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Footwear — Test methods for stiffeners and toepuffs — Mechanical characteristics

Chaussures — Méthodes d'essai pour contreforts et bouts durs — Caractéristiques mécaniques

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Foreword

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The main task of technical committees is to prepare International Standards. 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 the member bodies casting a vote.

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.

ISO 20864 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 216, *Footwear*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read “...this European Standard...” to mean “...this International Standard...”.

Annex ZA provides a list of corresponding International and European Standards for which equivalents are not given in the text.

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Foreword

This document (EN ISO 20864:2004) has been prepared by Technical Committee CEN/TC 309 "Footwear", the secretariat of which is held by AENOR, in collaboration with Technical Committee ISO/TC 216 "Footwear".

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of an identical text or by endorsement, at the latest by June 2005, and conflicting national standards shall be withdrawn at the latest by June 2005.

This document includes a Bibliography.

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, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This document specifies three methods for determining the shape retention properties and compression strength of a domed test specimen. These methods are the following and they are applicable to footwear toepuff and stiffener:

Method 1: Applicable to heat activated materials

Method 2: Applicable to solvent activated materials

Method 3: Applicable to non-thermoplastic fibreboard

NOTE Although it is usual to determine both the shape retention properties and the compression strength of a domed test specimen, either can be determined alone by carrying out the procedures relating to the respective property.

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 12222, *Footwear - Standard atmospheres for conditioning and testing of footwear and components for footwear.*

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).*

3 Terms and definitions

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

3.1
shape retention
aptitude of the material to maintain the original shape (dome) after loading the test piece several times

3.2
compression strength
force required to deform the test piece in determined extent

4 Apparatus and material

4.1 General

The following apparatus and material shall be used.

4.2 Methods 1 and 2

4.2.1 A dome forming tool made of a rigid heat and solvent resistant material and consisting of:

4.2.1.1 A dome capped piston of diameter 47,5 mm ± 0,5 mm and dome of curvature radius 35,0 mm ± 0,5 mm. This will produce a dome of height 9,3 mm ± 0,2 mm.

4.2.1.2 A metal cylinder with:

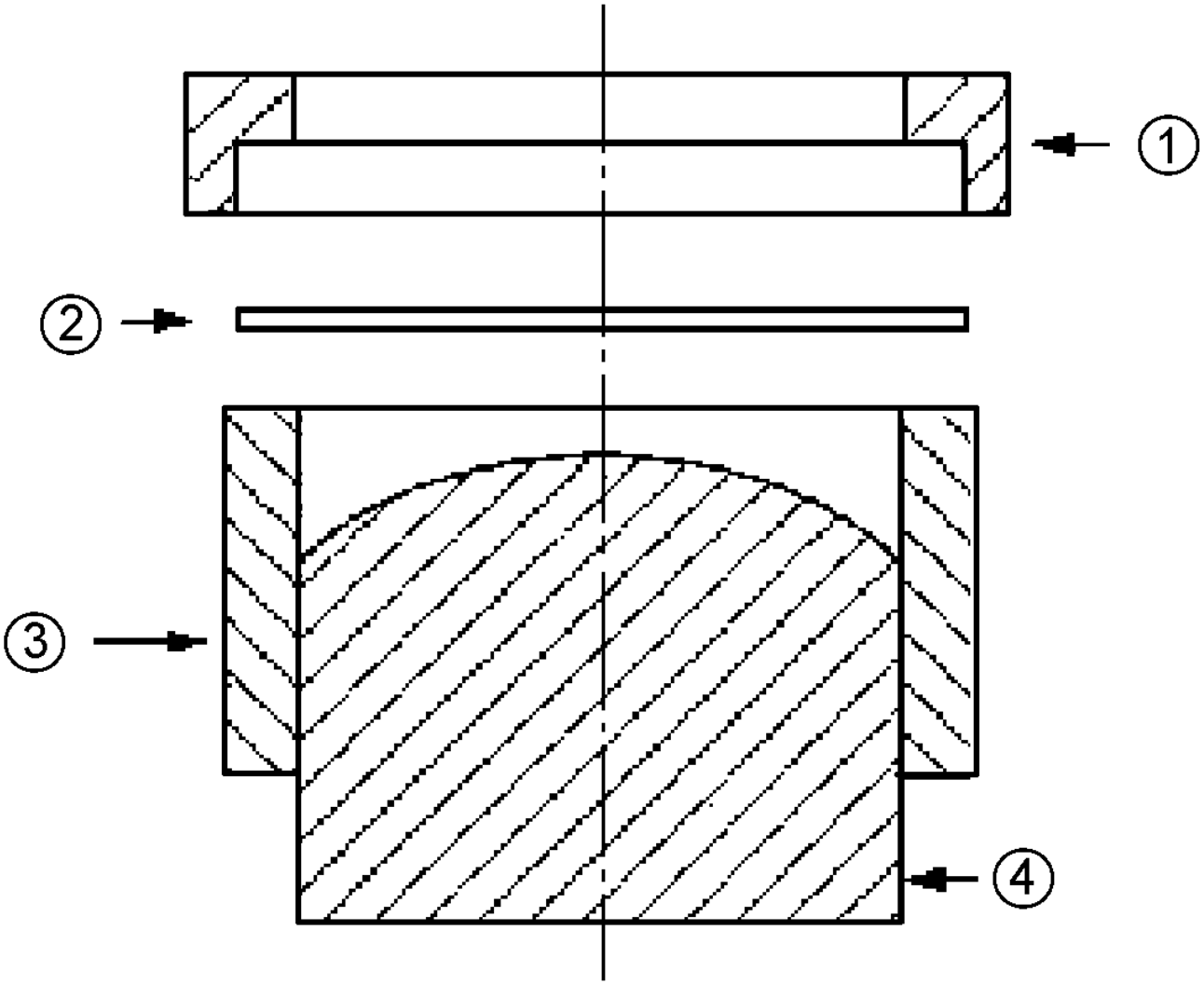
- an internal diameter less than 48 mm but large enough to allow the piston (4.2.1.1) to move freely within it;
- a length of at least 25 mm;
- a clamping ring flange on one end to take the clamping ring as specified (4.2.1.4).

4.2.1.3 Means of holding the piston to the cylinder in a position such that the edge of the domed cap is aligned with the outer surface of the clamping ring flange.

4.2.1.4 A clamping ring with:

- an internal diameter of less than 48 mm but large enough to allow the piston (4.2.1.1) to move freely within it;
- an external diameter and design of any surface pattern that should ensure that the test specimen does not slip during the test, and should neither stretch nor compress the central area of the test specimen as it is clamped;
- a method of tightening the clamping ring to the clamping flange on the end of the cylinder (4.2.1.2).

A diagram of the apparatus is given in Figure 1.



Key

1 Clamping ring (4.2.1.4)
2 Test specimen
3 Metal cylinder (4.2.1.2)
4 Piston

Figure 1 — Dome forming tool

4.2.1.5 A device, such as a press, for forcing the piston (4.2.1.1) into the metal cylinder (4.2.1.2).

4.2.2 A device, such as a press knife, for cutting circular test specimens of diameter to fit the dome forming tool (4.2.1).

4.2.3 Thin polyethylene sheet material.

4.2.4 A device, such as a press knife, for cutting circular polyethylene rings of suitable diameter for the dome forming tool (4.2.1).

4.2.5 An electric fan.

4.3 Method 1 (only)

4.3.1 A fan assisted oven capable of maintaining a temperature of 80 °C ± 5 °C.

4.3.2 Heat resistant gloves.

4.4 Method 2 (only)

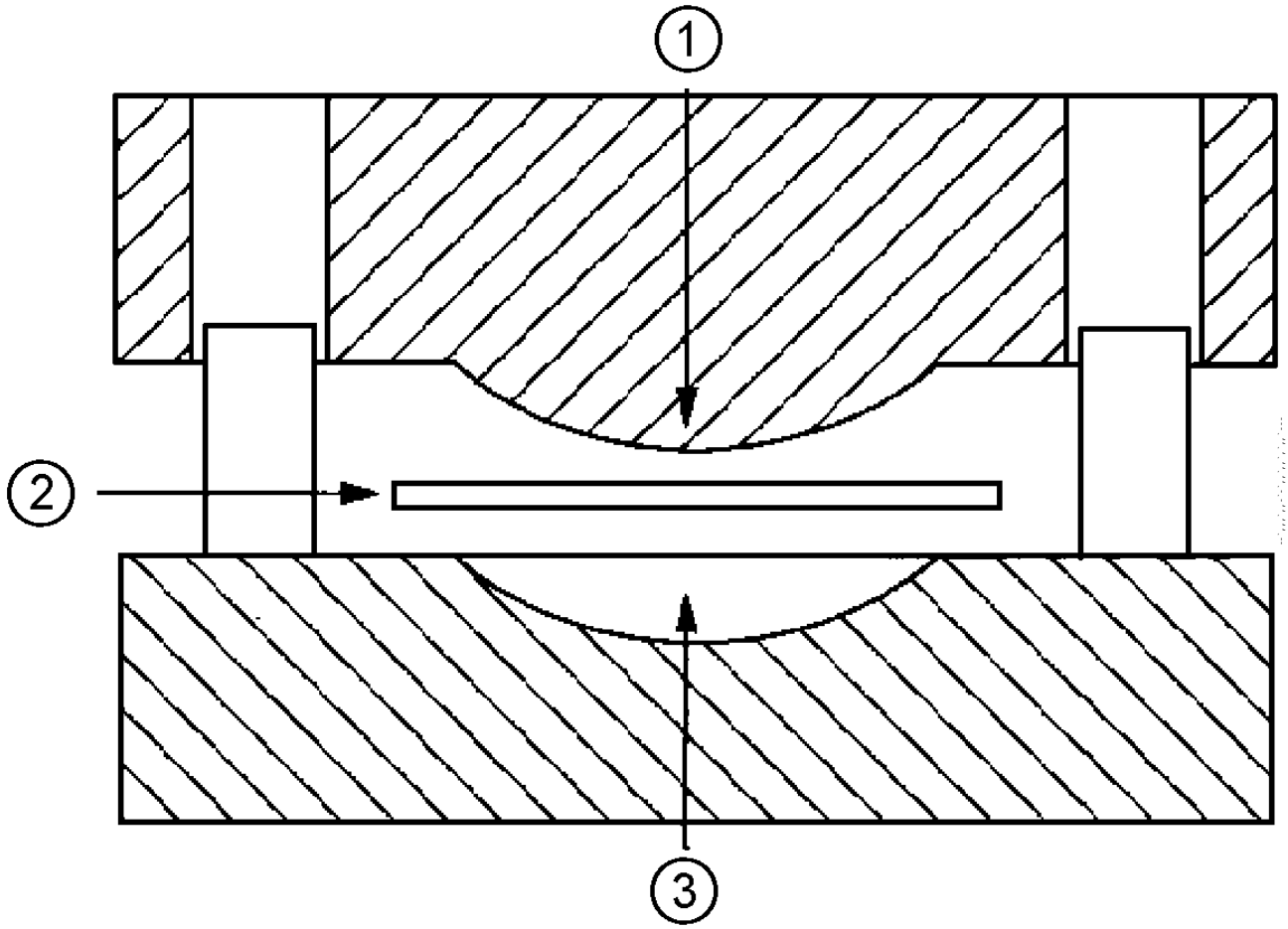
4.4.1 Acetone or other solvent recommended by the material manufacturer.

4.4.2 Silicone based release agent in the form of a spray.

4.5 Method 3

4.5.1 A two part metal mould (see Figure 2) with:

- a lower block having a spherical recess of diameter 47,5 mm ± 0,5 mm, depth 9,3 mm ± 0,2 mm and radius of curvature 35,0 mm ± 0,5 mm;
- an upper block having a downward facing spherical dome of the same dimensions as the spherical recess in the lower block, such that the dome will fit into the recess;
- a mechanism for holding together the two halves of the mould.



Key

1 Spherical dome
2 Test specimen
3 Spherical recess

Figure 2 — Two part metal mould

4.5.2 A hydraulic press capable of applying a force of up to 120 kN ± 10 kN to the mould.

4.5.3 A device, such as a press knife, for cutting circular test specimens of diameter to fit the mould (4.5.1).

4.5.4 A source of steam, such as an electric kettle which can be kept boiling.

4.5.5 Thongs or similar apparatus for holding test specimens in a jet of steam.

4.6 All methods

4.6.1 A height gauge (see Figure 3), consisting of:

4.6.1.1 A flat plate with:

– a clamping ring meeting the requirements of (4.2.1.4) fitted on its lower surface;

– means of supporting the plate so that:

  - it is horizontal;

- the clamping ring is lowermost;
- there is at least 20 mm of clearance below the plate.

– a hole through the plate which is at the centre of the clamping ring and of diameter less than the clamping ring but large enough to allow the spindle of the thickness gauge (4.6.1.2) to move freely within it.

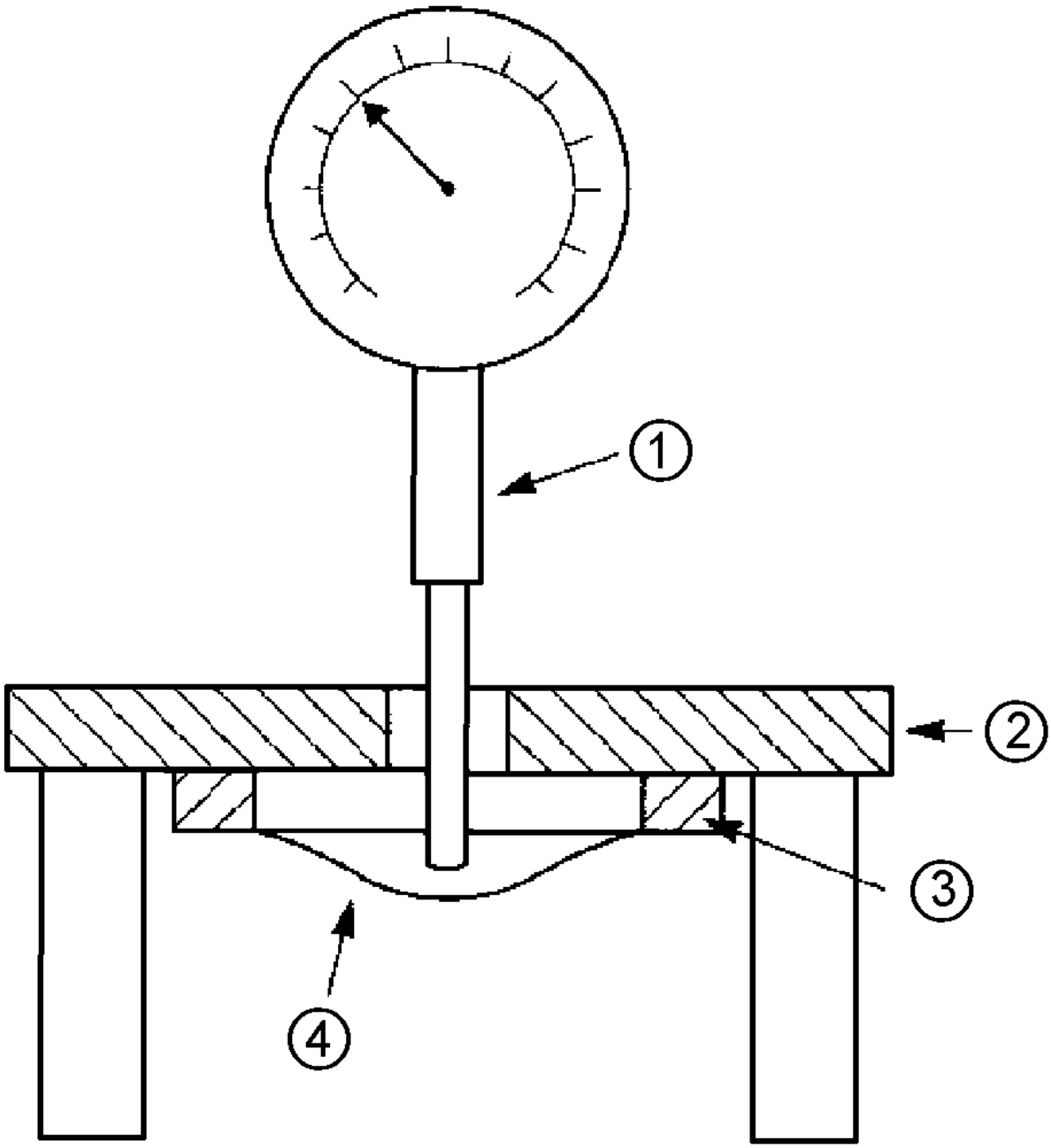
4.6.1.2 A thickness gauge which:

– has a spindle with a spherical lower surface of radius 1,5 mm ± 0,2 mm.

– applies a force of 0,55 N ± 0,10 N to the spindle.

– is capable of measuring to the nearest 0,05 mm.

– is mounted so that the spindle passes vertically through the hole in the flat plate (4.6.1.1).



Key

1 Thickness gauge (4.6.1.2)
2 Flat plate (4.6.1.1)
3 Clamping ring
4 Test specimen

Figure 3 — Height gauge

4.6.2 A device that can be used to cover the hole in the flat plate (4.6.1.1) from the lower surface. The device should have a flat face such that, when placed over the hole, it provides a surface which is flush with the lower surface of the flat plate. A metal cylinder is suitable.

4.6.3 A tensile testing machine with:

4.6.3.1 A jaw separation rate of 50 mm/min ± 5 mm/min.

4.6.3.2 A force range appropriate to the test specimen material. This will usually be less than:

– 200 N for toe puff materials

– 500 N for stiffener materials

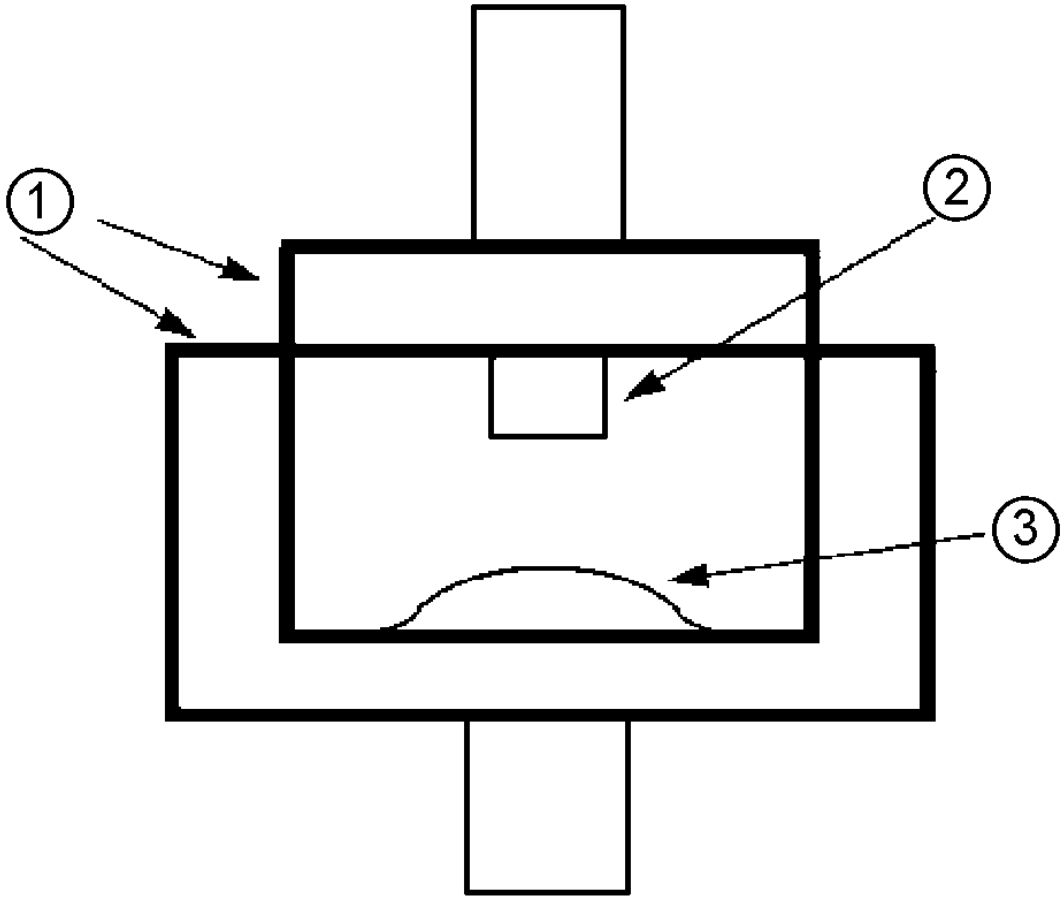
4.6.3.3 Means of measuring the force to an accuracy of better than 2 % as specified by class 2 in EN ISO 7500-1.

4.6.4 A compression cage (see Figure 4), for use with the tensile testing machine, with:

4.6.4.1 A vertically mounted plunger, the end face of which is circular and has a diameter of 19,00 mm ± 2,5 mm.

4.6.4.2 A platform upon which the domed test specimen can be mounted centrally under the plunger.

4.6.4.3 A minimum clearance of 20 mm between the plunger and the platform.



Key

1 Compression cage
2 Plunger
3 Test specimen

Figure 4 — Compression cage

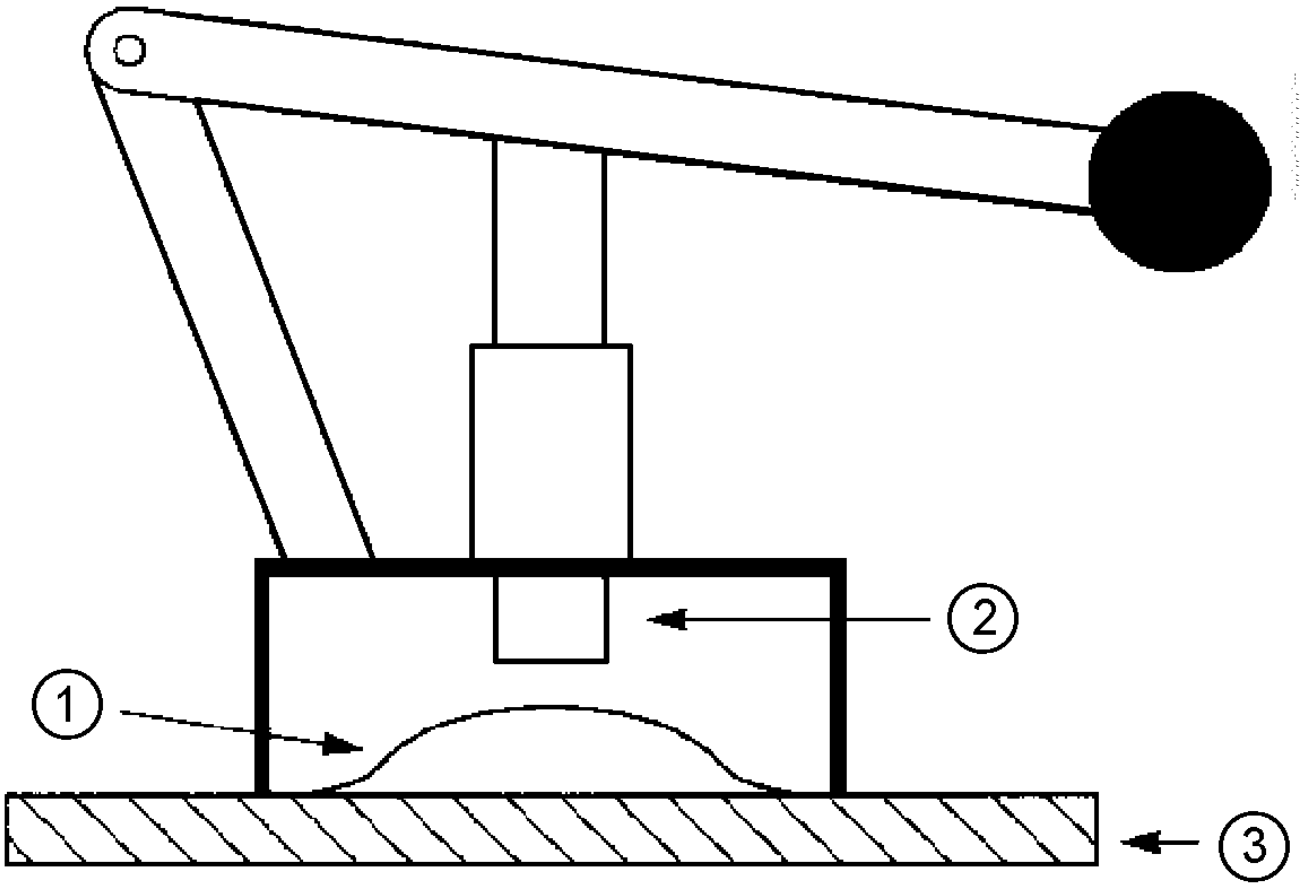
NOTE If suitable apparatus is available, the specimen can be compressed directly, without the use of the compression cage.

4.6.5 A device (see Figure 5) for manually compressing the domed test specimens with:

4.6.5.1 A vertically mounted plunger, the end face of which is circular and has a diameter of 19,00 mm ± 2,5 mm.

4.6.5.2 A rigid base plate upon which the domed test specimen can be mounted centrally under the plunger.

4.6.5.3 A minimum clearance of 20 mm between the base plate and the plunger.



Key

1 Test specimen
2 Plunger
3 Base plate

Figure 5 — Manual compression device

4.6.6 Distilled or deionised water.

5 Sampling and conditioning

5.1 Method 1

5.1.1 Use the device (4.2.2) to cut six circular specimens of suitable diameter. In the case of sheet material, no part of any test specimen should be cut from an area closer than 50 mm to a manufactured edge.

5.1.2 If the test specimen is coated with adhesive on only one side, use the device (4.2.4) to cut six rings from the polyethylene sheet material (4.2.3).

5.1.3 If the test specimen material is coated with adhesive on both sides, use the device (4.2.2) to cut six circular discs of polyethylene. Additionally, follow the procedure in 5.1.2 to cut six rings of polyethylene.

5.1.4 If the test specimen material is not coated with adhesive, place one of the test specimens centrally over the flange of the metal cylinder (4.2.1.2).

5.1.5 If the test specimen material is coated with adhesive on only one side, place one of the test specimens centrally over the flange of the metal cylinder (4.2.1.2) with the coated side uppermost. Place a polyethylene ring (5.1.2) over the test specimen before fitting the clamping ring.

5.1.6 If the test specimen material is coated with adhesive on both sides, place a polyethylene disc (5.1.3) centrally over the flange of the metal cylinder, followed by one of the test specimens and a polyethylene ring.

5.1.7 Fit the clamping ring (4.2.1.4) centrally over the test specimen and fully tighten it to the flange of the metal cylinder so that the specimen is securely clamped.

5.1.8 Activate the test specimen by heating the clamped test specimen assembly in the oven (4.3.1) at the temperature specified by the manufacturer or, if it is not provided, at 80 °C ± 5 °C for 2 min ± 0,5 min. Remove the test specimen assembly from the oven wearing heat resistant gloves (4.3.2) then form the test specimen into a dome shape within 30 s.

5.1.9 Use the device (4.2.1.5) to force the piston (4.2.1.1) into the test specimen until the edge of the piston is aligned with the outer surface of the flange of the cylinder. The test specimen will now be formed into a dome shape. Clamp the piston in this position.

5.1.10 Leave the test specimen assembly (5.1.9) in a standard controlled environment according to EN 12222, in front of the fan (4.2.5), for at least 1,5 h.

5.1.11 Slowly withdraw the piston: if it is withdrawn too quickly this may cause the test specimen to be sucked down. Remove the test specimen from the dome forming tool. From this stage onwards, take care not to accidentally deform the domed test specimen.

5.1.12 Store the test specimen in a standard controlled environment according to EN 12222 for at least 24 h prior to the test, and carry out the test in this environment.

5.1.13 Repeat the procedure given in 5.1.1 to 5.1.12 for the remaining test specimens. Alternatively, if the appropriate apparatus is available, six test specimens may be prepared simultaneously.

5.2 Method 2

5.2.1 Use the device (4.2.2) to cut six circular test specimens of suitable diameter. In the case of sheet material no part of any test specimen should be cut from an area closer than 50 mm to a manufactured edge.

5.2.2 Use the device (4.2.4) to cut six rings from the polyethylene sheet material (4.2.3).

5.2.3 Use the device (4.2.2) to cut six circular discs of polyethylene.

5.2.4 Spray the piston and the interior of the dome forming tool (4.2.1) with the release agent (4.4.2). This is a precautionary measure to prevent any contamination of the dome forming tool caused by the solvent and the polyethylene.

5.2.5 Activate the test specimen by applying acetone or other solvent (4.4.1) to it until it is uniformly wetted, then leave it for 2,5 min ± 0,5 min.

5.2.6 Place a polyethylene disc (5.2.3) centrally over the flange of the metal cylinder (4.2.1.2), followed by the activated test specimen and a polyethylene ring (5.2.2).

5.2.7 Fit the clamping ring (4.2.1.4) centrally over the test specimen and fully tighten it to the flange of the metal cylinder so that the specimen is securely clamped.

5.2.8 Use the device (4.2.1.5) to force the piston (4.2.1.1) into the test specimen until the edge of the piston is aligned with the outer surface of the flange of the cylinder. The test specimen will now be formed into a dome shape. Clamp the piston in this position.

5.2.9 Leave the test specimen assembly (5.2.8) in a standard controlled environment according to EN 12222, in front of the fan (4.2.5), for at least 24 h.

5.2.10 Slowly withdraw the piston: if it is withdrawn too quickly this may cause the test specimen to be sucked down. Remove the test specimen from the dome forming tool. From this stage onwards take care not to accidentally deform the domed test specimen.

5.2.11 Store the test specimen in a standard controlled environment according to EN 12222 for at least 24 h prior to the test and carry out the test in this environment.

5.2.12 Repeat the procedure given in 5.2.1 to 5.2.11 for the remaining test specimens. Alternatively, if the appropriate apparatus is available, six test specimens may be prepared simultaneously.

5.3 Method 3

5.3.1 If required, store the test material in a standard controlled environment according to EN 12222 for at least 24 h.

5.3.2 Use the device (4.5.3) to cut six circular test specimens of suitable diameter. In the case of sheet material no part of any test specimen should be cut from an area closer than 50 mm to a manufactured edge.

5.3.3 Grip a test specimen with the apparatus (4.5.5) and hold it in a jet of steam from the device (4.5.4) to maintain it at approximately 50 °C for 6 min. Turn the test specimen in the jet so that it is heated and moistened uniformly.

5.3.4 Immediately place the test specimen (5.3.3) on the lower block of the mould (4.5.1) so that it is positioned centrally over the spherical recess.

5.3.5 Fit the upper block of the mould and place the assembly in the hydraulic press (4.5.2).

5.3.6 Apply a force to the assembly of:

– 100 kN ± 10 kN for a leatherboard sample.

– 120 kN ± 10 kN for a mixed fibreboard sample.

5.3.7 Maintain this force for 3,0 min ± 0,1 min, then remove the mould from the press and the test specimen from the mould.

5.3.8 Store the test specimen in a standard controlled environment according to EN 12222 for at least 24 h prior to the test and carry out the test in this environment.

5.3.9 Repeat the procedure given in 5.3.1 to 5.3.8 for the remaining test specimens.

6 Procedure (all methods)

6.1 Shape retention value

6.1.1 Dry testing

6.1.1.1 Support the flat plate (4.6.1.1) with the clamping ring lowermost.

6.1.1.2 Fit the device (4.6.2) to the flat plate so that the hole in the plate is covered from the lower surface.

6.1.1.3 Gently lower the spindle of the thickness gauge (4.6.1.2) through the hole in the flat plate until it makes contact with the top surface of the device.

6.1.1.4 When the spindle of the thickness gauge has applied a force to the device for 5 s ± 1 s record the reading on the gauge to the nearest 0,05 mm. Record this value as *X*.

NOTE 1 Once a reliable and consistent value for the height of the lower surface of the plate has been obtained, 6.1.1.1 to 6.1.1.5 can be ignored and the same value of *X* used repeatedly.

NOTE 2 If required, the thickness of the unmoulded test specimen should be measured according to EN ISO 2589.

6.1.1.5 Remove the device from the flat plate.

6.1.1.6 Fit the test specimen to the flat plate using the clamping ring.

6.1.1.7 Support the flat plate so that the domed specimen is inverted.

6.1.1.8 Gently lower the spindle of the thickness gauge through the hole in the flat plate until it makes contact with the inner surface of the domed test specimen.

6.1.1.9 When the spindle of the thickness gauge has applied a force to the test specimen for 5 s ± 1 s record the reading on the gauge to the nearest 0,05 mm. Record this value as *Y*.

6.1.1.10 Remove the test specimen from the flat plate and determine the shape retention value according to 7.1.1 and 7.1.2.

6.1.1.11 Repeat the procedure given in 6.1.1.6 to 6.1.1.10 for other two test specimens and determine the mean shape retention value according to 7.1.3.

6.1.2 Wet testing

6.1.2.1 Soak the remaining three test specimens in distilled or deionised water (4.6.6), at 23 °C ± 2 °C, for approximately 16 h.

6.1.2.2 Determine the shape retention values by following the procedure given in 6.1.1.1 to 6.1.1.11.

6.2 Collapsing load of the test specimen

6.2.1 Dry testing

6.2.1.1 Fit the compression cage (4.6.4) to the tensile testing machine (4.6.3).

6.2.1.2 Place the test specimen centrally under the plunger and operate the machine with a crosshead speed of 50 mm/min ± 5 mm/min.

6.2.1.3 Stop the tensile testing machine once the peak force has been reached and record this value, *L*, to the nearest newton.

6.2.1.4 Return the jaws of the tensile testing machine to their starting position and remove the test specimen.

6.2.1.5 Repeat the procedure given in 6.2.1.2 to 6.2.1.4 for two other test specimens and determine the first collapsing load value according to 7.2.1.

6.2.1.6 Manually push out any deformation from one of the test specimens and place it centrally under the plunger of the compression device (4.6.5).

6.2.1.7 Use the device (4.6.5) to collapse the test specimen ensuring that the dome of the test specimen touches the base plate (4.6.5.2).

6.2.1.8 Repeat the procedure given in 6.2.1.6 and 6.2.1.7 a further seven times.

6.2.1.9 Repeat the procedure given in 6.2.1.6 and 6.2.1.7 for the two remaining specimens and determine the peak load value, *L*, of the test specimens following the procedure given in 6.2.1.1 to 6.2.1.5.

6.2.1.10 Determine the tenth collapsing load value according to 7.2.2.

6.2.2 Wet testing

6.2.2.1 Proceed as given in 6.1.2.1.

6.2.2.2 Determine the collapsing load values by following the procedure given in 6.2.1.1 to 6.2.1.10.

6.3 Shape retention after ten collapses

6.3.1 Dry testing

Manually push out any deformation from the test specimens, then follow the procedure given in 6.1.1.1 to 6.1.1.11, and determine the mean of the shape retention values according to 7.3.

6.3.2 Wet testing

Proceed as given in 6.1.2.1 and determine the shape retention values according to 6.3.1.

7 Expression of results

7.1 Shape retention

7.1.1 Calculate the height of the test specimen, H_2, by using the formula

$$H_2 = Y - X$$

where

Y is the value recorded in 6.1.1.9, in mm;

X is the value recorded in 6.1.1.4, in mm.

7.1.2 Calculate the area shape retention value of the test specimen, *S*, in per cent to the nearest one per cent, using the formula:

$$S = \frac{H_2^2}{H_1^2} x100$$

where H_1 is the height of the relevant forming tool, either the dome capped piston (4.2.1.1) or the spherical dome of the metal mould (4.5.1), in mm.

7.1.3 Calculate the arithmetic mean of the shape retention values to the nearest one per cent. Record this value as the initial shape retention area.

7.2 Collapsing load

7.2.1 Calculate the arithmetic mean of the three peak load values, *L*, to the nearest newton and record this value as the first collapsing load.

7.2.2 Calculate the arithmetic mean of the peak load values, *L*, to the nearest newton and record this value as the tenth dry collapsing load.

7.3 Shape retention after ten collapses

Calculate the arithmetic mean of the three shape retention values to the nearest one per cent. Record this value as the area shape retention after tenth collapse.

7.4 Resilience

Calculate the resilience of the test specimen material, in per cent to the nearest one per cent, using the formula:

Resilience = (tenth dry collapsing load / first dry collapsing load) X 100

7.5 Moisture resistance

Calculate the moisture resistance of the test specimen material, in per cent to the nearest one per cent, using the formula:

Moisture resistance = (first wet collapsing load / first dry collapsing load) X 100

8 Test report

The test report shall include the following information:

a) for both dry and wet testing:

– the initial area shape retention value as calculated in 7.1.3;

– the first collapsing load value as calculated in 7.2.1;

– the tenth collapsing load value as calculated in 7.2.2;

– the area shape retention value after ten collapses as calculated in 7.3.

b) the resilience of the test specimen material, as calculated in 7.4;

c) the moisture resistance of the test specimen material, as calculated in 7.5;

d) a full description of the samples tested, including commercial styles codes, colours, nature, etc.;

e) reference to this test method;

f) date of testing;

g) any deviations from this standard test method.

Annex ZA
(normative)

Normative references to International publications with their corresponding European publications

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.

Publication	Year	Title	EN	Year
ISO 7500-1	1999	Metallic materials - Verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Verification and calibration of the force-measuring system.	EN ISO 7500-1	2004
ISO 18454	2001	Footwear - Standard atmospheres for conditioning and testing of footwear and components for footwear	EN 12222	1997

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[1] EN ISO 2589, *Leather - Physical and mechanical tests - Determination of thickness (ISO 2589:2002)*.

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