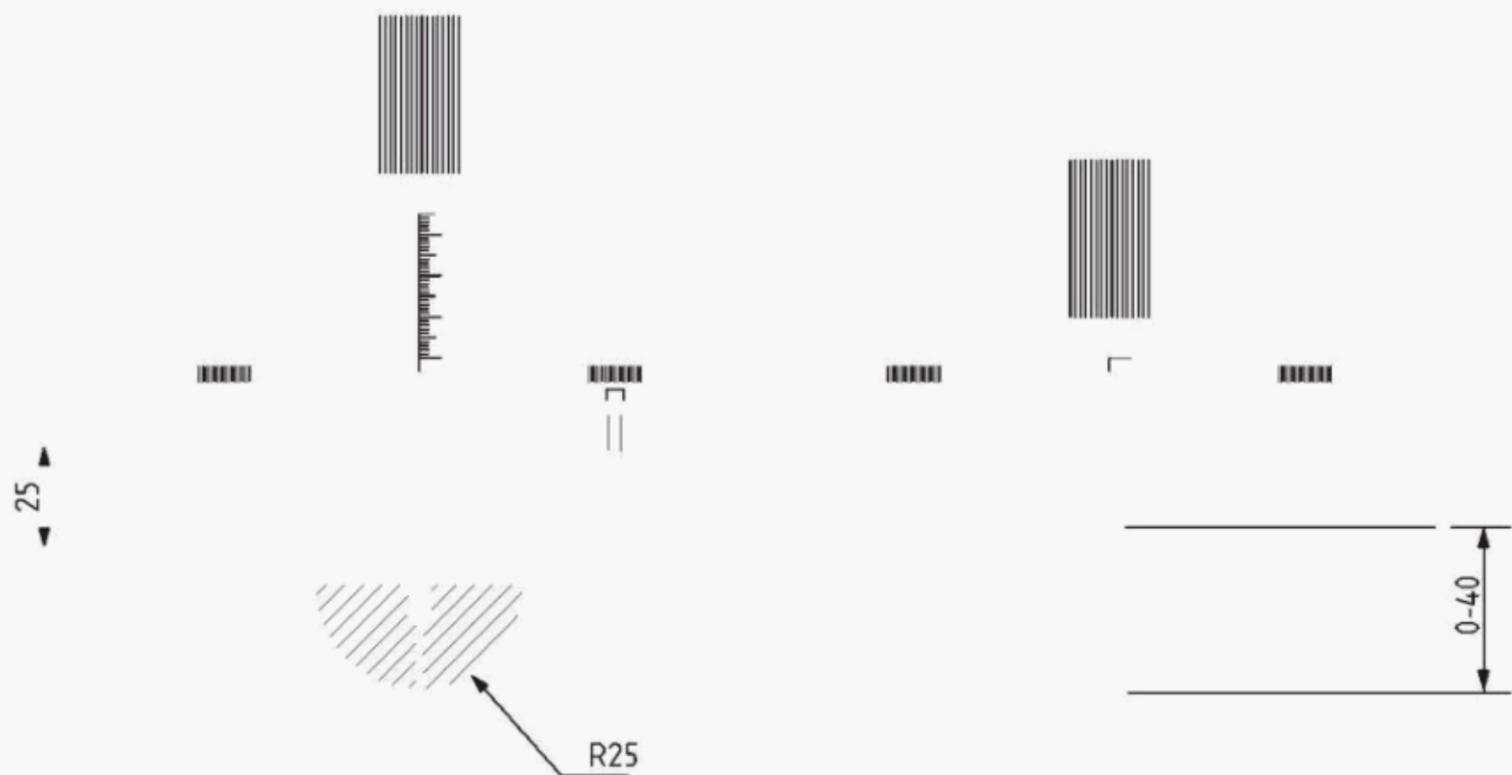


Figure E.3 — View on arrow A

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