BRITISH STANDARD

BS EN ISO 20344:2004

Incorporating corrigendum no. 1 and amendment no. 1

Personal protective equipment — Test methods for footwear

The European Standard EN ISO 20344:2004, incorporating amendment A1:2007, has the status of a British Standard

ICS 13.340.50

BSI British Standards

National foreword

This British Standard is the UK implementation of EN ISO 20344:2004, incorporating corrigendum December 2005 and amendment A1:2007. It is identical with ISO 20344:2004, incorporating amendment 1:2007. It supersedes BS EN 344-1:1993 and BS EN 344-2:1997 which are withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags 〚A1〉 〈A1〛. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by 〚A1〉 〈A1〛.

The UK participation in its preparation was entrusted to Technical Committee PH/1, Safety, protective and occupational footwear.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Amendments issued since publication

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16165 Corrigendum No. 1	31 August 2006	Changes to page 6, clause **2**, page 63, **6.14** and page 68, **8.2**.
17444	31 October 2007	See national foreword

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English version

Personal protective equipment - Test methods for footwear (ISO 20344:2004)

Equipement de protection individuelle - Méthodes d'essai pour les chaussures (ISO 20344:2004)

Persönliche Schutzausrüstung - Prüfverfahren für Schuhe (ISO 20344:2004)

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Foreword

This document (EN ISO 20344:2004) has been prepared by CEN /TC 161, "Foot and leg protectors", the secretariat of which is held by BSI in collaboration with ISO/TC 94 "Personal safety - Protective clothing and equipment".

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of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by August 2005.

This document supersedes EN 344:1992 and EN 344-2:1996.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

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

Foreword to amendment A1

This document (EN ISO 20344:2004/A1:2007) has been prepared by Technical Committee CEN/TC 161 "Foot and leg protectors", the secretariat of which is held by BSI, in collaboration with Technical Committee ISO/TC 94 "Personal safety - Protective clothing and equipment".

This Amendment to the European Standard EN ISO 20344:2004 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2008, and conflicting national standards shall be withdrawn at the latest by March 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

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1. Scope

This Standard specifies methods for testing footwear designed as personal protective equipment.

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 388:2003, Protective gloves against mechanical risks

EN 12568:1998, Foot and leg protectors — Requirements and test methods for toecaps and metal penetration resistant inserts

EN 50321:1999, Electrically insulating footwear for working on low voltage installations

EN ISO 868, Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003)

EN ISO 3696, Water for analytical laboratory use – Specification and test methods (ISO 3696:1987)

EN ISO 3376:2002, Leather — Physical and mechanical tests - Determination of tensile strength and percentage extension (ISO 3376:2002)

EN ISO 4044, Leather — Preparation of chemical test samples (ISO 4044:1977)

EN ISO 4045, Leather — determination of pH (ISO 4045:1977)

EN ISO 4674-1:2003, Rubber- or plastics-coated fabrics - Determination of tear resistance - Part 1: Constant rate of tear methods (ISO 4674-1:2003)

EN ISO 17249:2004, Safety footwear with resistance to chain saw cutting (ISO 17249: 2004)

EN ISO 20345, Personal protective equipment - Safety footwear (ISO 20345:2004)

EN ISO 20346, Personal protective equipment - Protective footwear (ISO 20346:2004)

EN ISO 20347, Personal protective equimpent - Occupational footwear (ISO 20347:2004)

ISO 34-1:2004, Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1 : Trouser, angle and crescent test pieces

ISO 1817:1999, Rubber, vulcanised — Determination of the effect of liquids

ISO 2023:1994, Rubber footwear - Lined industrial vulcanized rubber boots - Specification

ISO 3290, Rolling bearings — Balls — Dimensions and tolerances

ISO 3377-2, Leather — Physical and mechanical tests — Determination of tear load — Part 2: Double edge tear

ISO 4643:1992, Moulded plastic footwear — Lined or unlined poly(vinyl chloride) boots for general industrial use — Specification

ISO 4648:1991, Rubber, vulcanized or thermoplastic — Determination of dimensions of test pieces and products for test purposes

ISO 4649:2002, Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device

ISO 5423:1992, Moulded plastic footwear — Lined or unlined polyurethane boots for general industrial use — Specification

[A1] ISO 13287:2006, Personal protective equipment — Footwear — Test method for slip resistance [A1]

3. Terms and definitions

For the purposes of this standard, the terms and definitions given in EN ISO 20345, EN ISO 20346 and EN ISO 20347 shall apply.

4. Sampling and conditioning

The minimum numbers of samples to be tested in order to check compliance with the requirements specified in EN ISO 20345, EN ISO 20346, EN ISO 20347 and any specific job related footwear standards (e.g. EN ISO 17249 footwear with resistance to chain saw cutting), together with the minimum number of test pieces taken from each sample, shall be in accordance with Table 1.

Table 1 — Minimum number of samples and test specimens or test pieces and their origin

	Property under test **B : basic requirement** **A : additional requirement**		**Clause reference**	**Number of samples**	**Number of test pieces from each sample**	**Test only on the final footwear**
5. Whole footwear	Specific ergonomic features	B	5.1	3 pairs from 3 different sizes	1 pair	yes
	Upper/outsole and sole interlayer bond strength	B	5.2	1 from each of 3 sizes	1	yes
	Internal toecap length	B	5.3	1 pair from each of 3 sizes	1 pair	yes
	Impact resistance	B	5.4	1 pair from each of 3 sizes	1 pair	yes
	Compression resistance	B	5.5	1 pair from each of 3 sizes	1 pair	yes
	Corrosion resistance of metallic toecaps or penetration-resistant metallic inserts	B	5.6	2 from different sizes	1	No for classification I Yes for classification II
	Leakproofness	B	5.7	2 from different sizes	1	yes
	Dimensional conformity and penetration resistance of inserts	A	5.8	1 pair from each of 3 sizes	1 pair	yes
	Flex resistance of penetration-resistant insert	A	5.9	1 pair from each of 3 sizes	1 pair	no
	Electrical resistance	A	5.10	1 pair from each of 3 sizes	1 pair	yes
	Electrical insulation	A	5.11	1 pair from each of 3 sizes	1 pair	yes
	Insulation against heat	A	5.12	2 from different sizes	1	yes
	Insulation against cold	A	5.13	2 from different sizes	1	yes
	Energy absorption of seat region	A	5.14	1 pair from each of 3 sizes	1 pair	yes
	Water resistance	A	5.15	3 pairs (minimum 2 different sizes)	1 pair	yes
	Impact resistance metatarsal protective device	A	5.16	1 pair from each of 3 sizes	1 pair	yes
	Ankle protection	A	5.17	1 pair from each of 3 sizes	1 pair	yes

Table 1 (continued)— Minimum number of samples and test specimens or test pieces and their origin

	Property under test B : basic requirement		Clause reference	Number of samples	Number of test pieces from each sample	Test only on the final footwear
6. Upper Lining And Tongue	Thickness	B	6.1	1 from each of 3 sizes	3	yes
	Height of the upper	B	6.2	1 from each of 3 sizes	3	yes
	Tear strength	B	6.3	1 from each of 3 sizes	3	yes
	Tensile properties	B	6.4	1 from each of 3 sizes	3	yes
	Flexing resistance	B	6.5	1 from each of 3 sizes	1	yes
	Water vapour permeability	B	6.6	1 from each of 3 sizes	1	yes
	Water vapour absorption	B	6.7	1 from each of 3 sizes	1	yes
	Water vapour coefficient	B	6.8	1 from each of 3 sizes	1	yes
	pH value	B	6.9	1	2	no
	Hydrolysis	B	6.10	1 from each of 3 sizes	1	yes
	Chromium VI content	B	6.11	1	2	no
	Abrasion resistance of lining	B	6.12	3	4	no
	Water penetration and water absorption	A	6.13	3	1	no
	Cut resistance	A	6.14	3	4	yes
7. Insole and Insock	Thickness of insole	B	7.1	3 [a]	1	no
	pH value	B	6.9	1	2	no
	Water absorption and desorption	B	7.2	3 [a]	1	no
	Abrasion resistance of insole	B	7.3	3 [a]	1	no
	Chromium VI content	B	6.11	1	2	no
	Abrasion resistance of insock	B	6.12	3	4	no
8. Outsole	Thickness	B	8.1	1 from each of 3 sizes	1	yes
	Tear strength	B	8.2	1 from each of 3 sizes	1	yes
	Abrasion resistance	B	8.3	1 from each of 3 sizes	1	yes
	Flexing resistance	B	8.4	1 from each of 3 sizes	1	yes
	Hydrolysis	B	8.5	1 from each of 3 sizes	1	yes
	Resistance to fuel oil	B	8.6	1 from each of 3 sizes	1	yes
	Resistance to hot contact	A	8.7	1 from each of 3 sizes	1	yes

[a] if the samples are taken from the footwear use 3 different sizes

Wherever possible and necessary to ensure the essential safety requirements, test pieces shall be taken from the whole footwear. This paragraph is applicable for all the table 1.

NOTE If it is not possible to obtain a large enough test piece from the footwear, then a sample of the material from which the component has been manufactured may be used instead and this should be noted in the test report.

Where samples are required from each of three sizes, these shall comprise the largest, the smallest and a middle size of the footwear under test.

All test pieces shall be conditioned in a standard atmosphere of (23°± 2) °C and (50 ± 5)% r.h. for a minimum of 48 h before testing, unless otherwise stated in the test method.

The maximum time which shall elapse between removal from the conditioning atmosphere and the start of testing shall not be greater than 10 min, unless otherwise stated in the test method.

Each individual test piece shall satisfy the specified requirement, unless otherwise stated in the test method.

The uncertainty of measurement for each test method described in the present standard shall be assessed. One of the two following approaches shall be used:

— a statistical method, e.g. that given in ISO 5725-2;

— a mathematical method, e.g. that given in ENV 13005.

5. Test methods for whole footwear

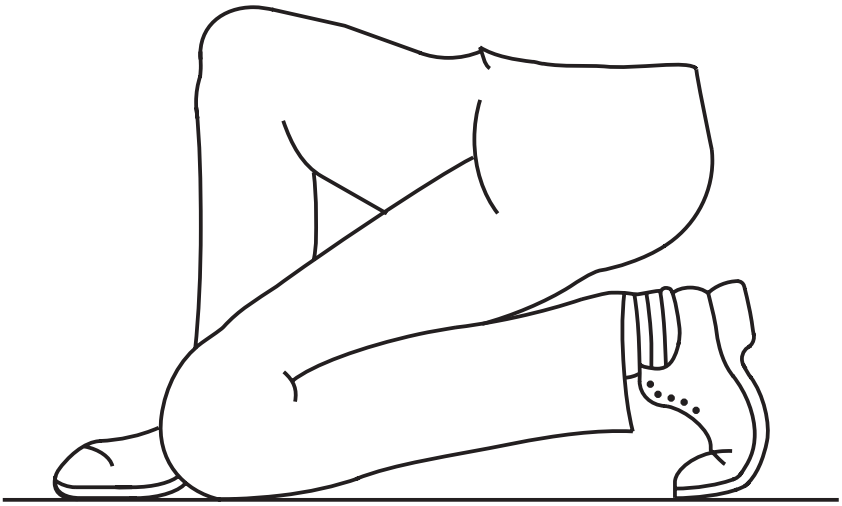
5.1 Specific ergonomic features

The specific ergonomic features of the footwear shall be assessed by examining the footwear using wear trials on 3 wearers with appropriate foot sizes.

During the trials the wearers wearing each pair of the correctly fitting footwear will simulate typical tasks likely to be undertaken in general use.

These tasks are :

- walk normally for 5 min at a speed of approx. 6 km/h.
- climb and descend (17 ± 3) stairs for 1 min
- kneel / crouch down, see figure 1



Note : This degree of shoe flexion will not be achieved for all types of footwear (for example footwear with a steel midsole)

Figure 1 - Position to adopt during the kneel / crouch down test

After having completed all tasks, each wearer shall fill in the questionnaire given in table 2.

Table 2 : Questionnaire for the assessment of ergonomic features

1.	Is the inside surface of the footwear free from rough, sharp or hard areas that caused you irritation or injury?	YES	NO
2	Are there no pinch points caused by the toecap or the edge covering of the toecap ?	YES	NO
3.	Is the footwear free of features that you consider to make wearing the footwear hazardous ?	YES	NO
4.	Can the fastening be adequately adjusted ? (if necessary)	YES	NO
5.	Can the following activities be performed without problems :		
	walking	YES	NO
	Climbing stairs	YES	NO
	Kneeling / crouching down	YES	NO

5.2 Determination of upper/outsole and sole interlayer bond strength

5.2.1 Principle

The force required to separate the upper from the outsole or to separate adjacent layers of the outsole or to cause tear failure of the upper or the sole is measured.

NOTE In all cases the objective should be to test the bond strength nearest to the edge of the assembly. The test need not be carried out when the bond has been made by grindery (using, for example, nails or screws) or stitching.

5.2.2 Apparatus

Tensile machine, with a means of continuously recording load, with a jaw separation rate of (100 ± 20) mm/min and a force range of 0 N to 600 N. The machine shall be fitted with either pincers or flat jaws (depending on the construction of the test sample see 5.2.4), (27,5 ± 2,5) mm wide, capable of firmly gripping the test pieces.

5.2.3 Preparation of test pieces

5.2.3.1 Sole/upper bond strength: construction type a (see figure 2)

Take a test piece from either the inner or the outer joint region.

Make cuts at X-X and Y-Y at right angles to the edge of the sole, insole or outsole to produce a test piece about 25 mm wide. The length of the upper and sole shall be about 15 mm measured from the feather line (see figure 3). Remove the insole.

5.2.3.2 Sole/upper bond strength: construction types b, c, d and e (see figure 2)

Take a test piece from either the inner or outer joint region.

Cut the upper and sole at X-X and Y-Y to produce a test piece with a width of about 10 mm and a length of not less than 50 mm. Remove the insole.

Separate the upper from the sole for a length of about 10 mm by inserting a hot knife in the adhesive layer (see figure 4).

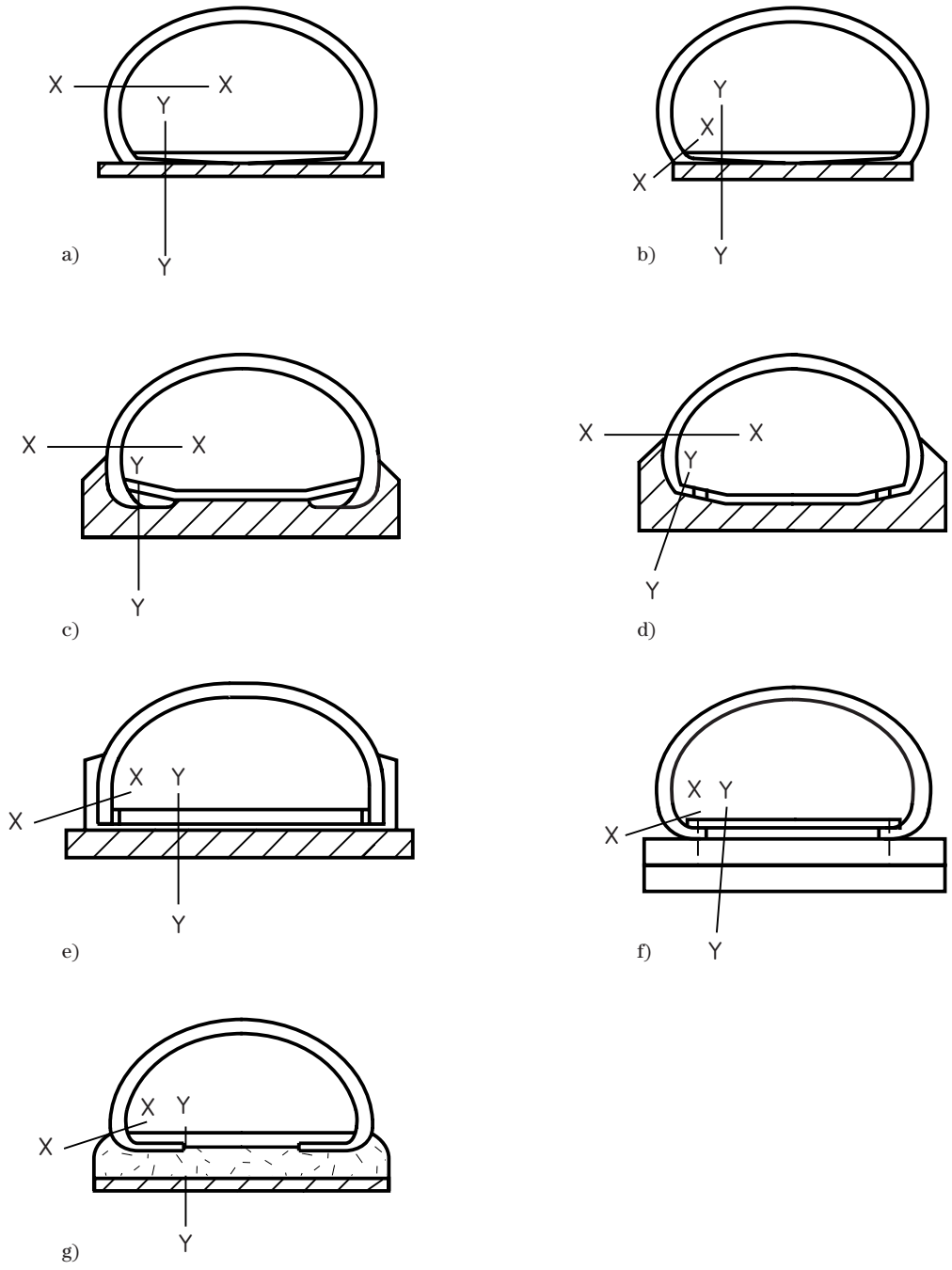
NOTE It is considered that a construction is c or d when the distance from X-X to the upper face of the insole is at least 8 mm.

5.2.3.3 Interlayer bond strength: construction types f and g (see figure 2)

Take a test piece from either the inner or the outer joint region.

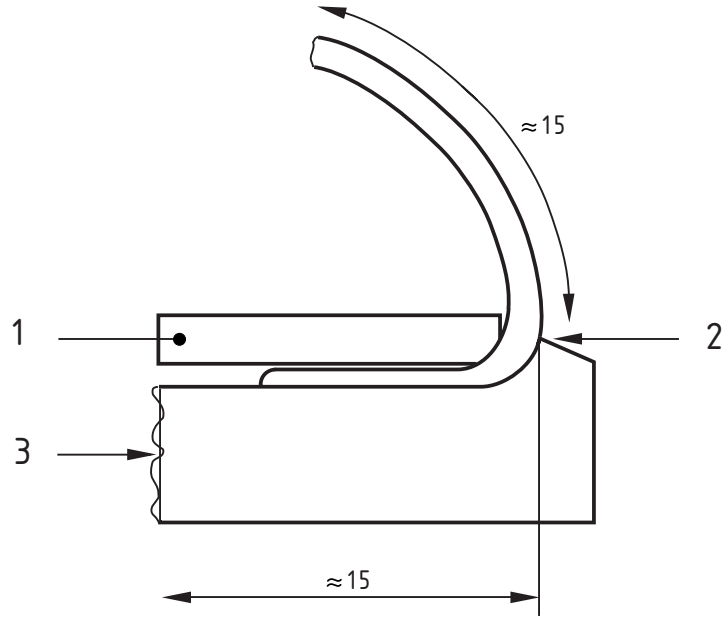
Remove the upper by cutting along the feather line at X-X. Remove the insole if present. Cut a strip parallel to and including the sole edge at Y-Y to produce a test piece about 15 mm wide and at least 50 mm long.

Separate the sole layers for a length of about 10 mm by inserting a hot knife into the adhesive layer (see figure 4).



Type a: Conventional lasting, Cemented or moulded outsole having an extended range
Type b: Conventional lasting, Close trimmed outsole
Type c: Conventional lasting, Direct injected or vulcanised outsole or cemented dished outsole
Type d: Strobel stitched, Cemented dished outsole or direct injected or vulcanised outsole
Type e: Conventional lasting or Strobel stitched with rubber mudguard and cemented outsole
Type f: Machine sewn or welted where the outsole is bonded to the throughsole
Type g: Multilayered sole, e.g. moulded-on sole, a moulded unit or a built unit

Figure 2 — Types of construction showing position for preparation of the test piece for bond strength



1 Insole (removed) Dimensions are in mm
2 Feather line
3 Outsole

Figure 3 - Cross section of test piece

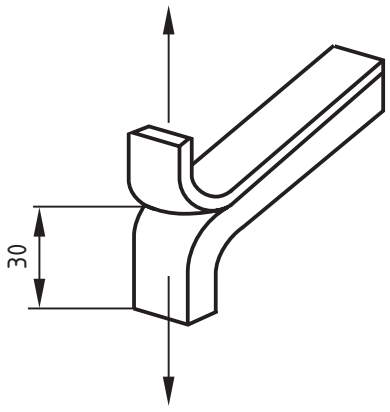


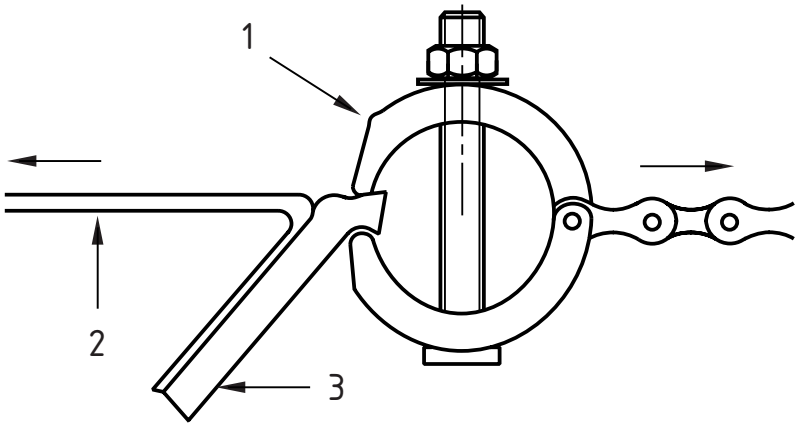
Figure 4 - Prepared test piece

5.2.4 Measurement of bond strength

Before carrying out the test, measure the width of the test piece to the nearest mm at several points using a calibrated steel rule and calculate the average value to the nearest mm. Then measure the bond strength on a minimum length of 30 mm in one of the following ways:

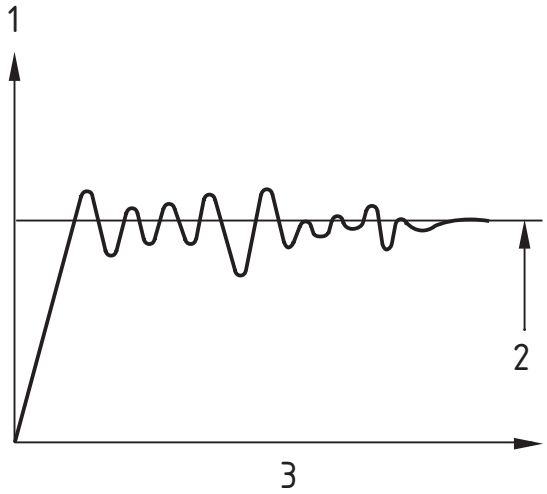
a) *For sole/upper bond strength: Construction type a.* Clamp the test piece into the jaws of the tensile machine, using a pincer jaw to grip the short edge of the sole (see figure 5), and record the load/deformation graph (see figure 6) at a separation speed of (100 ± 20) mm/min.

b) *For sole/upper bond strength: Construction types b, c, d and e and sole interlayer bond strength: construction types f and g:* Clamp the separated ends of the test piece in the flat jaws and record the load/deformation graph (see figure 6) at a jaw separation speed of (100 ± 20) mm/min.



1 Pincer jaw for sole edge
2 Upper
3 Sole

Figure 5 — Pincer jaw showing position of test piece



1 Peeling force in Newtons
2 Average
3 Deformation

Figure 6 — Example of load/deformation graph

5.2.5 Calculation and expression of results

Determine, from the load/deformation graph, the average peeling load in Newtons and divide by the average width (calculated in 5.2.4) to give the bond strength in N/mm.

5.3 Determination of internal toecap length

5.3.1 Preparation of test piece

Carefully extract the toecaps from an untested pair of footwear and remove all foreign materials adhering to them, or take a new pair of identical toecaps.

NOTE Preconditioning of the test piece is unnecessary.

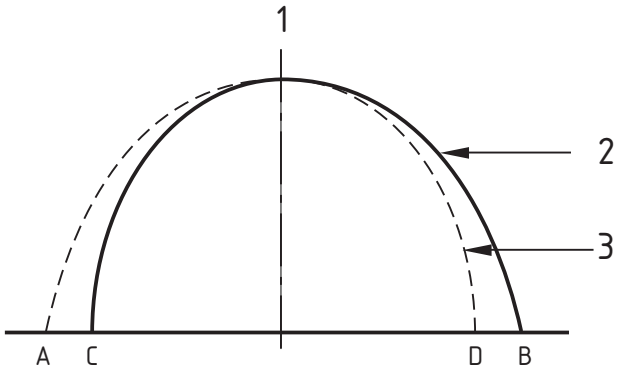
5.3.2 Determination of the test axis

Position the left toecap with its rear edge in line with a base line and draw its outline. Repeat the exercise with the right toecap of the pair. Position the outlines in such a manner that the outlines at both the toe end of the toecaps and the base lines coincide (see figure 7).

Mark the four points A, B, C and D where the outlines of the left and right toecaps intersect on the base line. Erect the perpendicular from the base line at the mid point of A-B or C-D. This constitutes the test axis of the toecap.

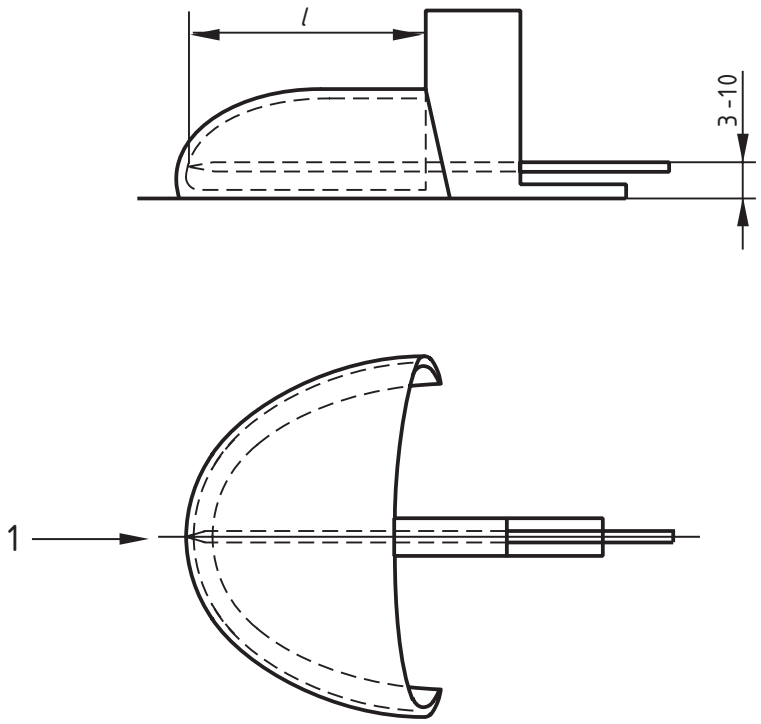
5.3.3 Test procedure

Place the toecap, open side down, on a flat surface. Using an appropriate gauge, measure the internal length, *l*, along the test axis from the toe to the back edge at a distance between 3 mm and 10 mm above and parallel to the surface upon which the toecap rests (see figure 8). *l* is the maximum length which can be measured.



1 Test axis
2 Right cap
3 Left cap

Figure 7 — Determination of test axis



1 Test axis
l = internal length

Dimensions are in mm

Figure 8 — Measurement of internal toecap length

5.4 Determination of impact resistance

5.4.1 Apparatus

5.4.1.1 **Impact apparatus**, incorporating a steel striker of mass 20 kg ± 0,2 kg adapted to fall freely on vertical guides from a predetermined height to give the required impact energy. Provision should be made for a mechanism to catch the striker after the first impact so that the test specimen is struck only once.

The striker (see figure 9) shall consist of a wedge at least 60 mm long, the faces of which subtend an angle of (90 ± 1)°. The apex where the faces meet shall be rounded to a (3 ± 0,1) mm radius. During the test the apex shall be parallel within ± 17’ to the surface of the clamping device.

The base of the apparatus shall have a mass of at least 600 kg and a metal block of dimensions of at least 400 mm x 400 mm x 40 mm deep shall be bolted to it.

The apparatus shall be free standing on a flat and level floor which is sufficiently massive and rigid to support the test equipment.

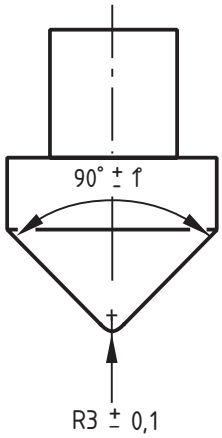


Figure 9 — Impact striker

5.4.1.2 Clamping device, consisting of a smooth steel plate at least 19 mm thick and 150 mm x 150 mm, of minimum hardness 60 HRC with a screw clamp for clamping the forepart of the insole/insock of the toe-end of the footwear under test to the plate in a way which will not restrict lateral expansion of the toecap during the impact test (see figure 10). The stabilizing fork, which is to be introduced into the front part of the footwear, shall be adjusted by means of the adjusting screw to rest on the insole, parallel to the base plate. The clamping screw (M8 thread) shall be tightened by applying a torque of (3 ± 1) Nm.

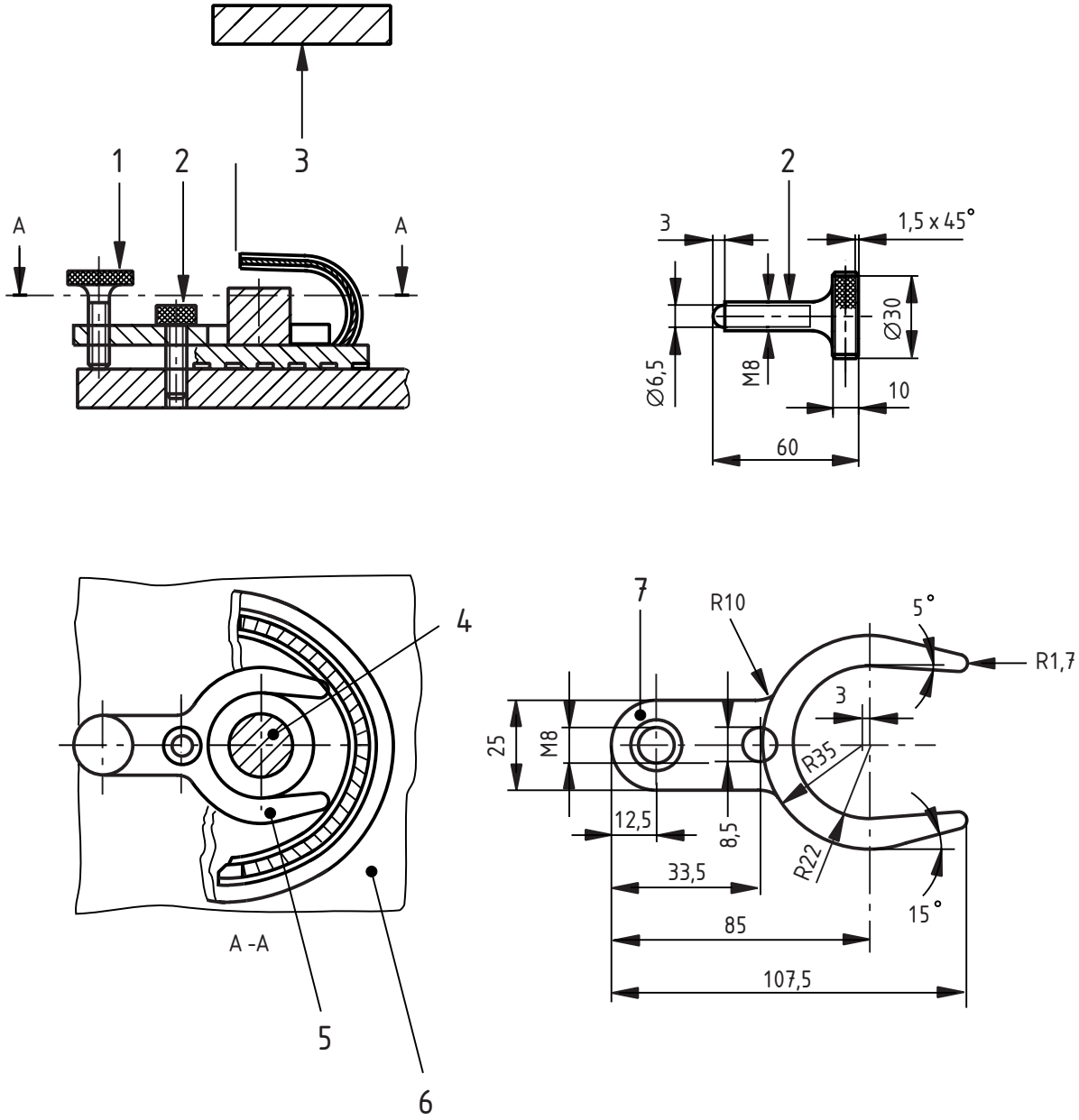
5.4.1.3 Cylinders, of modelling clay of diameter (25 ± 2) mm and of height (20 ± 2) mm for footwear up to and including size 40 (French) and of height (25 ± 2) mm for footwear above size 40. The flat ends of the cylinder shall be covered with aluminium foil to prevent them sticking to either the test specimen or the test equipment.

5.4.1.4 Dial gauge, with a hemispherical foot of (3,0 ± 0,2) mm radius and a hemispherical anvil of (15 ± 2) mm radius exerting a force of not greater than 250 mN.

5.4.2 Procedure

5.4.2.1 Determination of the test axis (see figure 11)

Locate the testing axis by placing the footwear on a horizontal surface and against a vertical plane so that it touches the edge of the sole at points A and B on the inner side of the footwear. Construct two further vertical planes at right angles to the first vertical plane so that they meet the sole at points X and Y, the toe point and heel point respectively. Draw a line through X and Y. This constitutes the test axis for the forepart of the footwear.



1 Clamping screw
2 Adjusting screw
3 Striker
4 Modelling clay cylinder
5 Stabilizing fork
6 Baseplate
7 Thickness = 10 mm
Dimensions are in mm

NOTE The dimensions given in this figure are illustrative only. Smaller stabilizing forks of the same proportions may be used for smaller toecaps.

Figure 10 — Example of footwear clamp

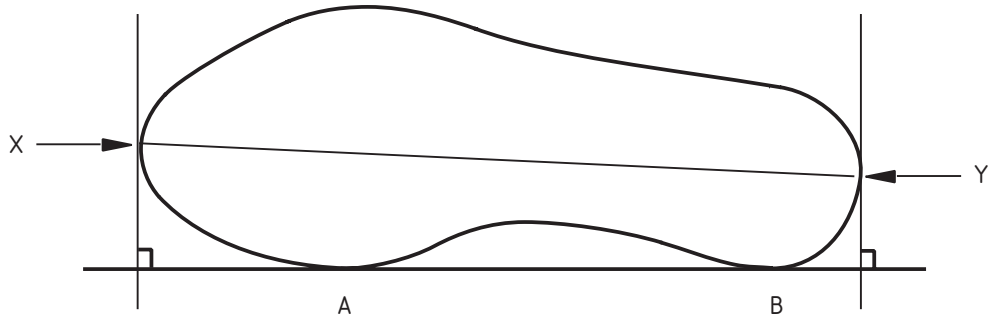


Figure 11 — Test axis for footwear

5.4.2.2 Preparation of test piece

Prepare the forepart of the footwear by cutting off the toe end 30 mm behind the rear edge of the toecap. Then remove the complete upper assembly flush with the rear edge of the toecap. Do not remove the upper and lining in the toecap area. If the footwear has been supplied with a removable insock, carry out the test with it in place.

NOTE Preconditioning of the test piece is unnecessary.

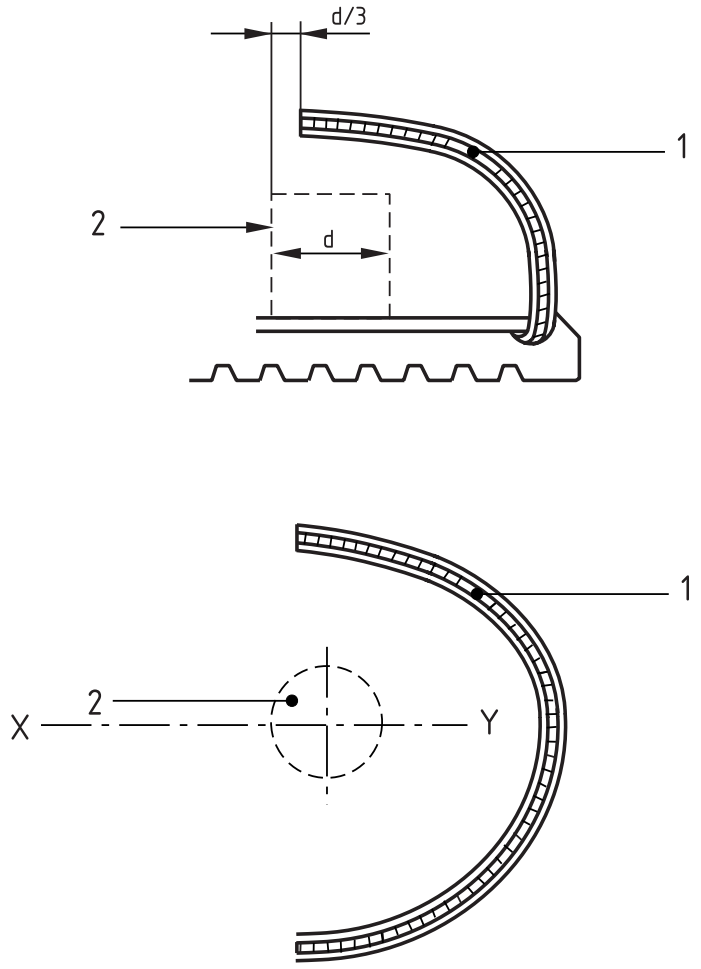
5.4.2.3 Test procedure

Position a cylinder (5.4.1.3) on one of its ends inside the test piece as shown in figure 12.

Position the test piece in the impact apparatus (5.4.1.1) so that when the striker hits it, the striker shall project over the back and the front of the toecap. Adjust the clamping device (5.4.1.2).

Allow the striker to drop on to the test axis from the appropriate height to give an impact energy of (200 ± 4) J for safety footwear or (100 ± 2) J for protective footwear.

With the measuring device (5.4.1.4) measure the lowest height to which the cylinder has been compressed to the nearest 0,5 mm. This value is the clearance at the moment of impact.



1 Toe cap
2 Modelling clay cylinder
Test axis X Y

Figure 12 — Position of cylinder for impact or compression test of footwear

5.5 Determination of compression resistance

5.5.1 Apparatus

5.5.1.1 **Compression testing machine**, capable of subjecting the test piece to a force of at least 20 kN (to a tolerance of ± 1 %) between platens which move at a speed of (5 ± 2) mm/min. The platens shall remain parallel during the application of the load and shall have a minimum hardness of 60 HRC. The measurement of the force shall not be affected by eccentrically applied forces.

5.5.1.2 **Cylinders**, as described in 5.4.1.3.

5.5.1.3 **Dial gauge**, as described in 5.4.1.4.

5.5.1.4 **Clamping device**, as described in 5.4.1.2.

5.5.2 Procedure

5.5.2.1 Determination of the test axis

Determine the test axis as described in 5.4.2.1.

5.5.2.2 Preparation of test piece

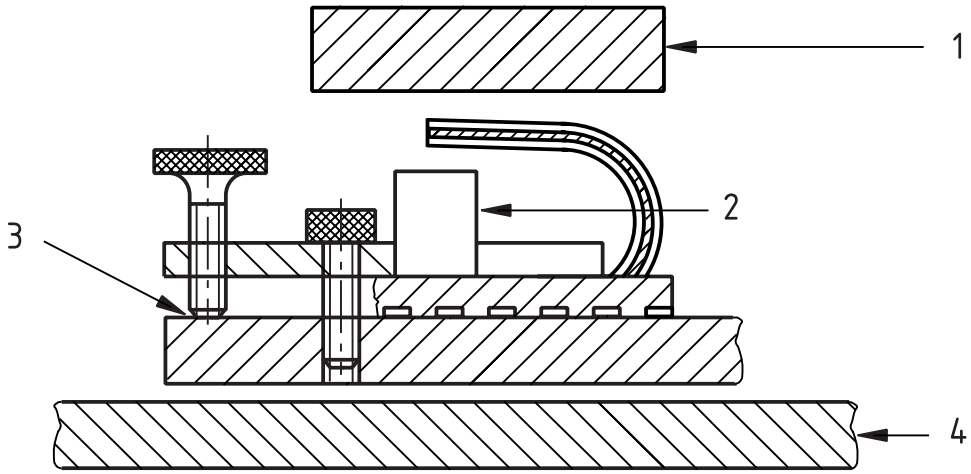
Prepare the test piece as described in 5.4.2.2.

NOTE Preconditioning of the test piece is unnecessary.

5.5.3 Test procedure

Position a cylinder (5.5.1.2) on one of its ends inside the test piece as shown in figure 12. Place the test piece in the clamping device (5.5.1.4) and adjust.

Position the clamping device and test piece between the platens of the compression machine (5.5.1.1) and compress the specimen with a load of either $(15 \pm 0{,}1)$ kN for safety footwear or $(10 \pm 0{,}1)$ kN for protective footwear (see figure 13).



1 Upper platen
2 Modelling clay cylinder
3 Clamping device
4 Lower platen

Figure 13 — Apparatus for compression test

Reduce the load, remove the cylinder and with the measuring device (5.5.1.3) measure the lowest height to which the cylinder has been compressed to the nearest 0,5 mm. This value is the compression clearance.

5.6 Determination of corrosion resistance

5.6.1 Determination of corrosion resistance of metallic toecaps or penetration-resistant metallic inserts in classification II footwear

5.6.1.1 Preparation of test piece

Use the complete item of footwear as the test piece.

NOTE Preconditioning of the test piece is unnecessary.

5.6.1.2 Test solution

Use a mass fraction of 1% aqueous solution of sodium chloride.

5.6.1.3 Procedure

Pour sufficient test solution into a test piece to fill it up to a depth of 150 mm. Cover the top of the footwear with, for example, a polyethylene cover, to minimise evaporation.

Allow to stand for 7 days and then discard the test solution.

Remove the toecap or insert from the footwear and examine for any evidence of corrosion. When present, measure the size of each area of corrosion in mm^2 and record also the number of such areas.

5.6.2 Determination of corrosion resistance of metallic toecaps in classification I footwear

Remove the toecap from the footwear or take a new identical toecap and test in accordance with the method described in EN 12568:1998 (4.2).

5.6.3 Determination of the corrosion resistance of penetration-resistant metallic inserts in footwear other than all-rubber footwear

Remove the insert from the footwear or take a new identical insert and test in accordance with the method described in EN 12568:1998 (5.1).

5.7 Determination of leakproofness

5.7.1 Apparatus

5.7.1.1 Waterbath.

5.7.1.2 Supply of compressed air.

5.7.2 Preparation of test piece

Take the entire item of footwear as the test piece.

5.7.3 Procedure

Carry out the test at a temperature of (23 ± 2)°C.

Seal the top edge of the test piece, e.g. with a rubber collar through which compressed air may be fed via appropriate connections. Immerse the test specimen in a waterbath up to the edge and apply a constant internal pressure of (10 ± 1) kPa for 30 s. Observe the test piece throughout the test and determine whether there is a continued formation of air bubbles, indicating leakage of air.

5.8 Determination of the dimensional conformity of inserts and the penetration resistance of the sole

5.8.1 Dimensional conformity of inserts

Measure *L*, the length of the inside of the bottom of the footwear. Draw as in figure 14 the shaded areas N°1 and N°2.

Section the footwear and measure the distances X and Y (see figure 14) being the distances between the edge of the insert and the line left by the feather edge of the last, to the nearest 0,5 mm, using, for example, a ruler.

1 Line left by feather edge of the last
2 Alternative shapes of insert
3 Insert
4 Heel region
5 Shaded area 1
6 Shaded area 2
L Length of the inside of the bottom of the footwear

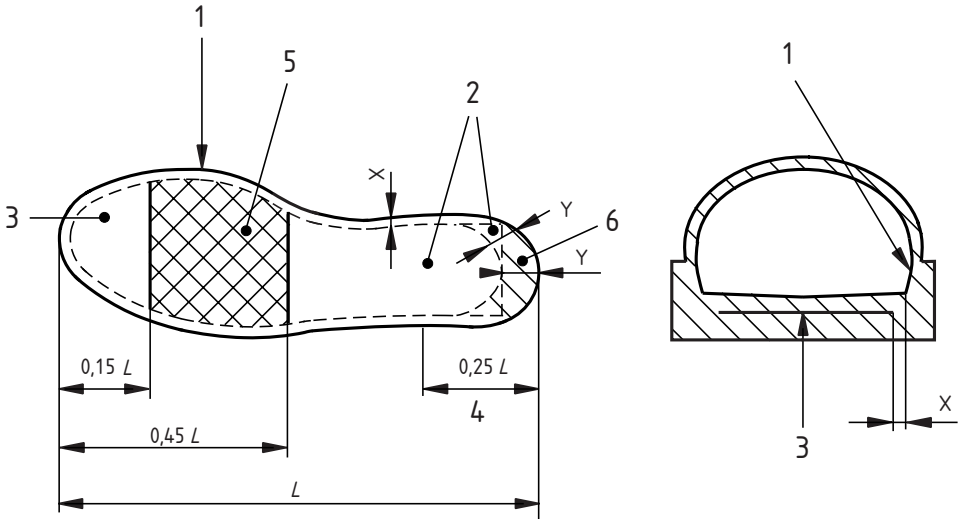


Figure 14 — Determination of dimensions for the insert

5.8.2 Determination of the penetration resistance of the sole

5.8.2.1 Apparatus

5.8.2.1.1 Test equipment, capable of measuring a compressive force up to at least 2 000 N, fitted with a pressure plate, in which a test nail (5.8.2.1.2) is fixed, and a parallel base plate with a circular opening of diameter 25 mm. The axes of this opening and the test nail shall be coincident (see figure 15).

5.8.2.1.2 Test nail, of diameter (4,50 ± 0,05) mm with a truncated end of the form and dimensions shown in figure 16. The point of the nail shall have a minimum hardness of 60 HRC.

The form of the test nail shall be examined at intervals and if deviations from the dimensions shown in figure 16 are observed the test nail shall be replaced.

5.8.2.2 Preparation of test piece

Remove the upper from the bottom of the footwear and use the bottom as the test piece.

For absorbent soling material (e.g. leather) carry out the tests after the sole unit has been immersed in deionised water at (23 ± 2)°C for (16 ± 1) h.

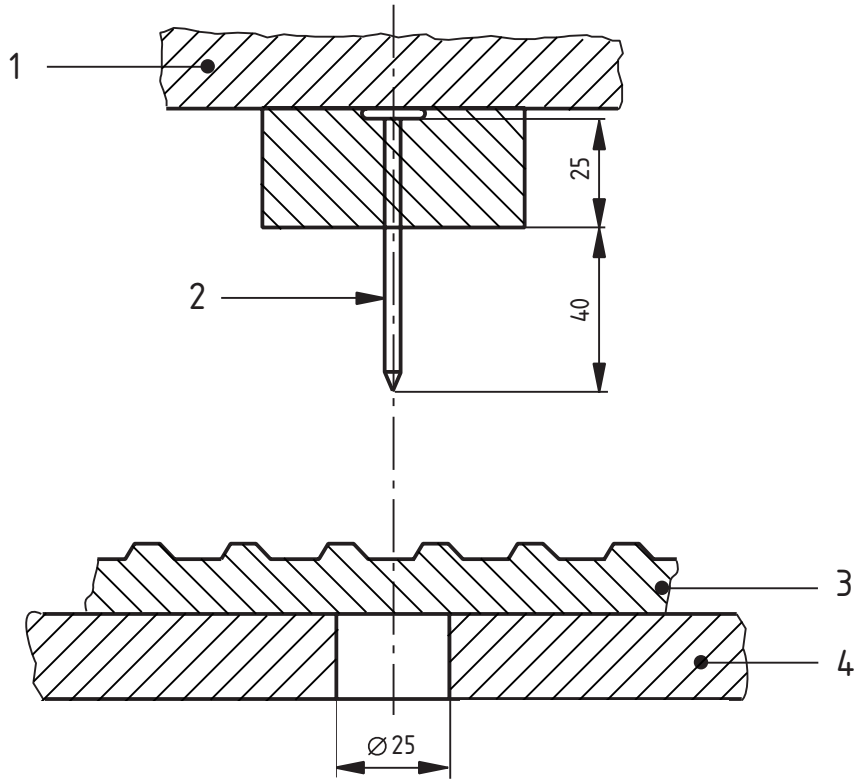
NOTE Preconditioning of non-absorbent test piece is unnecessary.

5.8.2.3 Test procedure

Place the test piece on the base plate in such a way that the steel nail can penetrate it through the bottom. Press the nail against the sole unit at a speed of (10 ± 3) mm/min until the point has penetrated completely and measure the maximum force.

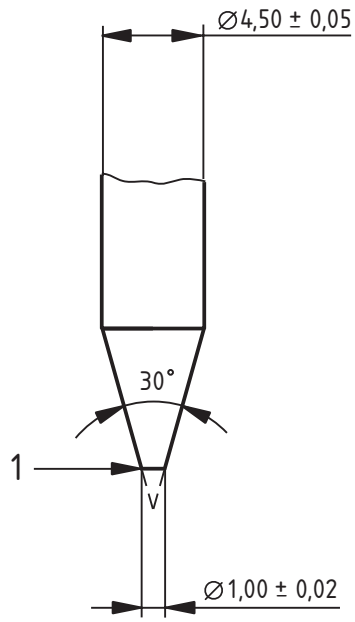
Carry out the test at four different points on the sole unit (at least one in the heel region) with a minimum distance of 30 mm between any two penetration points and a minimum distance of 10 mm from the edge of the insole. For cleated soles, carry out the test between cleats. Two of the four measurements shall be made at a distance of 10 mm to 15 mm from the line represented by the feather edge of the last.

Report the minimum value of the individual measurements as the test result.



1 Pressure plate
2 Nail
3 Sole unit of the test piece
4 Base plate
Dimensions in mm

Figure 15 — Apparatus for penetration resistance test



1 Truncated end
Dimensions in mm

Figure 16 — Nail for penetration resistance test

5.9 Determination of the flex resistance of penetration-resistant inserts

Determine the flex resistance of penetration-resistant inserts according to the method described in 7.2.2.3 of EN 12568:1998.

5.10 Determination of electrical resistance

5.10.1 Principle

The electrical resistance of conductive footwear is measured after conditioning in a dry atmosphere (5.10.3.3 a.). The electrical resistance of antistatic footwear is measured after conditioning in a dry atmosphere and after conditioning in a wet atmosphere (5.10.3.3 a. and b.).

5.10.2 Apparatus

5.10.2.1 Testing instrument, capable of measuring electrical resistance to an accuracy of ± 2,5% while applying a voltage of (100 ± 2) V DC.

5.10.2.2 Internal electrode, comprising stainless steel balls of 5 mm diameter and of total mass 4 kg. The steel balls shall conform to the requirements of ISO 3290. Steps should be taken to prevent or remove oxidation of the steel balls and the copper plate since oxidation could affect their conductivity.

5.10.2.3 External electrode, comprising a copper contact plate cleaned with ethanol before use.

5.10.2.4 Conductive lacquer.

5.10.2.5 Device for measuring the conductive resistance of the lacquer, consisting of three conductive metal probes, each (3 ± 0,2) mm radius, attached to a base plate. Two of the probes are (45 ± 2) mm apart and connected by a metal strap. The third probe is set at a distance of (180 ± 5) mm from the centre line joining the other two and is electrically insulated from them.

5.10.3 Preparation for conditioning of test piece

5.10.3.1 Preparation

If the footwear has been supplied with a removable insock, carry out the test with it in place. Clean the surface of the sole of the footwear with ethanol to eliminate all traces of mould silicone, wash with distilled water and allow to dry at (23 ± 2)°C. The surface shall not be buffed or abraded or cleaned with organic materials which attack or swell the sole.

5.10.3.2 Specific preparation for wet condition

For test pieces which are tested following conditioning under wet conditions (see 5.10.3.3), apply a conductive lacquer (5.10.2.4) to the sole over an area 200 mm by 50 mm, including the heel and the fore part. Allow to dry and then check that the resistance of the lacquer is less than 1×10^3 Ω.

Fill the footwear with clean steel balls and place on the metal probes of the device (5.10.2.5) such that the front area of the outsole is supported by the two probes spaced 45 mm apart and the heel area is supported by the third probe. Using the testing instrument (5.10.2.1), measure the resistance between the front probes and the third probe.

5.10.3.3 Conditioning

Condition the prepared test piece in one after the following atmospheres, according to the type of footwear being tested:

a) Dry conditions. (20 ± 2)°C and (30% ± 5)% r.h. (for 7 days)

b) Wet conditions. (20 ± 2)°C and(85% ± 5)% r.h. (for 7 days)

The test shall be performed within 5 min of the removal of the test piece from the conditioning atmosphere if the test is not carried out in that atmosphere.

5.10.4 Procedure

Fill the test piece with clean steel balls to a total mass of 4 kg using a piece of insulating material to extend the height of the upper if necessary. Place the filled specimen on the copper plate, apply a test voltage of (100 ± 2) V DC between the copper plate and the steel balls for 1 min and calculate the resistance.

The energy dissipation in the sole shall not be greater than 3 W.

Wherever necessary, reduce the voltage in order to respect the 3 W limit and record the voltage value in the test report.

5.11 Determination of the electrical insulation

Determine the electrical insulation according to the method described in EN 50321:1999 clause 6.3.

5.12 Determination of insulation against heat

5.12.1 Apparatus

5.12.1.1 Sandbath,

The size of the bath holding the sand shall be (40 ± 2) cm x (40 ± 2) cm with a height of at least 5 cm (see figure 17)

Volume of sand (5 000 ± 250) cm^3, granular size 0.3 mm to 1.0 mm

The temperature of the plate shall be measured where the footwear will contact the plate (forepart and heel) and shall be regulated according to the test temperature. Depending on the properties claimed by the tested footwear, the temperature of the hot plate T_{hp} can be either 150 °C or 250 °C (tolerance ± 5°C).

The power of the heating system should be at least (2 500 ± 250) W

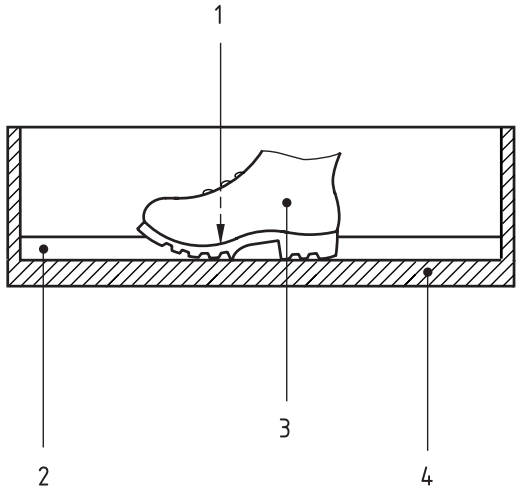
5.12.1.2 Heat transfer medium, comprising stainless steel balls 5 mm diameter and a total mass(4 000 ± 40) g. The stainless steel balls shall conform to the requirements of ISO 3290.

5.12.1.3 Temperature probe with an accuracy of ± 0,5°C, soldered to a copper disc (2 ± 0,1) mm thick and (15 ± 1)mm diameter.

5.12.1.4 Temperature measuring device, with a compensator, suitable for use with 5.12.1.3

5.12.2 Preparation of test piece

Use the complete item of footwear as the test piece. Fix the temperature probe to the insole. The temperature inside the footwear shall be measured in the forepart in an area directly above the area where the sole contacts the hot plate. Place the steel balls inside the footwear. If the footwear has been supplied with a removable insock, carry out the test with it in place. If the upper is not high enough to support the balls, increase its height with a collar.



1 Point for measuring temperature
2 Sand bath (height of sand 30 mm)
3 Footwear filled with stainless steel balls
4 Hotplate

Figure 17 — Heat insulation test apparatus

5.12.3 Test procedure

Condition the prepared test piece until the temperature of the insole is constant at (23 ± 2)°C and carry out the test under ambient conditions of (23 ± 2)°C.

Preheat the sandbath for 2 h minimum, and adjust the temperature of the hot plate to T_{hp}, maintain this temperature during the test. Place the test piece on it. Move the footwear forward and backward in order to get the best possible contact between the footwear and the hot plate.

Replace the sand around the footwear at the correct height. Then ensure that the surface of the sand is homogenously flat.

Use the temperature measuring device connected to the temperature probe to measure the temperature on the insole as a function of time, recording the temperature increase.

t_1 is the time when the final increase of temperature inside the footwear (θ in °C) is measured.

t_2 is the total duration of the test.

Calculate to the nearest 0,5°C, the increase in temperature (I_t in °C) after the test piece was placed on the hot plate for t_1.

$$I_t = \theta - 23$$

Continue the test until t_2. Immediately after heating over a period t_2 remove the sample and then the steel balls for inspection and note signs of serious damage, which affect the functionality of the footwear.

The results of the test are :

- the increase of temperature inside the footwear after t_1.
- report of damage which can seriously affect the functionality of the footwear (for example beginning of separation of upper and sole).

5.13 Determination of insulation against cold

5.13.1Apparatus

5.13.1.1 Insulated cold box, the internal air temperature of which can be regulated to (– 17 ± 2) °C (see figure 18).

5.13.1.2 Heat transfer medium, as described in 5.12.1.2.

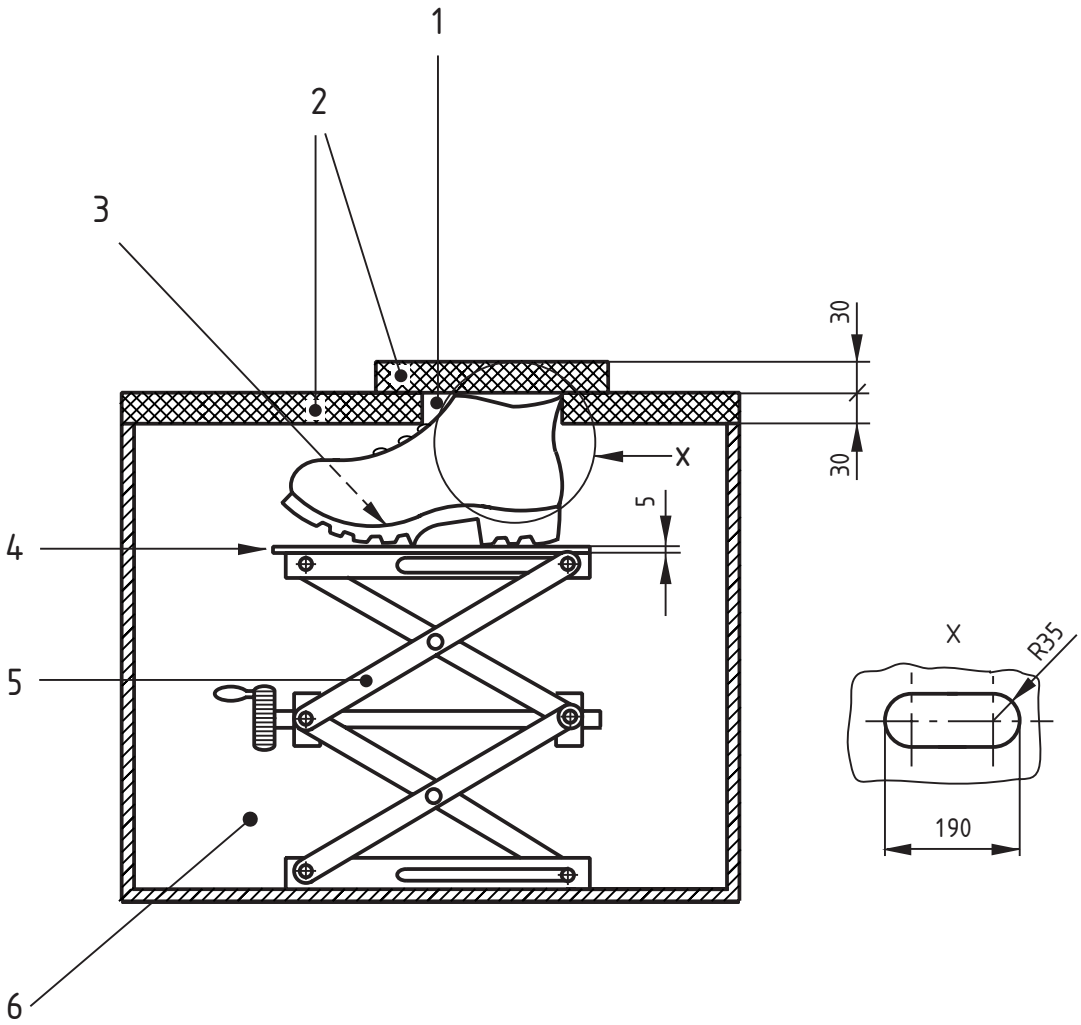
5.13.1.3 Temperature probe, as described in 5.12.1.3.

5.13.1.4 Temperature measuring device, as described in 5.12.1.4.

5.13.1.5 Copper plate, of length (350 ± 5) mm, width (150 ± 1) mm and thickness (5 ± 0,1) mm, positioned as illustrated in figure 18.

5.13.2 Preparation of test piece

Use the complete item of footwear as the test piece. Prepare the test piece as described in 5.12.2.



1 Elongated hole
2 Thermal insulating cover
3 Point for measuring temperature
4 Copper plate
5 Laboratory jack
6 Cold box

Figure 18 — Cold insulation test apparatus

5.13.3 Test procedure

Condition the prepared test piece until the temperature of the outsole is constant at (23 ± 2)°C.

Adjust the temperature of the cold box to (–17 ± 2) °C and maintain this temperature during the test. Place the test piece on the laboratory jack inside the cold box, adjusting the height so that the top line of the footwear is level with the opening and seal with a heat insulating cover.

Use the temperature measuring device connected to the temperature probe to measure the temperature on the insole as a function of time, recording the temperature decrease graphically.

Calculate, to the nearest 0,5°C, the decrease in temperature 30 min after the test piece was placed in the cold box.

5.14 Determination of energy absorption of seat region

5.14.1 Apparatus

5.14.1.1 Test equipment, capable of measuring compressive force up to 6 000 N, with a means of recording loading/deformation characteristics.

5.14.1.2 Test punch, being the back part of a standardised last made in polyethylene[1)]. The last shall be sectioned on a plane vertical to the feather edge and at 90° to the axis of the back part (see figure 19). The dimension of the punch in relation to footwear shall be in accordance with table 3.

Table 3: Dimensions of the test punch depending on sizes

Sizes			**Dimensions**			
Mondopoint	**French**	**English**	**L** ± **2 mm**	**l** ± **2 mm**	**W** ± **2 mm**	**e** ± **1 mm**
235	Up to 36	Up to 3 ½	65 mm	32,5 mm	52,25 mm	2 mm
245	37 / 38	4 to 5	67,5 m	33,7 mm	57 mm	2 mm
255	39 / 40	5 ½ to 6 ½	70,5 mm	35 mm	58,75 mm	2 mm
265	41 / 42	7 to 8	72,5 mm	36,2 mm	60,5 mm	3 mm
275	43 / 44	8 ½ to 10	75,5 mm	37,7 mm	62,25 mm	3 mm
285	45 and above	10 ½ and above	77,5 mm	38,5 mm	64 mm	3 mm

1) Information on availability of suitable punches may be obtained from the Secretariat of CEN/TC 161.

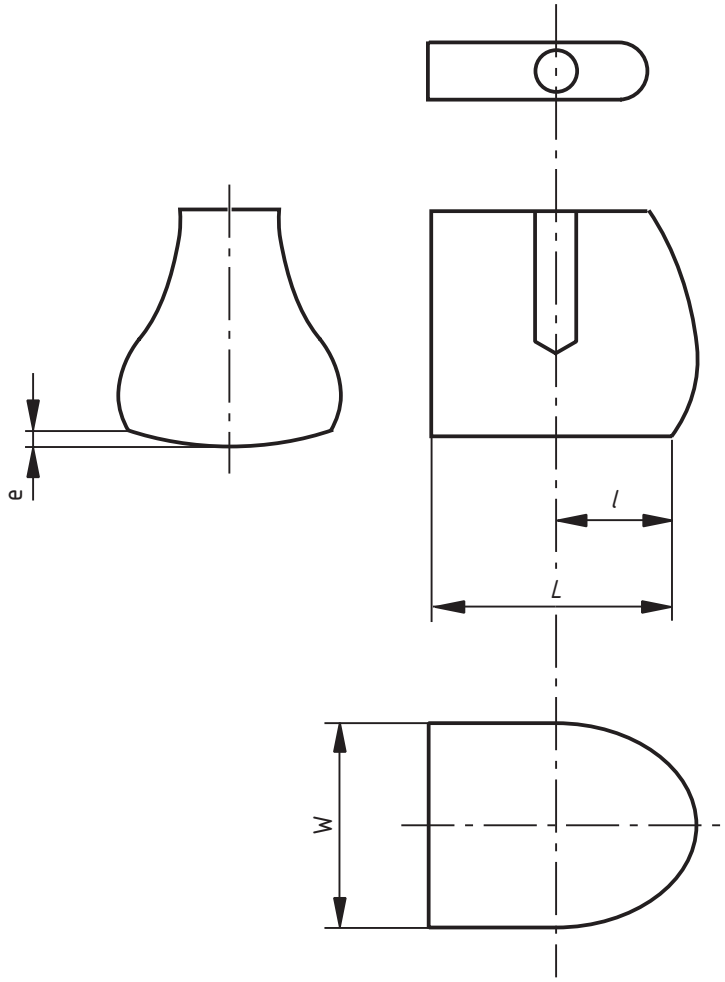


Figure 19 — Test punch for energy absorption test

5.14.2 Procedure

Place the test piece with the heel on a steel base and press the test punch against the bottom unit from the inside at the centre of the heel area at a test rate of (10 ±)3 mm/min until a force of 5 000 N is obtained.

Plot the load/compression curve for each test and determine the energy absorption *E* in joules, rounded to the nearest 1 J, using the equation:

$$E = \int_{50\ N}^{5000\ N} F ds$$

where

F is the applied compressive force, in N;

s is the distance, in mm

5.15 Determination of resistance to water for whole footwear

5.15.1 Trough test

5.15.1.1 Principle

A pair of footwear is worn whilst a defined number of paces is walked over a surface flooded with water to a defined depth. The extent of water penetration is determined by examination.

5.15.1.2 Testers

Choose the tester(s) so that the footwear fits the tester reasonably comfortably.

5.15.1.3 Apparatus

A horizontal watertight trough, having the following essential features (see also figure 20):

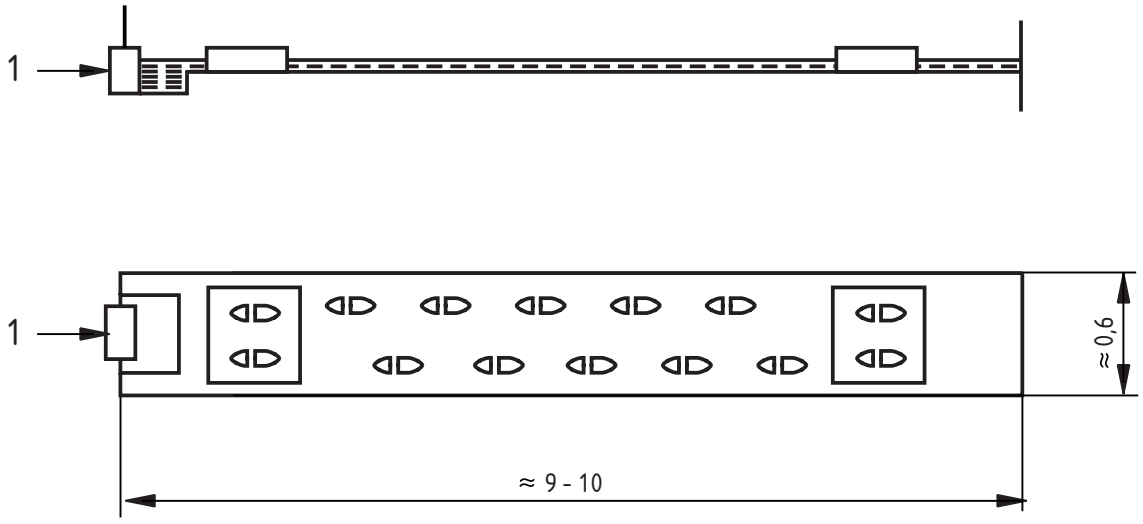
a) a moveable platform near each end, high enough and large enough to enable the tester to step up and turn around above the water level;

b) sufficient length to allow the tester to take 10 normal paces in the water between the platforms;

c) width of approximately 0,6 m;

d) a plug to enable the water to be drained away.

NOTE It is preferable for the trough to have a piped water supply so that it can readily be filled to the appropriate depth.



1 Plug

Figure 20 — Trough

5.15.1.4 Procedure

With the empty trough, position the turning platforms so that the tester takes 11 paces walking from one to the other with a normal length stride (i.e. so that each foot is placed on the floor of the trough five times). Fill the trough up to a depth of (30 ± 3) mm with water.

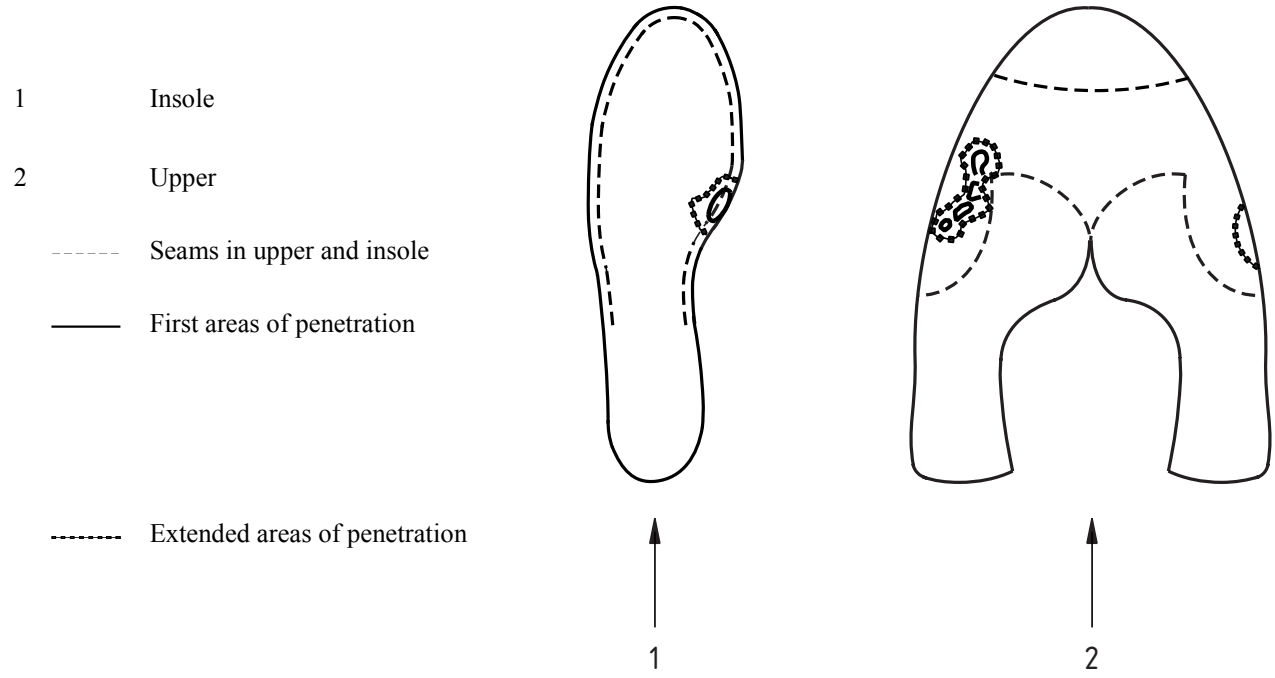


Figure 21 — Suitable form of diagram for a shoe, with an example of recorded penetration added

Ensure that the footwear is thoroughly dry. Put on the dry footwear over normal hose using a legging or guard to cover the topline, and step on to one of the platforms. Walk 100 trough lengths in the water using the platforms whenever turning. Take great care to make sure that no water is splashed over the topline of the footwear. To avoid splashing, walk at a slower pace than normal, if necessary, but preferably not slower than one pace per second.

After 100 trough lengths step out of the trough, remove the footwear carefully, and examine the inside both visually and by touch for signs of water penetration. If any penetration has occurred, record its position and extent on diagrams (figure 21 shows a suitable form of diagram) for each boot or shoe.

Repeat the test with the other two pairs of footwear.

5.15.2 Machine method

5.15.2.1 Principle

The whole footwear in a defined depth of water is subjected to the mechanical action of rotating wetted brushes. The extent of water penetration is determined by examination.

5.15.2.2 Apparatus

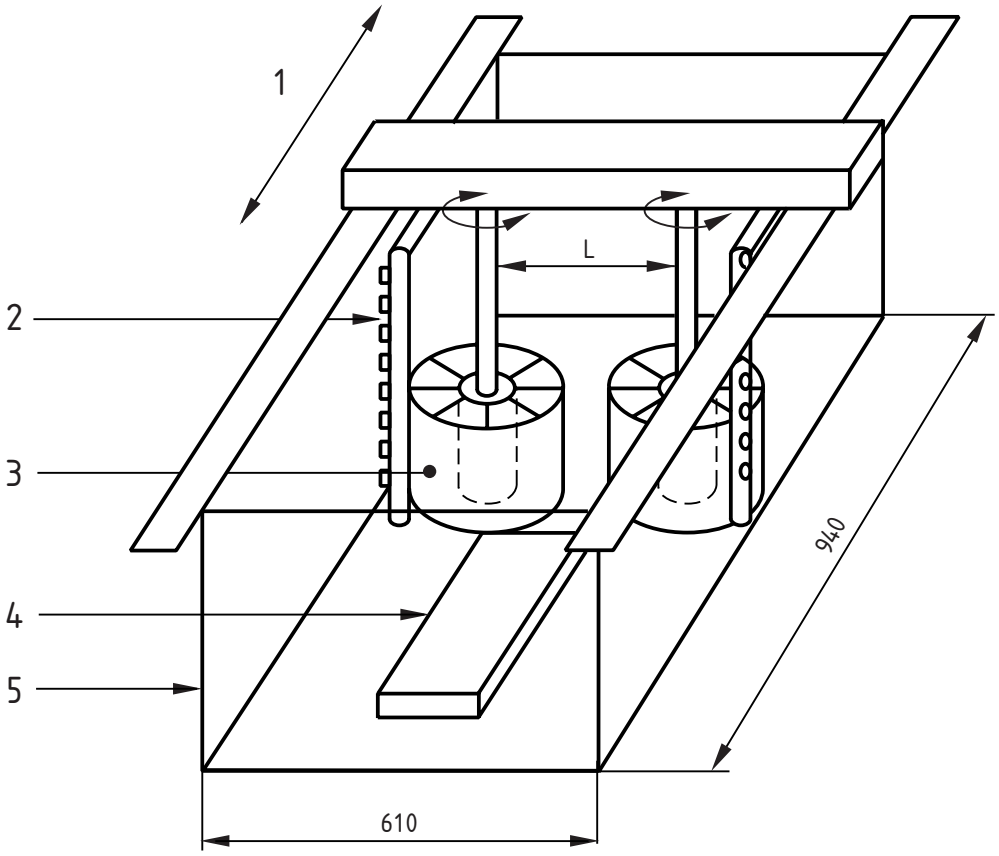
5.15.2.2.1 Balance, capable of weighing to 0,1 g.

5.15.2.2.2 Water resistance machine (see figure 22), with one or more test stations, each having the features described in 5.15.2.2.1 to 5.15.2.2.2.6.

5.15.2.2.2.1 Test piece support, consisting of a rectangular metal plate with a fixed jaw at one extremity and a sliding jaw at the other, enabling the test piece to be fixed for testing (figure 23).

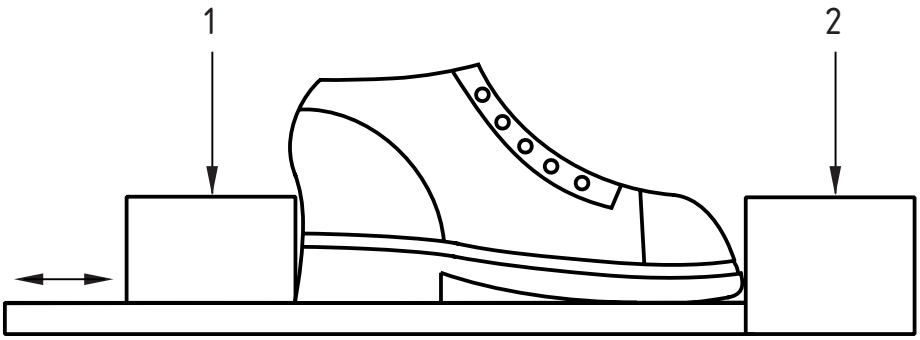
5.15.2.2.2.2 Two rotating brush systems, two brushes situated one on either side of the test piece, separated by adjusting distance *L* (see figure 22) describing a backwards and forwards motion over the whole length of the test piece, whatever its size. *L* is the addition of the width of footwear plus 80 mm.

The horizontal motion of each brush is completed by rotational movement, the direction of which changes at the end of each horizontal cycle. The direction of rotation of each brush is the same as the corresponding backwards or forwards motion, see figure 24.



1 Backwards and forwards movement
2 Spraying system
3 Brushes
4 Test piece support
5 Transparent water tank

Figure 22 — Water resistance machine



1 Sliding jaw
2 Fixed jaw

Figure 23 — Test piece support

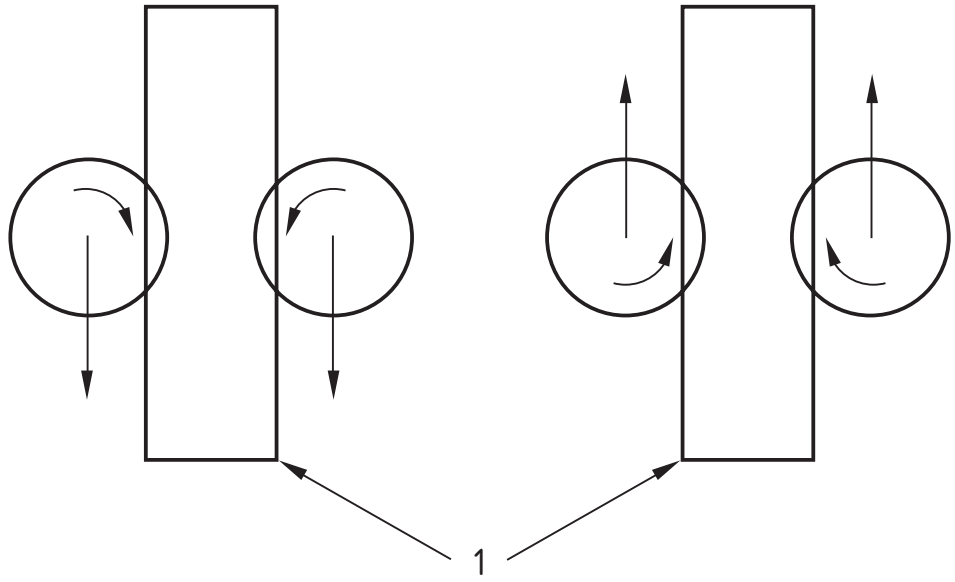
5.15.2.2.2.3 Spraying system, each brush having a spraying system with injectors spaced 50 mm apart (see figures 22 and 27), and a flow gauge to measure the water flow, by which the brushes are wetted.

5.15.2.2.2.4 Brush characteristics

- Modular helicoidal brushes are used. Each brush has a central cylinder of diameter 80 mm and length of 140 mm and 10 layers of 11 tufts of bristles, see figure 25.
- Each layer of 11 tufts is staggered, one from another, to create a helicoidal conformation, see figure 26.

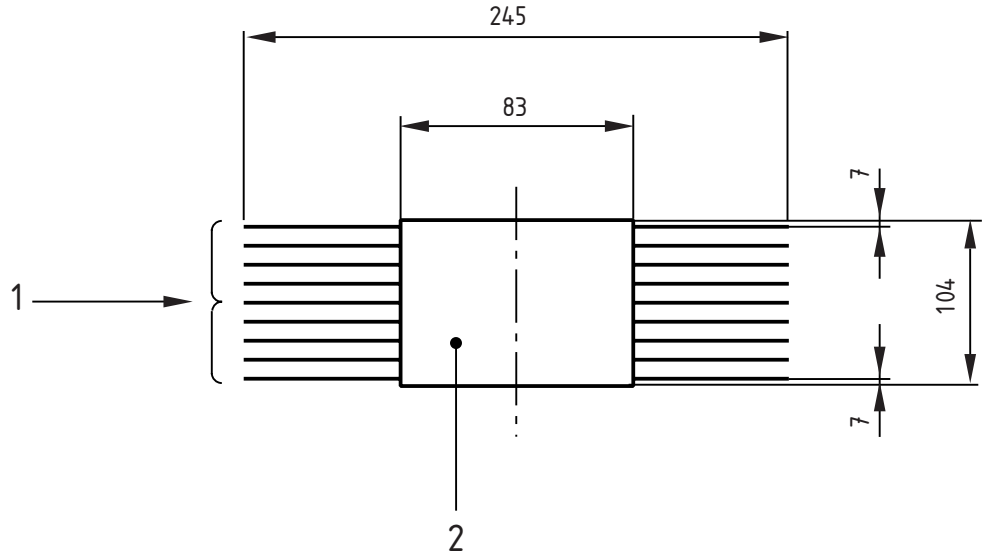
5.15.2.2.2.5 Bristle characteristics

- Material : polyamide
- Diameter : 0,4 mm
- Length : (81 ± 2) mm
- Tuft diameter in the central cylinder: 5 mm



1 Stationary test piece support

Figure 24 — Horizontal and rotational movement of the brushes



1 10 layers of tufts, 10 mm apart, staggered from one to another to create a helicoidal configuration (see figure 26)
2 Central cylinder

Figure 25 — Schematic diagram of a brush

5.15.2.2.6 Watertight tank, in which the whole of the apparatus is situated in a watertight tank equipped with a constant water level device.

5.15.2.3 Test parameters

- Rotation speed of brushes: (85 ± 5) r/m
- Horizontal speed of brushes: (20 ± 2) cycles/min (1 cycle is one complete backward and forward motion)
- Water flow rate: (0,50 ± 0,1) l/min

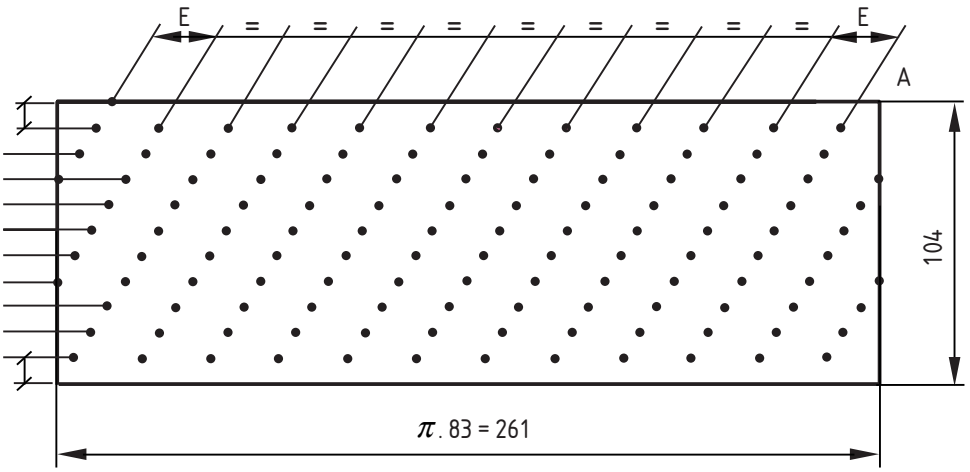
5.15.2.4 Procedure

Weigh the test piece to the nearest 0,1 g : M_1.

Fix the footwear firmly to the test piece support.

Make the top of the footwear watertight (for example with a rubber collar).

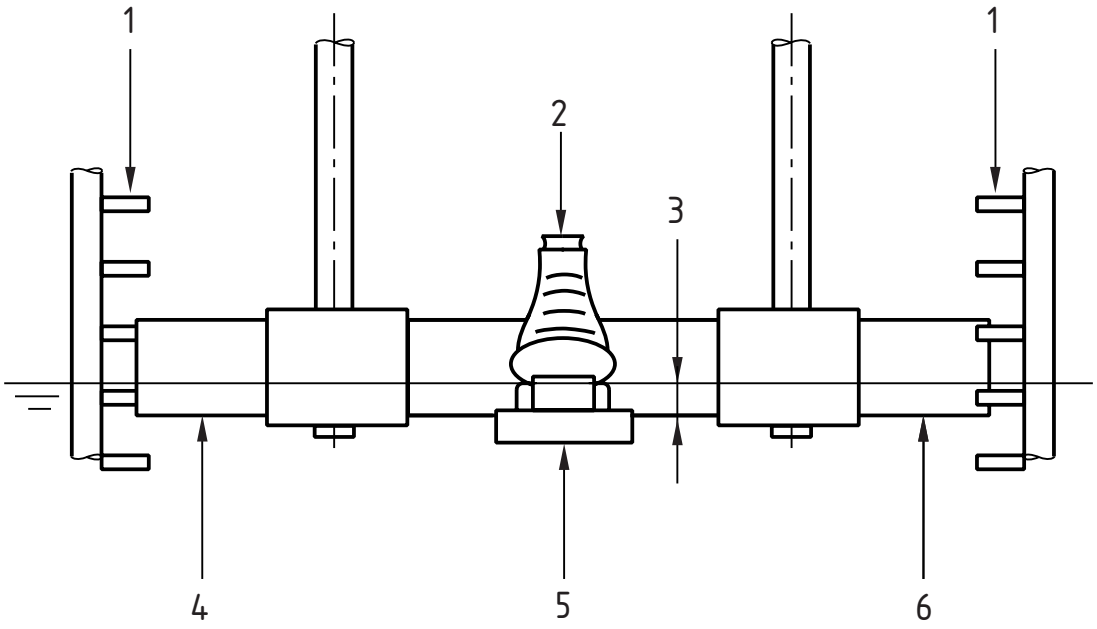
Fix the test piece support, with the test piece in the machine (see figure 27.)



B/B = π 83 = 261 mm
The horizontal distance E between tufts is 261/11 = 23,7 mm

I = 7 mm
L = 10 mm

Figure 26 — Tuft implantation of a brush



1 Water injectors
2 Test piece
3 Depth of water
4 Brush number 1
5 Test piece support
6 Brush number 2

Figure 27 — Front view of test equipment

Adjust the horizontal distance between the two brush systems so that the whole surface of the footwear upper is contacted by the bristles.

Fill the water tank until the water level is (20 ± 2) mm above the top surface of the test piece support. The constant level device should be adjusted to maintain this depth.

Spraying parameters are defined in table 4:

Table 4: Spraying parameters

Footwear (according to EN ISO 20345)	**Number of water injectors**	**Number of brushes**
Design A Low shoe	1	1
Design B Ankle boot	1	1
Design C Half knee boot	2	1
Design D Knee height boot	3	2
Design E Thigh boot	3	2

Open the number of injectors according to the type of footwear.

Adjust water supply to maintain constant level.

Program time the number of cycles for: 1 , 5 , 10 , 20 , 30 or 60 min.

Start the horizontal movement of the motor.

5.15.2.5 Detection of water penetration

5.15.2.5.1 Manual method

At the end of each programmed test period:

Stop the machine.

Remove the test piece support with test piece attached

Remove the test piece.

Dry the surface of the test piece rapidly.

Carefully remove the waterproof barrier from the top of the footwear.

Examine the interior of the footwear, visually, or by touch and/or by using blotting paper in order to detect any water penetration.

5.15.2.5.2 Machine method

An endoscope with a suitable lighting source linked to a video recorder is positioned in the test piece throughout the test. Water penetration is detected visually and photographic evidence can be recorded.

5.15.2.6 Water absorption

At the end of every programmed test period, after the test piece has been dried and checked for water penetration, it is weighed to the nearest 0,1 g, and the individual results are recorded as M_2, M_3, etc.

5.15.2.7 Expression of results

The time for initial water penetration in minutes is reported.

The water absorption *W*a, in grams is calculated

$$Wa = M_2 - M_1 \ ; \ M_3 - M_1 \ ; \text{ etc}$$

5.16 Determination of impact resistance of metatarsal protective device

5.16.1 Apparatus

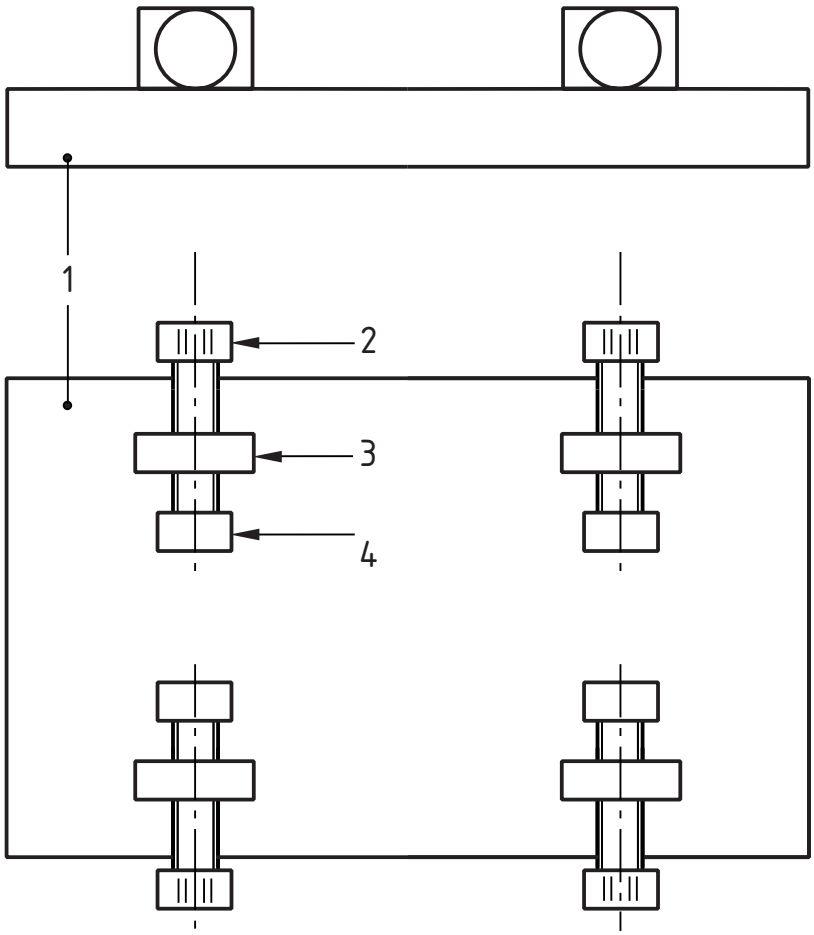
5.16.1.1 Impact apparatus, incorporating a steel striker of mass (20 ± 0,)2 kg adapted to fall freely on vertical guides through a predetermined height to give required impact energy calculated as potential energy.

The striker shall consist of a wedge at least 60 mm long, the faces of which subtend at an angle (90 + 1) ° and a minimum hardness of 60 HRC. The apex where the faces meet shall be rounded to a (3 ± 0,1) mm radius. During the test the apex shall be parallel within ± 17' to the surface of the clamping device (see figure 9).

The base of the apparatus shall have a mass of at least 600 kg and a metal block of dimensions at least 400 mm x 400 mm x 40 mm deep shall be bolted to it.

The apparatus shall be free standing on a flat and level floor, which is sufficiently massive and rigid to support the test equipment.

5.16.1.2 Clamping device, consisting of a smooth steel plate at least 19 mm thick of a minimum hardness 60 HRC with a device for clamping the heel and joint region of the shoe (see figure 28).



1 Base plate
2 Screw
3 Threaded lug
4 Clamping plate

Figure 28 — Clamping device

5.16.1.3 Dial gauge, with hemispherical foot of 3,0 mm ± 0,2 mm radius capable of exerting a force not greater than 250 mN.

5.16.1.4 Wax test form, which represents the inside of the footwear and which is used to measure the deformation of the metatarsal region during impact. This form shall be made by one of the methods described in 5.16.1.4.1 or 5.16.1.4.2.

5.16.1.4.1 Production of wax form using the making last (preferred method)

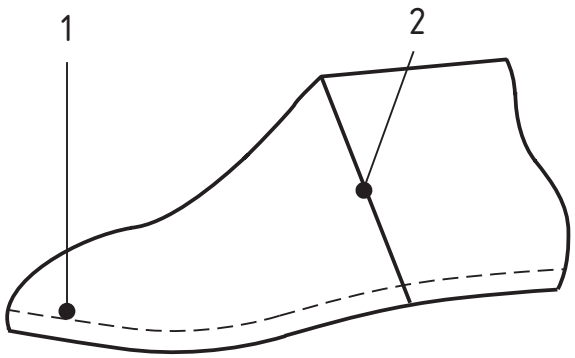
This involves a two stage operation, the first of which is to form of a mould of the last used to make the footwear. The second consists of producing a wax test form of this mould.

Stage 1: Using a last one size smaller than the test footwear, fill in any 'V' cut in the last and any holes and form a shell using a vacuum former and a thermoplastic material [2)] over the upper surface. When cool, trim off surplus material below the feather edge of the last and remove. Similarly, form a shell over the bottom surface and trim at between 5 mm and 10 mm above the feather edge to form a flange on the edge. Join the two shells, using a suitable tape, such that the upper shell fits inside the flange formed on the bottom shell and tape the join. Cut the joined shell to produce front and heel end moulds (see figure 29).

2) For example, 0,4 mm thick unplasticized PVC sheets.

Stage 2: Stand up the two moulds in a container such that the top surfaces are horizontal, and support with sand (see figure 30). Prepare the wax for the test last from a mixture of paraffin wax (with a melting point of 50°C to 53°C) and beeswax in a ratio 5:1. Combine the paraffin wax and the beeswax in a suitable mixing vessel, place in a oven and heat to approximately 85°C. Remove the vessel from the oven and stir until the mixture cools to approximately 60°C and pour into the two moulds. Insert a loop of thin tape into the molten wax to facilitate later removal from the test footwear, ensuring that the tape does not penetrate to the outer surface of the front mould (see figure 30). Allow to cool. Remove the wax forms from the moulds.

NOTE With care the moulds can be used to produce a number of wax forms.



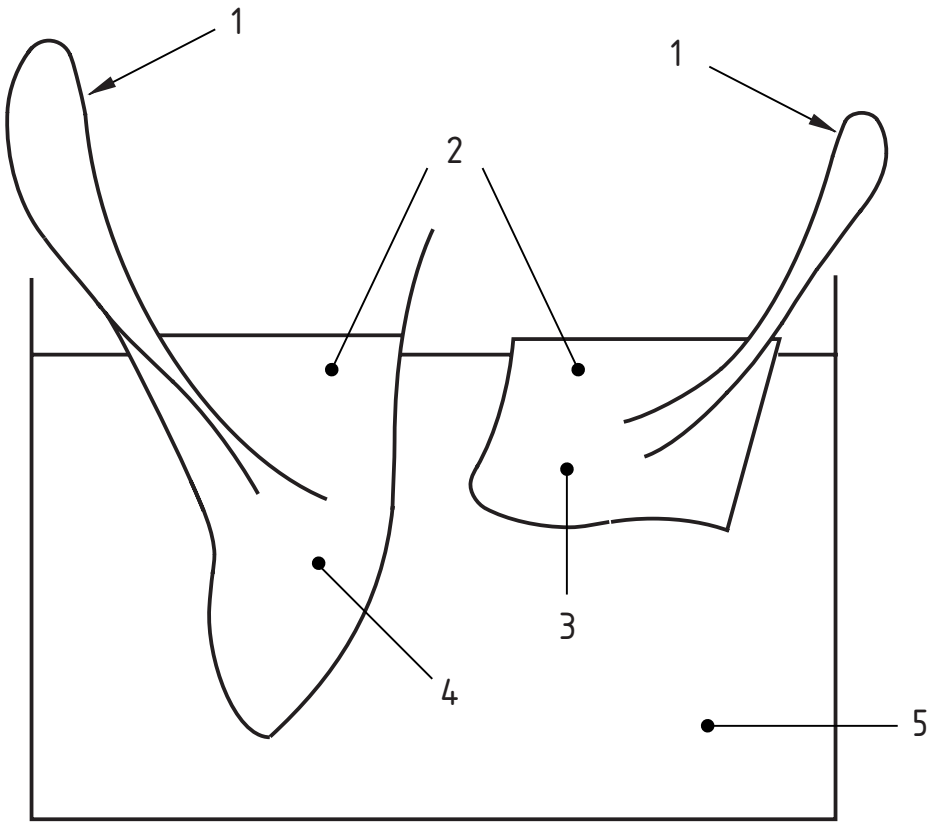
1 Flange overlapping top shell
2 Cut

Figure 29 — Shells joined together showing separation cut

5.16.1.4.2 Production of wax forms using footwear

This involves a three stage operation, the first of which is to produce a plaster of Paris cast of the inside of the footwear, followed by the production of moulds and casts as described in 5.16.1.4.1. It requires one extra item of footwear, which will be destroyed during the production of the plaster of Paris mould.

Stage 1: Coat the inside of an item of footwear the same size as that to be tested with petroleum jelly or releasing agent. Secure the fastening system and fill to the top of the opening with a mixture of plaster of Paris and water. Leave until set and then remove by cutting away the footwear. After removal place in an oven at about 80°C to dry.



1 Tape to help in removal from test piece
2 Moulds filled to top with wax
3 Heel end mould
4 Toe end mould
5 Container filled with sand

Figure 30 — Moulds supported in sand and filled with wax

Stage 2: Continue as for Stage 1 in 5.16.1.4.1 using the plaster of Paris cast in the place of making last.

Continue as for stage 2 in 5.16.1.4.1.

5.16.2 Preparation of test piece

Use the complete item of footwear as the test piece.

5.16.3 Procedure

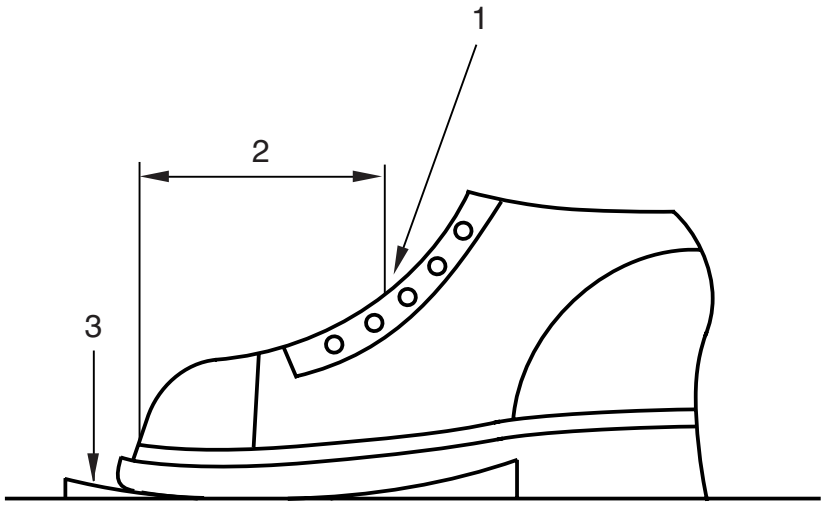
Insert the wax forms into the test piece and close the fastening system. The test axis as defined in 5.3.2 should be marked onto the wax test form by marking through the footwear. Clamp the test piece onto the base plate (5.16.1.1.) using the clamping device (5.16.1.2) and position it such that, at the moment of impact, the striker shall be at 90° to the axis of the test specimen as described in 5.4.2.1. The striker shall hit the test piece once, at a distance from the toe as specified in table 5 (see figure 31).

Table 5 - Distances of impact

Size of footwear		Distance of impact from toe[a]
French	English	mm
36 and below	Up to 3 ½	90
37 and 38	4 to 5	95
39 and 40	5 ½ to 6 ½	100
41 and 42	7 to 8	105
43 and 44	8 ½ to 10	110
45 and above	10 ½ and above	115
[a] This distance is measured along the test axis from the toe end.		

Place a wedge under the forepart of the test piece to prevent deformation of the footwear during impact.

Allow the striker to drop onto the test piece from an appropriate height (measured vertically from the impact point) to give an impact energy of (100 ± 2) J.



1 Point of impact
2 Dimension from table 5
3 Wedge

Figure 31 — Point of impact

5.16.4 Test results

After testing, carefully remove the wax form from the footwear and position it on a flat support such that it maintains the same horizontal orientation it had within the test piece.

Using the dial gauge (5.16.1.3), measure the vertical height above the flat surface on the axis as determined in 5.4.2.1 at the maximum point of deformation.

5.17 Determination of the shock absorption capacity of ankle protection materials incorporated into the upper

5.17.1 Principle

A test piece taken from the ankle protective area of the upper is subjected to an impact test and the transmitted force measured.

5.17.2 Apparatus

5.17.2.1 Impact apparatus

The apparatus shall consist of a guided mass of (5 000 ± 10) g which strikes a test anvil in a vertical drop. The centre of gravity of the falling weight shall be vertically above the centre of the anvil during the whole operation.

The drop height shall be approximately 0,2 m, in order to ensure a kinetic energy of 10 J.

5.17.2.2 Striker

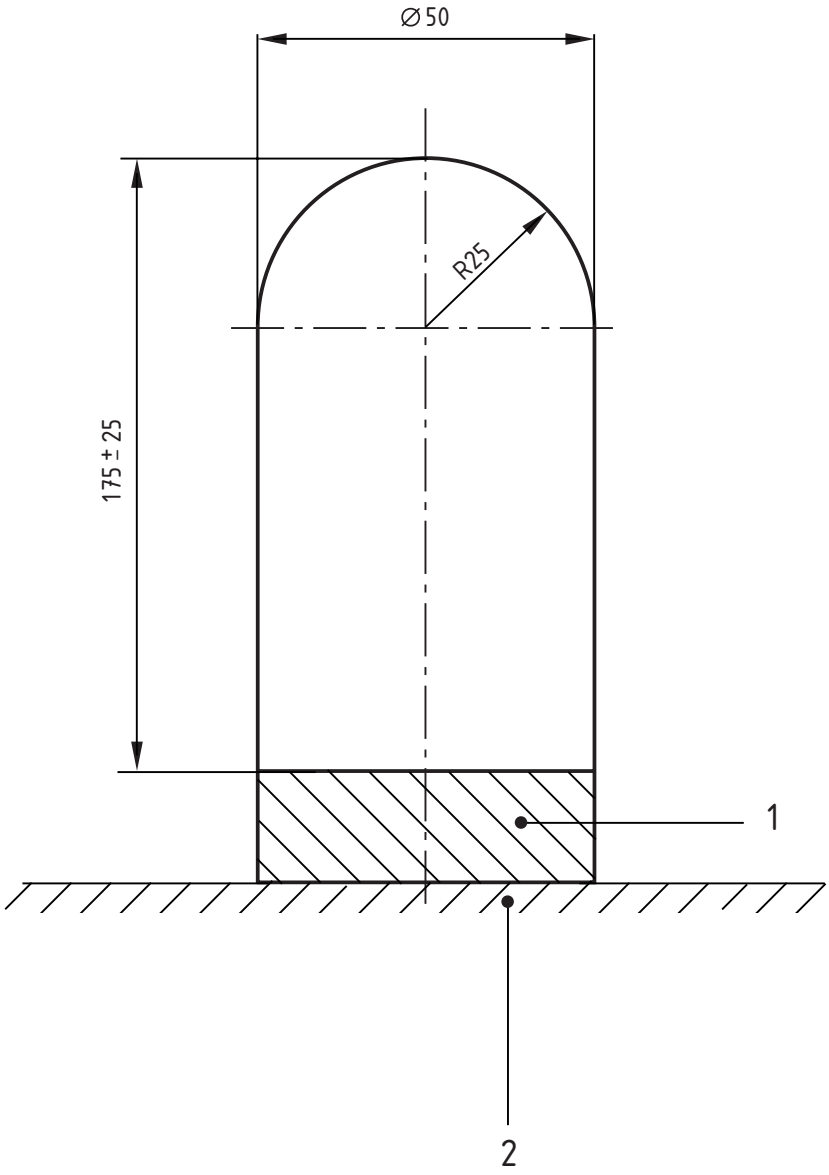
The drop striker face shall be made from polished steel with dimensions of 80 mm x 40 mm, all edges being rounded with a radius of (5 ± 1) mm.

5.17.2.3 Anvil

The anvil (see figure 32) made of polished steel has an overall height of (175 ± 25) mm and consists of a cylinder with the radius 25 mm which in its upper part is rounded to a hemispherical shape also with 25 mm radius. The anvil shall be attached, in vertical position and through a piezo-electric load cell, to a solid mass of a least 600 kg. The cell shall be properly preloaded and calibrated.

5.17.2.4 Force measurement instrumentation

The anvil shall be mounted so that during impact testing the whole force between the anvil and the compact base of the apparatus passes through the piezoelectric quartz force transducer in line with its sensitive axis. The force transducer shall have a calibrated range of not less than 120 kN and a lower threshold of less than 0,1 kN. The output of the force transducer shall be processed by a charge amplifier and the peak force shall be recorded by suitable instrumentation.



1 Force transducer 2 Solid base

Figure 32 — The anvil and base

5.17.2.5 Templates

Templates shall be prepared from suitable flexible material (e.g. fabric, fleece, paper, etc.), capable of maintaining its shape and dimensions during use.

The templates shall be circular and of the dimensions stated in table 6. Their centre point shall be indicated by suitable marking or by cutting a small hole.

5.17.2.6 Sampling

At least 2 samples (inside and outside) shall be taken from each of three pairs of footwear (small, medium and large sizes) to enable at least 6 impact tests to be performed, 3 on inner ankle protection and 3 on an outer ankle protection.

5.17.3 Preparation of test pieces

The selected footwear sample is fitted to the foot of an individual for whom it is the correct size. While this tester stands freely in an upright position, a second tester marks onto the footwear upper the position of the ankle, referring to the most prominent part of the ankle bone. A template of suitable size (see table 6) is then fitted onto the ankle protector by matching its centre to the centre marked on the upper.

The test area is defined by drawing around the template onto the upper, and the specimen containing all material layers is completed by cutting it in a way which assures an added margin of at least 1,0 cm around the marked template shape.

NOTE It is not mandatory that the extra margin surrounds the specimen completely on all sides. Benefits of the margin: if necessary, it can be used to attach the material layers to each other, this is useful when the tester intends to perform the impact test close to the border of the impact area.

The four ankle protectors of a pair of footwear need not necessarily be of a unified shape, but they shall match at least the circular sizes indicated in table 6.

Table 6 – Minimum size of ankle protectors

Size of footwear		**Minimum diameter**
French	**English**	**mm**
40 and below	6 ½ and below	56
41 to 43	7 to 9	60
44 and above	9 ½ and above	64

5.17.4 Conditioning

Samples and test pieces shall be conditioned for at least 24 h at (23 ± 2)°C and 50 % r.h ± 5 % r.h . before testing.

5.17.5 Procedure

Testing shall be carried out in the standard atmosphere of (23 ± 2)°C and (50 ± 5)% r.h. .

The test piece is positioned outer surface upwards on the anvil in such a way that a part of the test area covers the centre point of the anvil. The test piece may be fixed in the selected position by covering with a suitably thin net or fabric with a centre hole of 20 mm to 25 mm diameter to avoid influencing the result. This auxiliary device should be pulled down, by means of elastic straps, with an overall force of 5 N to 10 N, which can easily be controlled by the force measuring system itself.

The drop striker is then released and the transmitted force as well as damage or breakage of the test piece is recorded.

Test piece shall be tested once only at each point.

5.17.6 Test report

The mean force and the highest obtained single value are reported. In case of different inside/outside construction the results have to be stated separately for the ankle protectors from the inside and outside of the footwear's uppers. Any damage to the test pieces shall be recorded.

A1 5.18 Determination of footwear slip resistance

Determine the footwear slip resistance in accordance with Annex A. A1

6. Test methods for upper, lining and tongue

6.1 Determination of thickness of upper

Determine the thickness according to ISO 4648:1991, method A1, using a thickness gauge with a flat presser foot of 10 mm diameter and a load of 1 N. The thickness of the upper shall include any associated textile layer.

6.2 Measurement of the height of the upper

6.2.1 Preparation of test piece

Use one complete item of footwear as the test piece. Mark the longitudinal axis of the footwear, XY, see figure 11 along the line XY.

Note : If other tests have to be performed on the footwear the forepart can be removed first (e.g. impact test on toecap).

6.2.2 Measurement

The height (in mm) of the upper is the vertical distance between the lowest point on the insole/insock (i.e. between the heel breast H_b and the back of the heel B_h (see figure 33)) and the highest point on the upper.

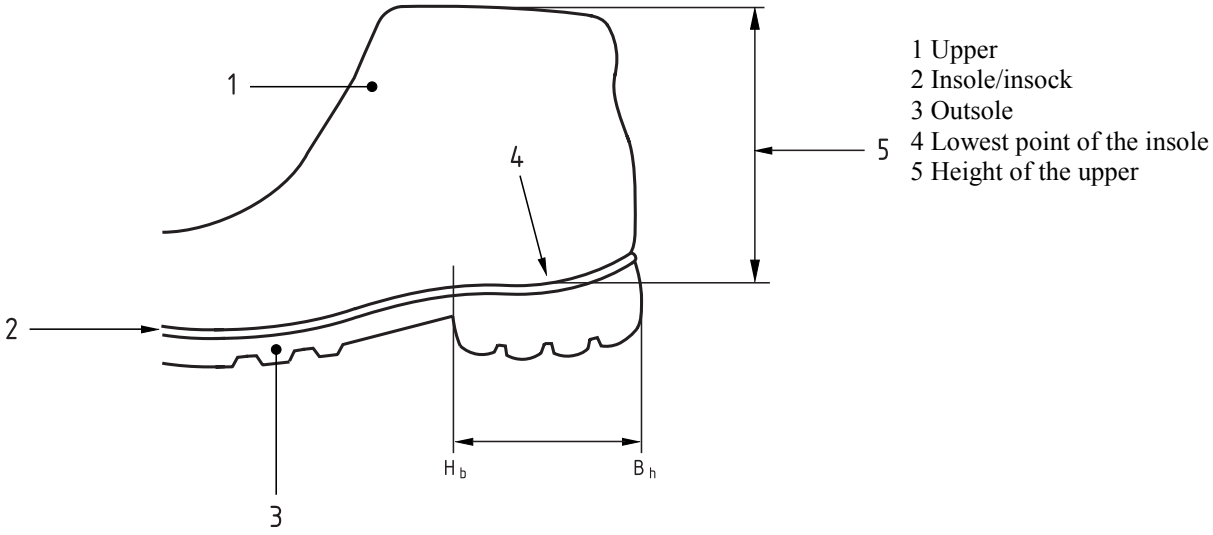


Figure 33 — Measurement of the height of the upper

6.3 Determination of tear strength of upper, lining and/or tongue

Determine the tear strength according to one of the following methods (whichever is appropriate):

- EN ISO 3377-2 for leather;
- EN ISO 4674-1:2003 method B, for coated fabric and textile

For coated fabric and textile, use a test piece as large as possible. The width shall be between 25 mm and 50 mm and the length between 50 mm and 200 mm, with a cut 20 mm long placed centrally and parallel with the longer sides to form a trouser shaped test piece. Carry out the test at a constant rate of transverse of 100 mm/min. For knitted and non woven materials, use the largest possible test piece obtainable from the footwear.

6.4 Determination of the tensile properties of upper material

Determine the tensile properties of the upper material according to the appropriate method given in table 7.

Table 7 — Tensile properties

Type of material	Test method	Tensile property
Leather split	EN ISO 3376:2002 [a]	Tensile strength
Rubber [b]	ISO 2023:1994 annex D	Breaking force
Polymeric [c]	ISO 4643:1992	Modulus at 100% elongation. Elongation at break
[a] Using the test piece l = 90 mm, b_1 = 25 mm.		
[b] The test pieces shall include any associated textile layer.		
[c] Remove the textile layer before testing.		

6.5 Determination of upper flexing resistance

Determine the upper flexing resistance according to whichever of the following methods is appropriate:

- ISO 2023:1994 - annex E for rubber (the test piece should include any associated textile layer)
- ISO 4643:1992 - annex B for polymers (test carried out at –5°C)

6.6 Determination of water vapour permeability

6.6.1 Principle

The test piece is fixed over the opening of a jar, which contains a quantity of solid desiccant. This unit is placed in a strong current of air in a conditioned atmosphere.

The air inside the container is constantly agitated by the desiccant, which is kept in movement by the rotation of the jar.

The jar is weighed in order to determine the mass of the moisture that has passed through the test piece and has been absorbed by the desiccant.

6.6.2 Apparatus

6.6.2.1 **Jars or bottles**, fitted with a screw top with a circular opening whose diameter is equal to the diameter of the neck of the jar (approximately 30 mm) (see figure 34).

6.6.2.2 **Holder**, in the form of a disc which is rotated at (75 ± 5) r/min by an electric motor. The jars are placed on this disc with their axes parallel to the axle of the disc and at a distance of 67 mm from it (see figure 35).

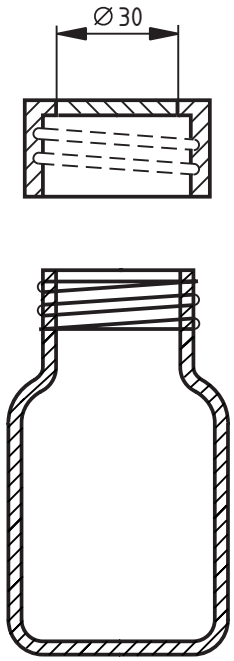


Figure 34 — Jar to be used in WVP test

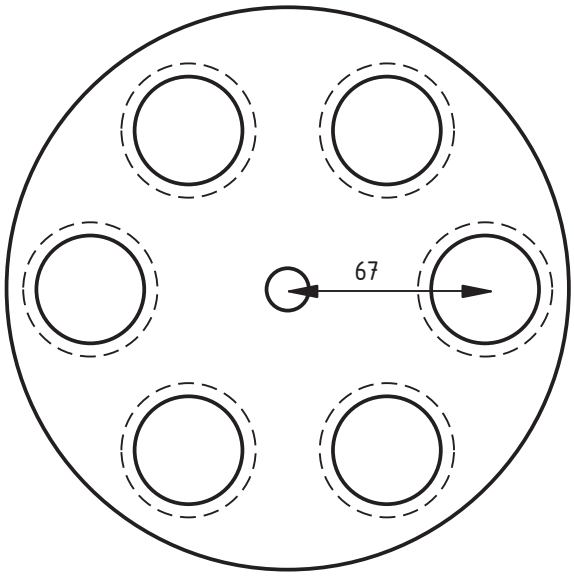


Figure 35 — Holder for jars used in WVP test

6.6.2.3 **Fan**, mounted in front of the mouths of the jars and consisting of three flat blades in planes that are inclined at 120° to one another. The planes of the blades shall pass through the prolongation of the axle of the disc. The blades shall have dimensions of approximately 90 mm by 75 mm, and the 90 mm long side of each blade nearest to the mouths of the jars passes them at a distance of not greater than 15 mm (see figure 36). The fan shall rotate at (1400 ± 100) r/min. The apparatus shall be used in a conditioning atmosphere of (23 ± 2)°C, (50 ± 5)% r.h..

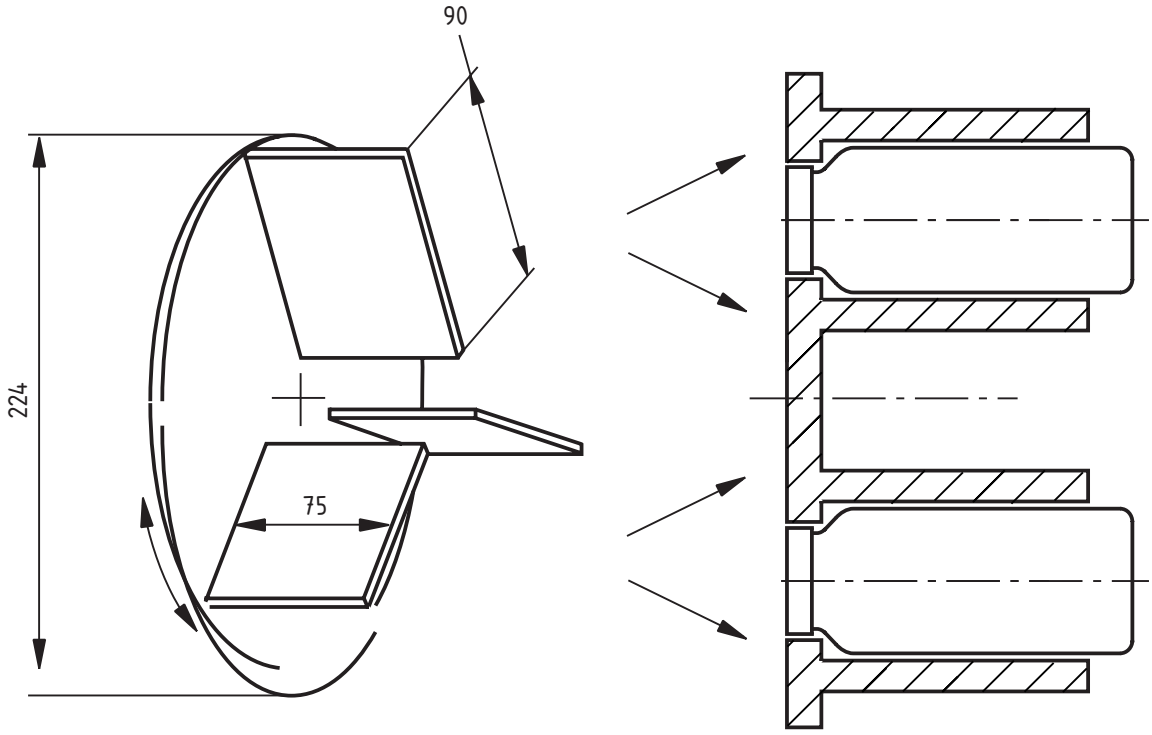


Figure 36 — Schematic diagram of apparatus to be used in water vapour permeability test

6.6.2.4 **Silica gel desiccant**, freshly regenerated by at least 16 h in a ventilated oven at (125 ± 5)°C then cooled to ambient temperature in a hermetically sealed vessel. The granular size of the crystals shall be such that they shall not pass through a sieve of mesh size 2 mm.

The silica gel should be sieved before regeneration in order to eliminate small particles and dust. At regeneration, the specified temperature 130°C should not be exceeded due to the risk of reducing the absorptive capacity of the gel. The ventilation of the oven by use of a fan is not necessary but the oven should not be sealed; it should allow continuous exchange of the air inside the oven with that outside. The gel should not be used whilst it is warmer than the test piece and since it cools slowly in a closed vessel, a long cooling time is needed.

6.6.2.5 **Balance**, capable of weighing to 0,001 g.

6.6.2.6 **Stopwatch**.

6.6.2.7 **Instrumen**t, capable of measuring to the nearest 0,1 mm the internal diameter of the neck of the jars.

6.6.2.8 **Pre-flexing apparatus**, comprising the following:

Upper clamp, consisting of a pair of flat plates. One has the shape of a trapezium ABCD (see figure 37) but with a sharp corner at D rounded to a radius of 2 mm. It shall have a ledge EF on which the folded test sample rests. The other plate shall have the shape EGHCF. The two plates shall be screwed together, so as to hold one end of the sample between them as shown in figure 38. The screw K which draws the plates together shall also act as a stop, to prevent the ends of the sample from being thrust too far towards the back of the clamp. Between the plates near the edge AB shall be a stop, which prevents them from coming together near AB, and so ensures that they clamp the sample firmly near F. The upper clamp shall be reciprocated by a motor about a horizontal axis.

In the position shown in figure 37 the ledge EF is horizontal, and the end F is its highest point. The clamp descends through an angle of 22,5° and returns (100 ± 5) times/min. The number of cycles is recorded by a counter.

Lower clamp, fixed and lying in the same vertical plane as the upper clamp. It shall consist of a pair of plates, which can be screwed together to hold the other end of the sample between them. If the upper clamp has been turned to the position where the ledge EF is horizontal (figure 37) the upper edges of the plates of the lower clamp shall be 25 mm below the ledge of EF.

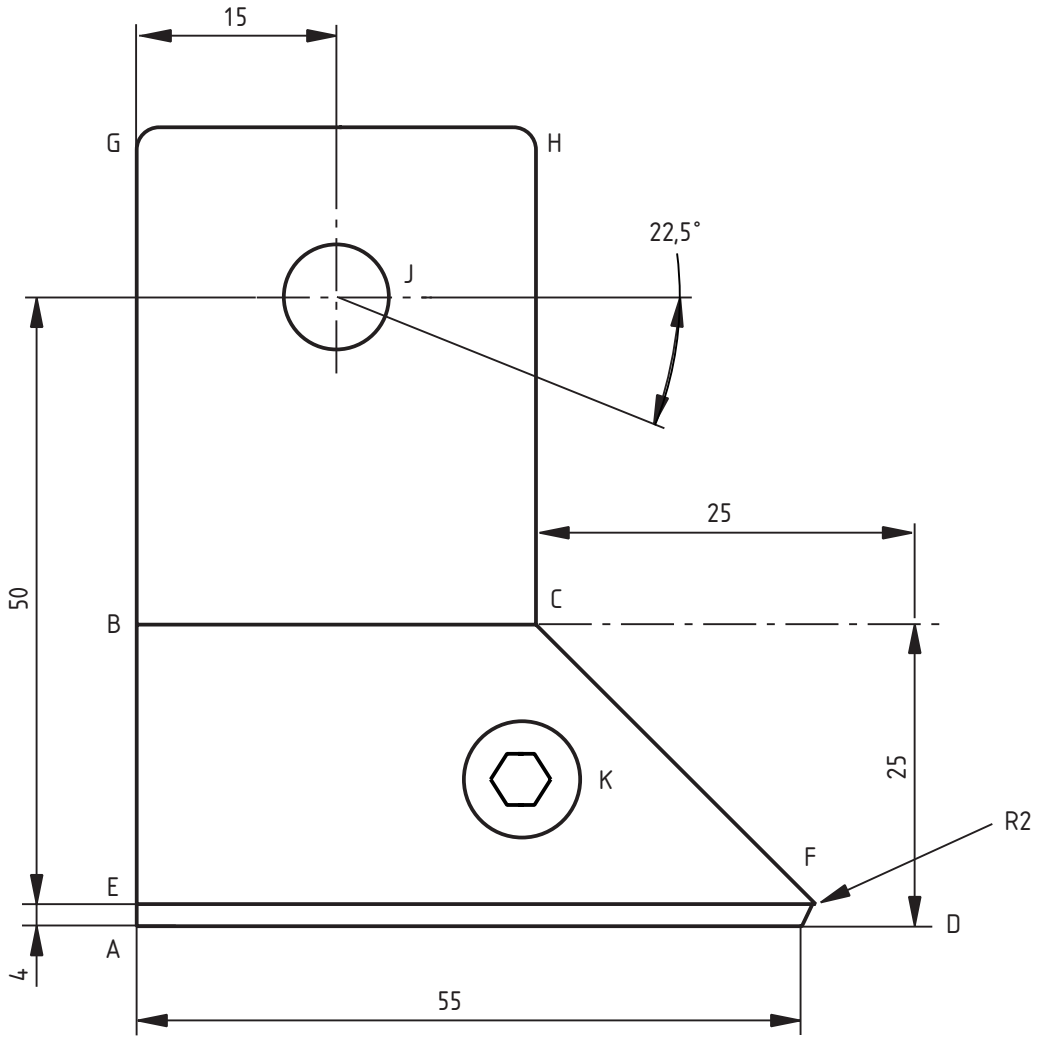


Figure 37 — Upper clamp

6.6.3 Preparation of test piece

6.6.3.1 Preflexing

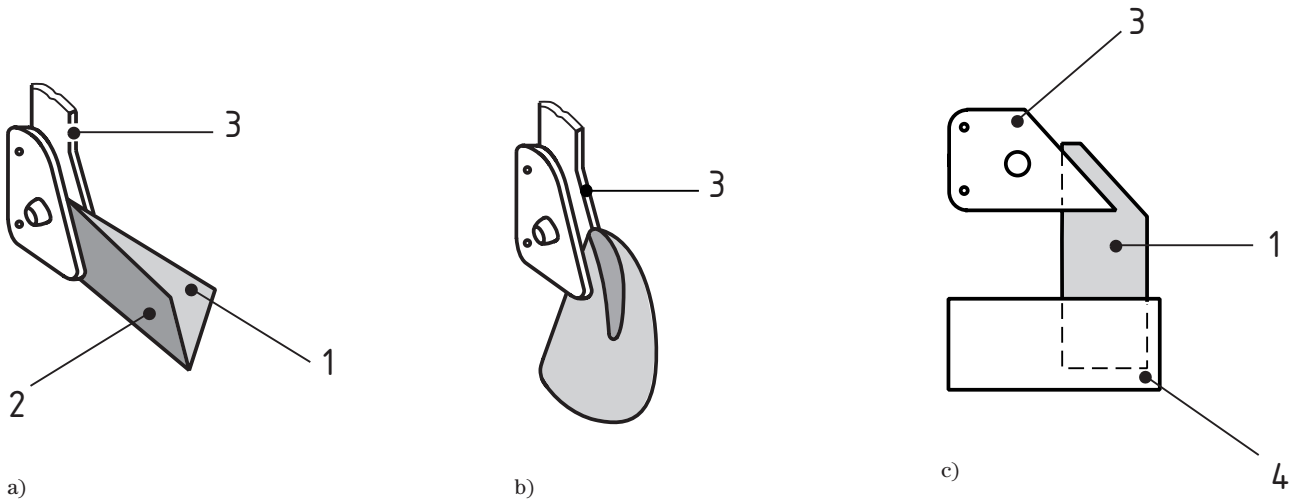
Cut a test sample of dimensions 70 mm x 45 mm.

Turn the motor until the ledge EF is horizontal. Fold the test sample in two, with the grain side inwards, and clamp it to the upper clamp as shown in figure 38 a), with one end of the sample against the stop and the folded edge against the ledge.

Draw the free corners of the sample outwards and downwards as shown in figure 38 b) so that the surface which is turned inwards in the clamp is turned outwards below it. Draw the sample down, bringing together its two corners which have not been clamped; clamp it in the lower clamp (as shown in figure 38 c) with the part of the fold between the clamps vertical, and using no more force than is needed to make the sample just taut.

Switch on the machine and carry out 20 000 flexing cycles.

Switch off the machine and remove the test sample from the clamps.



a) Sample in upper clamp **b) Sample folded back** **c) Sample clamped in upper and lower clamps**

1 Outer side
2 Inner side
3 Upper clamp (see figure 37)
4 Lower clamp

Figure 38 — Insertion of the test sample in the clamps

6.6.3.2 Cutting the test piece

Cut a circular test piece of 34 mm diameter from the preflexed sample, centrally about the point at which the flexing creases meet.

6.6.4 Test procedure

Half fill a jar with freshly regenerated cool silica gel. Fix the test piece over the jar by means of the screw top with the side facing the foot pointing outwards. Place the jar in the holder of the apparatus and switch on the machine.

Measure the internal diameter of the neck of a second jar (to the nearest 0,1 mm) in two directions perpendicular to each other and calculate the average diameter in mm.

If it is necessary to seal the junction between the test piece and the neck of the jar, warm the second bottle and apply a thin layer of wax to the flat end surface of the neck.

After at least 16 h but less than 24 h stop the machine, and remove the first jar. Half fill the second jar with freshly regenerated cool silica gel and immediately remove the test piece from the first jar and place onto the second (with the same side facing outwards).

If the opening of the jar has been coated with wax, warm to (50°C ± 5)°C before introducing the silica gel and fixing the test piece.

As quickly as possible, weigh the second jar with the test piece and silica gel, mass M_1, noting the time. Place the jar in the apparatus and switch on.

After at least 7 h and less than 16 h stop the machine and reweigh the jar to the nearest 0,1g, mass M_2, noting once again the time to the nearest minute.

6.6.5 Calculation and expression of results

Calculate the water vapour permeability (W_3 in mg/(cm^2·h))from the equation:

$$W_3 = \frac{M}{At} = \frac{M}{\pi r^2 t}$$

where:

$M = M_2 - M_1$, in mg

M_1 = the initial mass of the jar with test piece and silica gel, in mg

M_2 = the final mass of the jar with test piece and silica gel, in mg

$A = \pi r^2$ = the test surface area, in cm²

r = the radius of the test surface, in cm

t = the time between the first and second weighing, in h

6.7 Determination of water vapour absorption

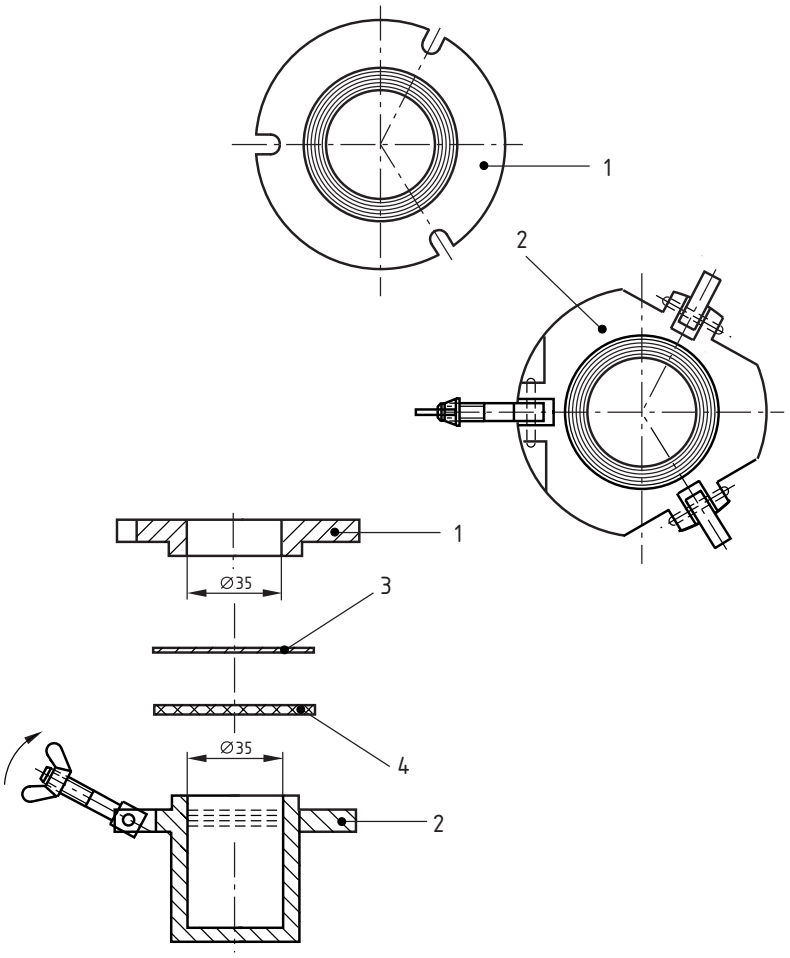
6.7.1 Principle

An impermeable material and the test piece are clamped over the opening of a metal container, which holds 50 ml of water, for the duration of the test.

Water absorption of the test piece is determined by its difference in mass before and after the test.

6.7.2 Apparatus

6.7.2.1 Circular metal container of volume 100 cm^3 and an upper ring, between which the impermeable material and the test piece are clamped (see figure 39). The container and the ring shall have an internal diameter of 3,5 cm which corresponds to a test area of approximately 10 cm^2. The upper ring shall be clamped to the apparatus with three hinged bolts equipped with wing nuts, or by any other appropriate means.



1 Top
2 Bottom
3 Seal
4 Specimen

Note : The means of clamping the top to the bottom is illustrative only

Figure 39 — Apparatus for determination of W.V.A.

6.7.2.2 **Balance**, capable of weighing to the nearest 0,001 g.

6.7.2.3 **Stopwatch**.

6.7.3 Preparation of test piece

Cut a test piece 4,3 cm in diameter.

6.7.4 Test procedure

Carry out the test in a conditioning atmosphere of (23 ± 2)°C and (50 ± 5)% r.h.

Weigh the conditioned test piece and record its mass, M_1.

Place 50 ml of water into the container and place the test piece over the container with the side facing the foot downwards. Place the impermeable disc and the upper ring over the test piece and screw down firmly. Ensure that no water laps against the bottom of the test piece.

Remove the test piece after 8 h and weigh immediately, recording its mass, M_2.

6.7.5 Calculation and expression of results

Calculate the water vapour absorption from the equation:

$$W_1 = \frac{M_2 - M_1}{a}$$

where

W_1 is the water vapour absorption, in mg/cm^2;

M_1 is the initial mass of the test piece, in mg;

M_2 is the final mass of the test piece, in mg;

a is the test surface area, in cm^2.

Round the result to the nearest 0,1 mg/cm^2.

6.8 Determination of water vapour coefficient

Calculate the water vapour coefficient from the following equation:

$W_2 = 8W_3 + W_1$

where :

W_2 is the water vapour coefficient in mg/cm^2;

W_3 is the water vapour permeability in mg/(cm^2.h); (see 6.6.5)

W_1 is the water vapour absorption in mg/cm^2. (see 6.7.5)

Round the result to the nearest 0,1 mg/cm^2.

6.9 Determination of pH value

Determine the pH value of leather (upper, lining, tongue, insole or insock) according to EN ISO 4045.

6.10 Determination of resistance to hydrolysis of upper

Determine the upper hydrolysis according to annex B of ISO 5423:1992, after preparation and conditioning as described in annex E of that standard. The test pieces shall include any associated textile layer.

6.11 Determination of chromium VI content

6.11.1 Principle

This method allows the determination of the chromium VI (hexavalent chromium) in leather.

Soluble chromium VI is leached from the sample at pH 7,5 to pH 8,0 and substances which influence the detection, are removed by solid phase extraction if necessary. The chromium VI in solution oxidises 1,5-diphenylcarbazide to 1,5-diphenylcarbazone to give a red/violet complex with chromium, which can be quantified photometrically at 540 nm.

The results obtained from the described method are strictly dependant on the extraction conditions. Results obtained by using other extraction procedures (extraction solution, pH, extraction time, etc.) are not comparable with the results produced by the procedure described in this standard.

6.11.2 Chemicals

All reagents used shall have at least analytical grade purity.

6.11.2.1 Extraction solution

22,8 g dipotassiumhydrogenphosphate K_2HPO_4 3 H_2O dissolved in 1000 ml water, adjusted to pH 7,9 to pH 8,1 with phosphoric acid (6.11.2.3). Degas the solution with argon or nitrogen to chase away oxygen.

6.11.2.2 Diphenylcarbazide solution

1,0 g 1,5-diphenylcarbazide $CO(NHNHC_6H_5)_2$ is dissolved in 100 ml acetone $(CH_3)_2CO$ and made acidic with one drop of glacial acetic acid CH_3COOH.

The solution shall be kept in a brown glass bottle. The shelf life is up to 14 days at 4° C.

6.11.2.3 Phosphoric acid solution

700 ml o-phosphoric acid d = 1,71 g/ml, made up to 1 000 ml with distilled water.

6.11.2.4 Chrome VI stock solution

2,829 g potassium dichromate ($K_2Cr_2O_7$) (6.11.2.8), is dissolved in water in a volumetric flask and made up to 1000 ml with water. 1 ml of this solution contains 1 mg of chromium.

6.11.2.5 Chrome VI standard solution

1 ml of solution (6.11.2.4), is pipetted in a 1 000 ml volumetric flask and made up to the mark with distilled water. 1 ml of this solution contains 1 µg of chromium.

6.11.2.6 **Argon or nitrogen**, oxygen free

6.11.2.7 **Distilled water in accordance with ISO 3696**.

6.11.2.8 **Potassium dichromate ($K_2Cr_2O_7$)**, dried for (16 ± 2) h at (102 ± 2) °C

6.11.3 Apparatus

6.11.3.1 **Suitable mechanical shaker**, (50 to 150) r/min

6.11.3.2 **Conical flask**, 250 ml, with stopper

6.11.3.3 **Aeration tube and flow meter**

6.11.3.4 **pH meter with glass electrode**

6.11.3.5 **Membrane filter of 0,45 µm pore size**, made of polytetrafluoroethylene (PTFE) or nylon

6.11.3.6 **Volumetric flasks**, of sizes 25 ml, 100 ml, 1000 ml

6.11.3.7 **Pipettes**, of nominal volumes 0,2 ml, 0,5 ml, 1,0 ml, 2,0 ml, 5,0 ml, 10 ml, 20 ml and 25 ml

6.11.3.8 **Spectrophotometer or filterphotometer, wavelength 540 nm**

6.11.3.9 **Photometric cell**, quartz, 2 cm length or any other suitable cell length

6.11.3.10 Glass or polypropylene cartridges, filled with suitable reversed phase material [3)]

NOTE In interlaboratory trials cartridges with 1 g SPE material and cartridges have been tested and found to be suitable. Nevertheless it may be in some cases advisable to use also other phases or more than 1 g of SPE material. In all cases the recovery rate should be tested very carefully. Charcoal proved to be unsuitable for the decolourisation of the extracts.

6.11.3.11 SPE-system (Solid Phase Extraction), with vacuum device or solvent resistant medical syringe.

6.11.4 Procedure

6.11.4.1 Preparation of samples

Grind the leather in accordance with EN ISO 4044.

6.11.4.2 Preparation of analytical solution

Weigh (2 ± 0,01) g of ground leather to the nearest 0,001 g. Pipette 100 ml of degassed solution (6.11.2.1), into a 250 ml conical flask (6.11.3.2) and add the leather. Close the flask.

The leather powder is extracted by shaking for (180 ± 5) min in a mechanical shaker.

The settings of the shaking apparatus shall be such that the leather powder is agitated in a smooth circular movement without adhering to the wall of the flask. Too fast movements shall be avoided.

After 3 h of extraction check the pH of the solution. The pH of the solution shall be between pH 7,5 and pH 8,0. If the pH of the solution is not within this range the complete procedure shall be started again.

Immediately after the extraction is completed the content of the conical flask is filtered through a membrane filter into a glass bottle with screw cap.

6.11.4.3 Determination of chromium VI in the solution obtained from the extraction procedure

The cartridges are pre-treated in the following way: flush the cartridge first with 5 ml methanol, afterwards with 5 ml distilled water and directly afterwards with 10 ml of extraction solution (6.11.2.1). The cartridges shall not be dried during or after the pre-treatment.

From the solution obtained in 6.11.4.2, 10 ml are taken and transferred quantitatively through the cartridge (6.11.3.10) on an SPE system with vacuum device (6.11.3.11). The eluate is collected in a 25 ml volumetric flask. The cartridge is flushed with 10 ml extraction solution (6.11.2.1), into the 25 ml flask. The flask is made up to volume with extraction solution (6.11.2.1). This solution is marked as S_1.

10 ml of solution S_1 are pipetted into a 25 ml volumetric flask. The solution is diluted to 3/4 of the flask's volume with extraction solution (6.11.2.1). 0,5 ml of diphenylcarbazide solution (6.11.2.2), is added and afterwards 0,5 ml of phosphoric acid (6.11.2.3). The flask is made up to volume with extraction solution (6.11.2.1) and mixed well.

Allow to stand for (15 ± 5) min. Measure the absorbance of the solution at 540 nm in a 2 cm cell against the blank solution (6.11.4.4). The extinction obtained is registered as E_1.

For each run another 10 ml aliquot of solution S_1 is pipetted into a 25 ml volumetric flask and treated as described above but without the addition of the diphenylcarbazide solution (6.11.2.2). The extinction of this solution is measured in the same way as before and registered as E_2.

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3) Dionex cartridges filled with RP 18 material is an example of a suitable product available commercially from Dionex (UK) Ltd, 4 Albany Court, Camberley, Surrey, GU16 7QL, UK or from Dionex offices in Member states. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by CEN of this product.

6.11.4.4 Blank solution

Three-quarters fill a 25 ml volumetric flask with extraction solution (6.11.2.1), add 0,5 ml of diphenylcarbazide solution (6.11.2.2). and 0,5 ml of phosphoric acid (6.11.2.3), make up to the mark with extraction solution (6.11.2.1) and mix well. This solution shall be stored in the dark. The blank solution is treated in the same way as the analytical solution, including the solid phase extraction.

6.11.4.5 Calibration

Calibration solutions are prepared from the standard solution (6.11.2.5). The chromium concentration in these solutions should cover the expected range of measurements. The calibrating solutions are prepared in 25 ml volumetric flasks.

A suitable calibration curve may be plotted by using a blank and at least 4 concentrations prepared with the chrome VI standard solution (6.11.2.5). The given volumes of standard solution (6.11.2.5), are pipetted into 25 ml volumetric flasks, 0,5 ml diphenylcarbazide solution (6.11.2.2), and 0,5 ml of phosphoric acid (6.11.2.3), are added to each flask. Make up to volume with extraction solution (6.11.2.1), mix well and allow to stand for (15 ± 5) min.

The extinction of the solutions is measured in the same photometrical cell as the samples at 540 nm against the blank obtained in 6.11.4.4.

The chromium VI concentrations in µg/ml are plotted against the extinction measured. The chromium VI concentration is plotted on the x-axis, the extinction on the y-axis.

Note : In interlaboratory tests the 2 cm cell proved to be most suitable. In some cases however a higher or lower cell length can be suitable.

6.11.5 Determination of the recovery rate

6.11.5.1 Influence of the matrix

The determination of the recovery rate is important to provide information about possible matrix effects, which can influence the results.

10 ml aliquot of the solution obtained in 6.11.4.2 are dosed with a suitable volume of chromium VI solution to double approximately the content of the chromium VI concentration of the extract (± 25%). The concentration of the spiking solution has to be selected in such a way that the final volume of the spiked solution is maximum 11 ml. This solution is treated in the same way as the sample (see 6.11.4.3).

The extinction of the solution shall be within the range of the calibration curve, otherwise the procedure is repeated by using a smaller aliquot. The recovery rate shall be greater than 80%.

6.11.5.2 Influence of the RP-material

A volume of solution 6.11.2.5 which corresponds to the chromium VI content of the leather is pipetted into a 100 ml volumetric flask and is made up to volume with extraction solution (6.11.2.1).

This solution is treated in the same way as the leather extract. The content in this solution is determined in the same way as that of the leather extract and compared with the calculated content. In cases were no chromium VI was detected in the leather sample, the concentration of the solution shall be 6 µg/100 ml. The recovery rate shall be greater than 90%. If the recovery rate is equal to or lower than 90% the RP material is not suitable for this procedure and has to be substituted.

Note 1: If added chromium VI can not be detected this may be an indication that the leather contains reducing agents. In some cases, if the recovery rate according to 6.11.5.2 is higher than 90%, and after intensive considerations, this may lead to the conclusion that this leather has no chromium VI content (below detection limit).

Note 2: The recovery rate is an indicator whether the procedure works or whether matrix effects are effecting the results. Normally the recovery rate is more than 80 %.

6.11.6 Calculation and expression of results

$$w_{CrVI} = \frac{(E_1 - E_2) \times V_1 \times V_2 \times 10^3}{50 \times A \times m \times F}$$

6.11.6.1 Calculation of chromium VI content

w_{CrVI} = Soluble CrVI in leather (mg/kg)

E_1 = Extinction of sample solution with DPC

E_2 = Extinction of sample solution without DPC

F = Gradient of calibration curve (y/x) (ml/µg)

A_1 = Aliquot taken from leather extract (ml)

m = Original mass of leather taken (g)

V_0 = Extraction volume (ml)

V_1 = Volume to which the aliquot A_1 was made up (ml)

A_2 = Aliquot taken from solution S_1 (ml)

V_2 = Volume to which the aliquot from S_1 was made up (ml)

6.11.6.2 Recovery rate (according to 6.11.5.1)

RR = Recovery Rate in % $RR = ((E_3 - E_1) \times 100) / M_2 \times F$

M_2 = Chromium VI added µg/ml

F = Gradient of calibration curve in ml/µg

E_3 = Extinction after adding chromium VI

E_1 = Extinction before adding chromium VI

6.11.6.3 Expression of results

In cases where the level of Cr VI is lower than 10 mg/kg, according to the analysis as carried out, chromium VI is not detectable.

In cases where the level of Cr VI is equal or greater than 10 mg/kg, the analysis result suggests that the leather submitted contains chromium VI. Then the chromium VI content is given in mg/kg rounded to the nearest 0,1 mg.

6.11.7. Test report

The test report shall include the following information:

a) content of chromium VI obtained from 6.11.6.3, the results obtained to 1 decimal place in mg/kg

b) a reference to this European Standard

c) a description of the sample tested

d) recovery rate in % if lower than 80% or higher than 105%

e) details of any deviations from the procedure

6.12 Determination of abrasion resistance of lining and insock

6.12.1 Principle

Circular test pieces are abraded on a reference abradant under known pressure with a cyclic planar motion in a form of a Lissajous figure which is the resultant of two simple harmonic motions at right angles with each other. The resistance to abrasion is assessed by subjecting the test piece to a defined number of cycles at which point it shall not exhibit any holes.

6.12.2 Apparatus

6.12.2.1 Abrasion machine [4)] fulfilling the following requirements:

- Rotational speed of each of the outer pegs: (47,5 ± 5) r/min
- Drive ratio of outer pegs to inner pegs: 32 : 30
- Dimensions of the Lissajous figure: (60 ± 1) mm
- Symmetry of Lissajous figure: Curves shall be parallel and evenly spaced
- Face diameter of specimen holder insert: (28,65 ± 0,25) mm
- Combined mass of specimen holder, spindle and weight: (795 ± 7) g
- Parallelism of plate and abrading tables: ± 0,05 mm
- Circumferential parallelism: ± 0,05 mm
- Diameter of abrading base: (125 ± 5) mm

NOTE see annex B

The test piece holders and abrading tables shall be plane and parallel over their entire surfaces. The drive from the motor to the machine shall be connected to a counter and switch so that the revolutions of the outer pegs are inducted and the machine shall be stopped after a predetermined number of cycles has been measured by the counter.

6.12.2.2 Reference abradant [4)], consisting of a crossbred worsted spun, plain woven fabric, conforming to table 8.

[4)] Information on the availability of a suitable abrasion machine, reference abradant, felt and polyetherurethane foam may be obtained from the Secretariat of CEN/TC 161

The reference abradant shall be mounted on the abrading tables over a piece of felt. The felt shall be woven felt of mass per unit area (750 ± 50) g/m^2 and (3 ± 0,5) mm thick.

NOTE The felt need not be renewed until damaged or soiled on both sides or until approximately 100 h of testing have been completed.

Table 8 — Reference abradant

	Warp	**Weft**
Yarn linear density	R63 tex/2	R74 tex/2
Threads per cm	17	12
Singles twist, turns per metre	540 ± 20 'Z'	500 ± 20 'Z'
Two-fold twist, turns per metre	450 ± 20 'Z'	350 ± 20 'Z'
Fibre diameter, μm	27,5 ± 2,0	29,0 ± 2,0
Mass per unit area of fabric, minimum g/m^2	195	
Oil content, %	0,9 ± 0,2	

6.12.2.3 Backing for test pieces, having a mass per unit area less than 500 g/m^2, consisting of polyetherurethane foam (3 ± 1) mm thick [4)], of density (30 ± 1) kg/m^2 and indentation hardness (5,8 ± 0,8) kPa, cut to the same size as the test piece. Backings shall be renewed with every test.

6.12.2.4 Fabric punch or press cutter, to produce a test piece to fit the holder, having a diameter of 38 mm.

6.12.2.5 Weight, of mass (2,5 ± 0,5) kg and diameter (120 ± 10) mm

6.12.2.6 Balance, capable of weighing to the nearest 0,001 g.

6.12.3 Atmosphere for testing

The testing atmosphere shall be (23 ± 2)°C and (50 ± 5)% r.h.

6.12.4 Preparation of test pieces and materials

Using the fabric punch (6.12.2.4) cut four circular test pieces from the lining, two for the dry test and two for the wet test. Expose the test pieces and materials to the standard atmosphere test for at least 24 h.

6.12.5 Procedure

6.12.5.1 General

Check that the top plate and abrading tables are parallel. Insert a diameter gauge through the spindle bearing and move the top plate by turning the drive shaft by hand. The needle movement of the dial gauge shall be within ± 0,05 mm over the whole surface of the abrading table. If machines are being used in which the test piece holders are connected to the weights by spindles, assemble each empty test piece holder and place each one in position on the appropriate abrading table and insert the spindles. Use a feeler gauge to check for any gap between the face of the holder insert and the table. The gap shall not be greater than 0,05 mm. Rock the spindle from side to side and recheck with the feeler gauge. To avoid damaging abrading tables and metallic inserts, do not run the machine with metallic inserts in contact with the uncovered abrading tables.

6.12.5.2 Mounting the test pieces

Remove the outer ring of a test piece holder together with the accompanying metallic insert. Insert the test piece centrally into the outer ring so that the face to be abraded shows through the hole.

For test pieces of fabric having a mass per unit area less than 500 g/m^2, insert a disc of polyetherurethane foam (6.12.2.3) having the same diameter as the test piece. Use a new backing for each test. Place the metallic insert carefully into the outer ring with its raised surface next to the test piece. Complete the assembly of the test piece holder by screwing on the back plate whilst pressing the face of the test piece firmly against a hard surface to prevent wrinkling. Check that no wrinkling has occurred. Repeat for remaining test pieces.

6.12.5.3 Preparation of abradant and backer for wet test

Thoroughly wet the fabric abradant and felt backer by one of the following methods:

a) soak overnight;

b) agitate thoroughly in water;

c) wet with a high pressure water jet.

Allow excessive water to drain and mount them according to 6.12.5.4.

Rewet the abradant fabric and felt at 6 400 cycles by gradually pouring on up to 30 ml of water and lightly rubbing it with the fingertips. Place the weight (6.12.2.5) on the fabric and leave for a few seconds to squeeze out excess water.

6.12.5.4 Mounting abradant

Mount a new piece of reference abradant (6.12.2.2) on each table with a piece of felt of the same dimensions beneath the reference abradant. Flatten the reference abradant by placing the weight (6.12.2.5) on its surface, and then position and tighten up the retaining frame evenly. Make sure that the reference abradant is held in place firmly and that there are no tucks or ridges.

6.12.5.5 Mounting test piece holders

Mount the test pieces in the machine.

Every time a holder is taken from the machine to check a test piece, re-tighten the holder before it is replaced on the machine.

If during the test pilling occurs, it shall not be cut off.

6.12.6 Method of assessment

Continue the test until either a hole forms in the test piece or 25 600 cycles have been performed for the dry sample (12 800 cycles for the wet test). If the fabric has a pile, only holes in the base fabric need to be taken account of. The assessment is done by naked eye.

6.13 Determination of water penetration and water absorption for upper

6.13.1 Principle

The material is partially immersed in water and flexed on a machine in a manner simulating conditions of wear. Measurements are made of:

a) the percentage gain in mass of the test piece due to water absorption 60 min from the start of the test;

b) the mass of water which has passed through the test piece after 60 min of test.

6.13.2 Apparatus

6.13.2.1 Test apparatus comprising

6.13.2.1.1 Two cylinders, 30 mm diameter, made of inert rigid material, mounted with their axis horizontal and co-axial. One cylinder shall be fixed and the other shall be movable along the direction of its axis.

6.13.2.1.2 Electric motor, which drives the movable cylinder backwards and forwards along its axis with crank motion at 50 cycles/min. When the movable cylinder is at the greatest distance from the fixed one, the adjacent flat faces of the two cylinders shall be 40 mm apart.

6.13.2.1.3 Tank, containing distilled water, in which the trough-shaped test piece can be partly immersed.

6.13.2.1.4 Metallic plate, carried by a spring, resting on the roll of absorbent cloth, applying a load of 1 N to 2 N.

6.13.2.2 Ring shaped clamps, to clamp the longer edges of the test piece round the adjacent ends of the cylinders so that it forms a trough whose ends are closed by the cylinders.

6.13.2.3 Absorbent cloth, used to absorb water transmitted to the interior of the trough formed by the test piece. The absorbency of the material may not be optimum when new. It shall therefore be washed before the first use.

NOTE A suitable cloth consists of a rectangle of cotton towelling-type textile of approximately 120 mm x 40 mm with a mass of approximately 300 g/m^2.

6.13.2.4 Balance, capable of weighing to 0,001 g.

6.13.2.5 Clock, capable of measuring to 1 min

6.13.3 Preparation of test piece

Cut from the upper a rectangle of 75 mm x 60 mm. The wear surface shall be buffed by rubbing with a grade 180 emery paper, placing a rigid plate and 10 N load on top of it and moving it 100 mm 10 times.

The absorbent cloth shall also be conditioned prior to use.

6.13.4 Procedure

Adjust the apparatus to give a 7,5% compression of the test piece.

Weigh the test piece to the nearest 0,001 g and record the mass M_1.

Fix the test piece in the apparatus, with the outer surface of the upper in contact with the water, as follows:

With the two cylinders at their maximum distance apart wrap the test piece round their adjacent ends so that it forms a trough whose upper edges, formed by the shorter side of the test piece, are horizontal and at the same level. Keep the test piece between the cylinders under slight tension to remove folds and with approximately the same length (about 10 mm) overlapping on each cylinder clamp it using ring clamps. Position the inner edges of the two ring clamps as close as possible in the planes of the adjacent ends of the cylinders, so that the length of the trough is the same as the free length of the test piece between the clamps.

Weigh the absorbent cloth (6.13.2.3), recording its mass P_1, roll it up to form a cylinder of 40 mm length and immediately place it in the trough formed by the test piece. Place the plate (6.13.2.1.4) so that it rests on the cloth.

Raise the level of water in the tank until water lies about 10 mm below the top of the cylinders.

Start the motor. Stop the motor after 60 min.

Remove the metal plate. Remove the absorbent cloth and mop up any surplus water within the trough. Reweigh the cloth. This mass is P_2

Remove the test piece, from the cylinders blot to remove adhering water and reweigh. This mass is M_2.

6.13.5 Calculation and expression of results

Calculate the water penetration, W_p, in g from the equation:

$$W_p = P_2 - P_1$$

where

P_1 is the initial mass of the absorbent cloth, in g

P_2 is the final mass of the absorbent cloth, in g

Calculate the water absorption, W_a, as a percentage by mass, from the equation:

$$W_a = \frac{M_2 - M_1}{M_1} \times 100$$

where

M_1 is the initial mass of the test piece, in g

M_2 is the final mass of the test piece, in g

6.14 Determination of resistance of upper to cutting

Test in accordance with the method described in 6.2 of EN 388:2003, subject to the following changes:

6.14.1 Preparation of test piece

Take three samples, then cut two test pieces from the protective area of each samples. The dimensions of the test pieces are 100 mm x 80 mm,

6.14.2 Procedure

Carry out one test on each test piece.

7. Test methods for insole and insock

7.1 Determination of insole thickness

Cut through the sole in the region of the cleat and measure the thickness of the insole using a graduated eyepiece with 0,1 mm scale graduations.

7.2 Determination of water absorption and desorption of insole and insock

7.2.1 Principle

A test piece is positioned on a wet base plate and is submitted to repeated flexing under a given pressure (in the same manner as the insole of a shoe during walking).

The water absorption at the end of test and the water desorption following the tests are determined.

7.2.2. Apparatus

See figure 40, composed of :

7.2.2.1 **Brass roller (A**), of diameter (120 + 1) mm and width(50 + 1) mm, which is placed over the test piece (B)

7.2.2.2 **Platform (C)**, with roughened upper surface and with sufficient perforations to allow the surface to be kept wet by a flow of water through the platform. The upper surface of the platform (C) is covered by a strip of cotton gauze consisting of 50% of cotton and 50% of polyamide of mass per unit area (60,5 ± 2) g/m².

7.2.2.3 **Clamp (D)**, to hold one short side of the test piece (B) in a horizontal position on the platform (C)

7.2.2.4 **Clamp (E)**, to attach the other short side of the test piece to the roller with the attached side being parallel to the axis of the roller. The clamp is held by a weak spring to maintain the sample under slight tension.

7.2.2.5 **Water supply (F)**, through the platform (C) and a means of draining away excess water.

7.2.2.6 **Means of moving the axis of the roller**, with a "to-and-fro" motion along the X-X axis, with an amplitude of (50 + 2) mm about a point directly over the mid point of the test piece at frequency of (20 ± 1) cycles per min. The movement of the axis causes the roller to move backwards and forwards along the test piece, raising one end and bending it to conform to the shape of the roller.

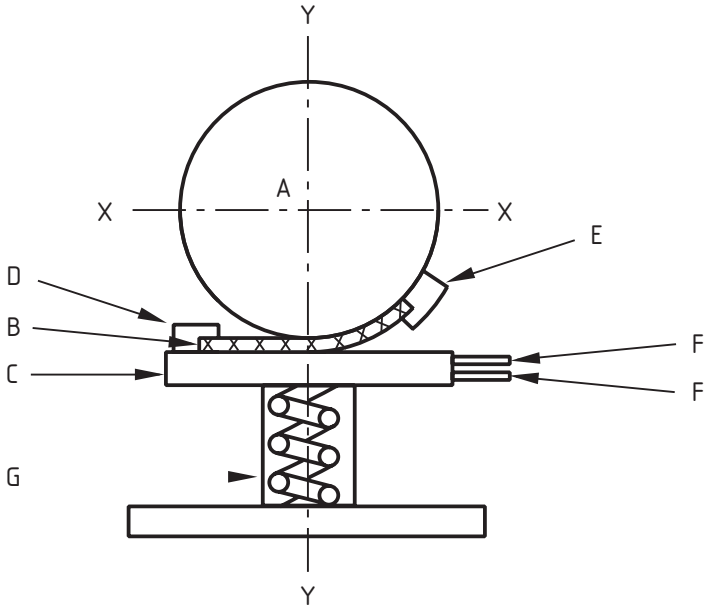
7.2.2.7 **Means (G) of pressing the platform**, test piece and roller together with a force of (80 + 5) N.

7.2.2.8 **Press knife**, to cut test pieces of dimensions (110 ± 11) mm × (40 ± 1) mm.

7.2.2.9 **Balance**, reading to 0,001 g.

7.2.2.10 **Clock,** reading to 1 s.

7.2.2.11 **Silicone grease**, or suitable adhesive



A Brass roller
B test piece
C Platform
D Clamp on the platform
E Clamp on the brass roller
F Water supply
G Means of pressing the platform

Figure 40 — Schematic diagram of test apparatus

7.2.3 Sampling and conditioning

In the case of footwear, the test piece should be taken from the forepart of the insole, in the longitudinal direction. For sheet materials, the test pieces are taken in the two principal directions, one at 90° to the other.

Test specimens shall be strips of (110 ± 11) mm × (40 ± 1) mm.

Apply a little silicone grease or suitable adhesive over the edges of the test piece in order to prevent the ingress of water through the sides.

7.2.4 Procedure

Weigh the test piece to the nearest 0,001 g (M_O).

Place the cotton gauze on the platform (C).

Apply the test piece in the apparatus with the surface which would be in contact with the foot in contact with platform (C) covered with the cotton gauze. Attach the narrow ends to the platform and roller, and apply a force of (80 ± 5) N.

Open the valve to permit the flow of water and adjust this to (7,5 ± 2,5) ml/min over the platform.

Switch on the machine and note the time.

Run the test for 4 h, stop the water supply 1 min before stopping the machine. The test time can be reduced if proof can be given that the material is saturated.

Note The material is saturated when the difference of two measurements obtained 15 min after each other does not exceed 20 mg.

Remove the test piece and weigh it to the nearest 0,001 g, recording its mass (M_F).

Recondition the test piece by hanging in a controlled environment (see clause 4) for a period of 24 h, then reweigh the test piece to the nearest 0,001 g (M_R).

7.2.5 Expression of results

7.2.5.1 Water absorption

Calculate the water absorption, W_A, expressed in mg/cm² using the following equation:

$$W_A = \frac{M_F - M_O}{A}$$

where:

M_O is the initial mass of the test piece, in mg

M_F is the final mass of the test piece, in mg

A is the area of the test piece in cm²

Express the water absorption to the nearest 1 mg/cm².

7.2.5.2 Water desorption

Calculate the water desorption, W_D, as a percentage of the mass of water absorbed using the following equation:

$$W_D = \frac{M_F - M_R}{M_F - M_O} \times 100$$

where :

M_O is the mass of the test piece, in g

M_F is the final mass of the test piece in g

M_R is the mass of the reconditioned test piece in g

Report the water desorption to the nearest 1%

7.2.6 Test report

Include in the test report :

a) the results for water absorption and water desorption expressed in accordance with 7.2.5.1 and 7.2.5.2;

b) nature and full identification of the sample;

c) description of sampling procedure, where relevant;

d) reference to the method of test; any deviation to the test method, if relevant.

7.3 Determination of abrasion resistance of insole

7.3.1 Principle

The test piece is rubbed with pieces of wet, white wool felt, covered with the abradant fabric, under a given pressure, with a number of 'to and fro' motion cycles. The test is carried out on conditioned insole material, and abrasion damage is assessed visually (with naked eye).

7.3.2 Apparatus[5)]

7.3.2.1 Test equipment, incorporating the following features:

a) carriage, with a horizontal, completely planar metal platform, a holder for fastening the material leaving 80 mm freely exposed and a device which allows the test piece to be maintained under a slight tension in the direction of the rubbing;

b) finger, of mass 500 g, removable but able to be fixed firmly, with a base of 15 mm × 15 mm, a device for attaching pieces of wool felt pads (7.3.2.2) to the base, an additional mass of 500 g and a means of guiding the finger when fully loaded (total mass 1 kg) flat on the test piece;

c) means for driving the carriage to and fro, with an amplitude of 35 mm and a frequency of (40 ± 2) cycles/min

NOTE The following items are convenient, but not essential parts of the equipment:

- means to move the finger at right angles to the direction of rubbing, so that two or three tracks may be used for rubbing on one test piece;

- means for pre-selecting a given number of cycles.

5) Information on the availability of suitable apparatus may be obtained from the Secretariat of CEN/TC 161.

7.3.2.2 Wool pads, square pieces of white wool felt, 15 mm x 15 mm, with a thickness of (5,5 ± 0,5) mm punched out of a sheet of white pure wool felt with the following specifications:

a) mass per unit area of (1750 ± 100) g/m^2;

b) mean water uptake of (1,0 ± 0,1) ml;

c) pH of 5,5 to pH 7,0 for an extract prepared by shaking 5 g of ground felt with 100 ml distilled water for 2 h in a polyethylene bottle.

7.3.2.3 Abradant fabric, cut pieces of fabric of the specification given in table 8 of a dimension sufficient to cover the felt and to attach it to a finger.

7.3.3 Preparation of test piece

Cut a rectangle of minimum dimensions 120 mm × 20 mm.

7.3.4 Preparation of abradant pads

Condition the wool pads (7.3.2.2) and pieces of abradant fabric (7.3.2.3) at (23 ± 2)°C and (50 ± 5)% r.h. for 48 h and then weigh the wool pads.

For each test piece place four wool pads and four rectangles of abradant fabric in distilled water, heat to boiling and allow to boil gently until they sink. Then decant the hot water and replace with cold, distilled water. Leave until the wool pads and abradant fabric have reached room temperature.

Before use, take each pad and abradant fabric from the water, squeeze or wipe it against the rim of the beaker so that it no longer drips. The pads should not be allowed to soak in water for more than 24 h before use.

Verify that the water uptake of the pad and the abradant fabric together is (1,0 ± 0,1) ml, by weighing.

7.3.5 Procedure

Fasten the test piece onto the apparatus and apply a slight tension to hold it flat.

Attach a wet wool pad to the finger, cover with a rectangle of wet abradant fabric and secure it to the finger with, for example, a rubber band or ring, avoiding any crease in the fabric over the surface of the wool pad. Place the finger 5 mm from one edge of the test piece. Attach the additional mass of 500 g to the finger.

Carry out 100 cycles, lift the finger, and examine the test area for abrasion damage.

Replace the wool pad and abradant fabric with fresh ones and carry out a further 100 cycles.

Replace the wool pad and abradant fabric every 100 cycles and stop the test when the abrasion damage of the test piece is equal to, or more severe than the ”acceptable” degree of abrasion of the corresponding reference test piece, or after 400 cycles, whichever occurs first.

7.3.6 Method of assessment

Examine the abraded surface of the test piece visually and evaluate the abrasion damage by comparison to the reference piece[6)] for the same family of materials.

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6) Information on the availability of suitable reference test pieces may be obtained from the Secretariat of CEN/TC 161.

8 Test methods for outsole

8.1 Determination of outsole thickness

8.1.1 Determination of conformity of the cleated area

By means of visual examination check and record whether, with the exception of the region under the flange of the toecap, at least the shaded areas as shown in figure 41, have cleats that are open to the side.

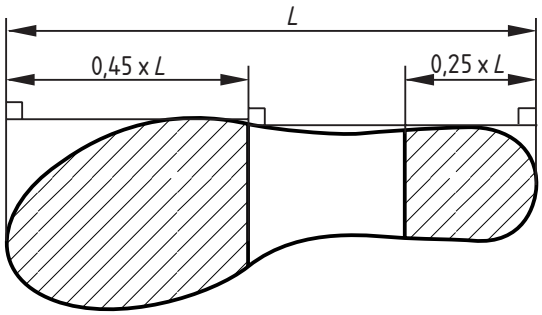
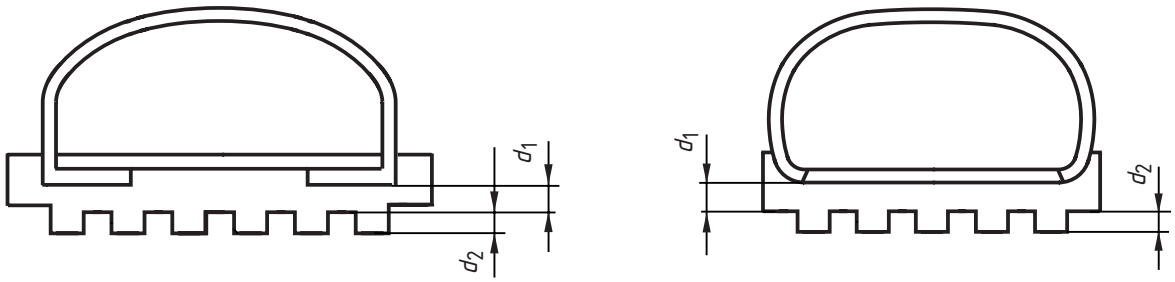


Figure 41 — Cleated area



a) conventional construction **b) Strobel construction**

Figure 42 — Direct injected, vulcanised and cemented outsoles

8.1.2 Outsole thickness

Measure the thickness, d_1, or cleat height, d_2, as indicated in figure 42 a) or b), figure 43 or figure 44, using an adequate instrument with 0,1 mm scale/graduation, after cutting through the sole in the region of the tread corresponding to the shaded area in figure 41. If there is a cavity in the sole it is ignored when measuring d_1. For all-rubber and all-polymeric footwear, make an additional measurement, d_3, as indicated in figure 44.

8.2 Determination of tear strength of outsole

Determine the tear strength of non-leather outsoles according to Method A of ISO 34-1:2004.

The test piece shall be taken transverse to the longitudinal axis in the waist region, if possible.

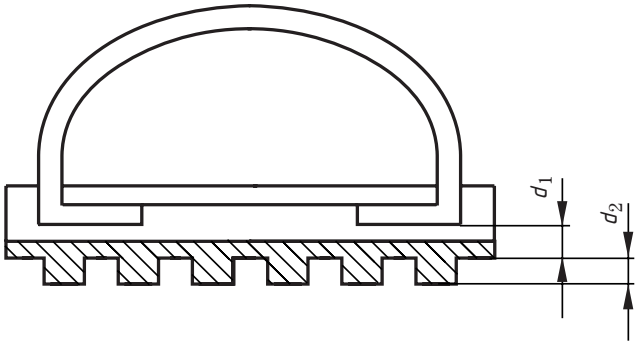


Figure 43 — Multilayered outsoles

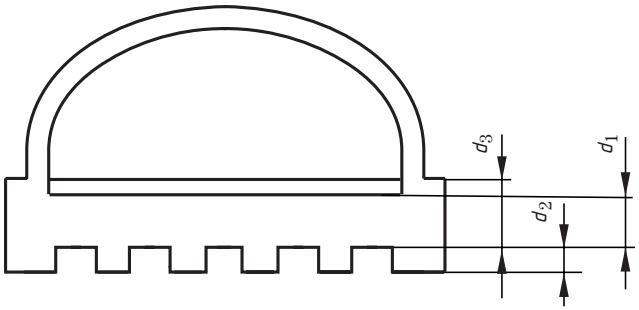


Figure 44 — All-rubber and all-polymeric footwear

8.3 Determination of outsole abrasion resistance

Determine the outsole abrasion resistance of non-leather outsoles according to method A of ISO 4649:2002 (with a vertical force of 10 N over an abrasion distance of 40 m). Test pieces may be taken from anywhere on the sole.

8.4 Determination of flexing resistance of outsole

8.4.1 Rigidity test

8.4.1.1 Apparatus

The apparatus consists of:

8.4.1.1.1 Smooth metal hinged plate, fixed to a rigid base.

8.4.1.1.2 Clamping device, to fix the forepart of the footwear to be tested to the rigid base.

8.4.1.1.3 Sensor, capable of measuring force in the range 0 N to 50 N, to a tolerance of ± 1%, fixed to the hinged plate at a distance of 315 mm from the hinge.

8.4.1.2 Preparation of test pieces

Use one complete item of footwear as the test piece. The middle size of the range should be selected. This will normally be size 42 French / 8 English or size 39 French / 6 English.

Mark the longitudinal axis of the footwear, XY, following the method described in 5.3.2.

The flexing line is defined as the line at 90° to the longitudinal axis passing through it at one third of the distance XY from the toe at X. The flexing line is AC (figure 45).

8.4.1.3 Test procedure

Clamp the forepart of the footwear to the rigid base using a solid block (corresponding to the forepart of the last) in such a way that the flexing line AC is aligned with the hinge axis of the base plate (8.4.1.1.1), see figure 45.

The rear edge of the block shall be positioned 10 mm forward of the flexing line (A-C as shown in figure 46).

NOTE It is possible that when the front part of the shoe is fixed the heel will not touch the plate.

Measure the flexed angle α when a force of (30 ± 0,5) N is applied normal to the plane of the hinged plated (8.4.1.1.1) at a distance of 315 mm from the centre of the hinge (see figure 47).

The 30 N shall be applied progressively by increasing the force at a rate of (100 ± 10) mm/min.

It is possible to add a lubricant under the heel to facilitate the test.

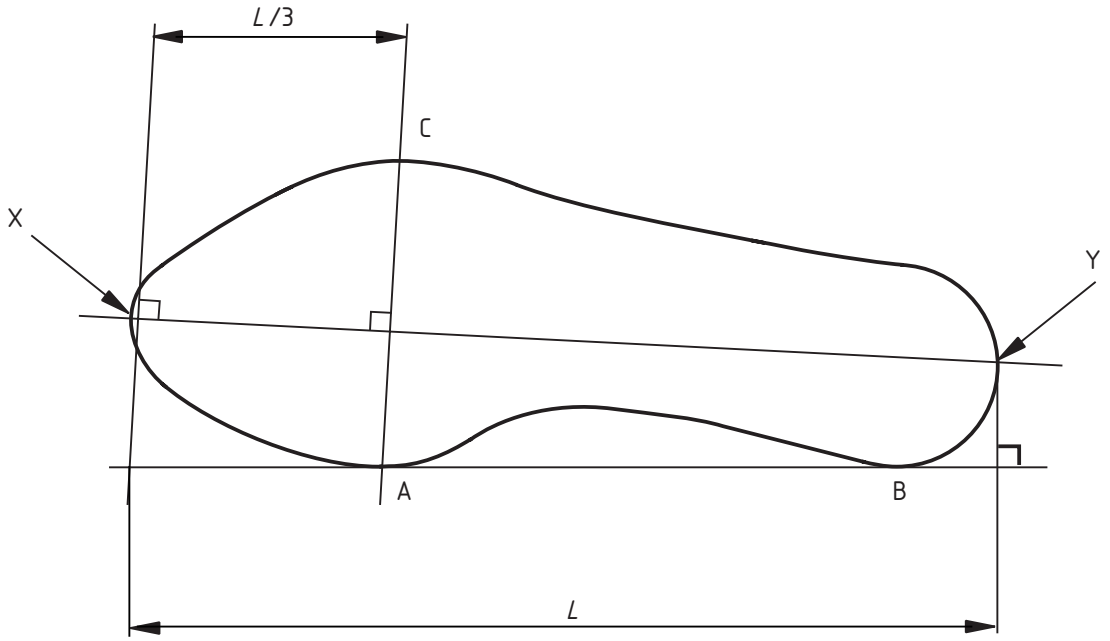
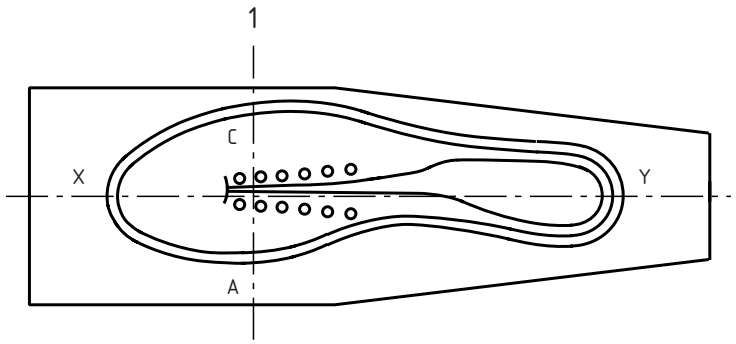


Figure 45 — Position of flexing line on the sole

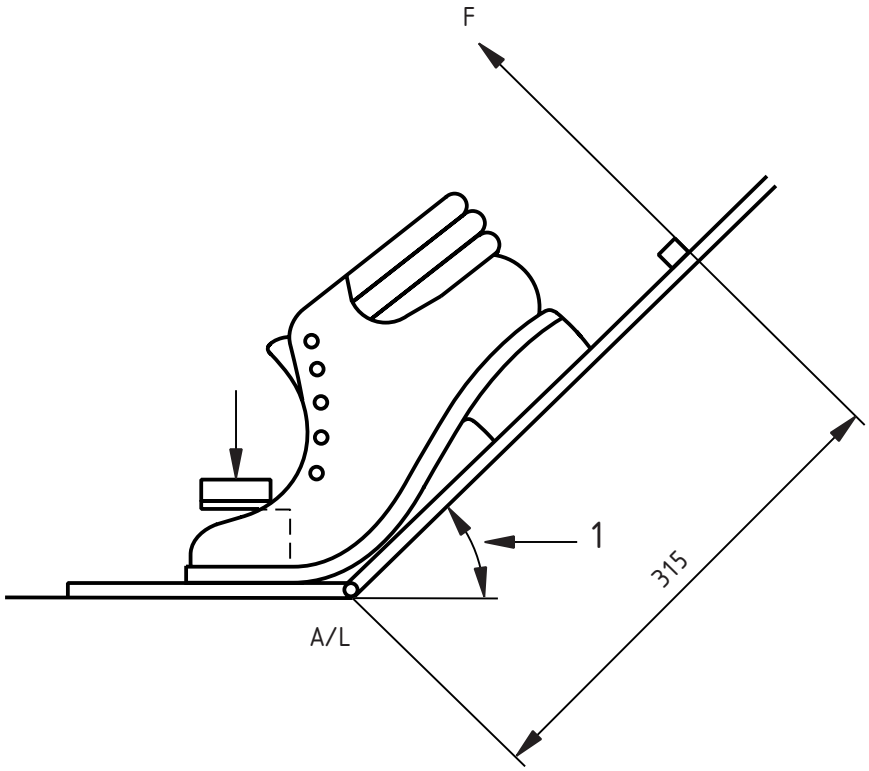


1 Flex line

Figure 46 : Position of the footwear on the test machine

8.4.1.4 Selection criteria

Footwear whose angle under the applied force is lower than 45° from the horizontal is not subjected to the flexing test described in 8.4.2.



1 Flex angle α
dimension in mm

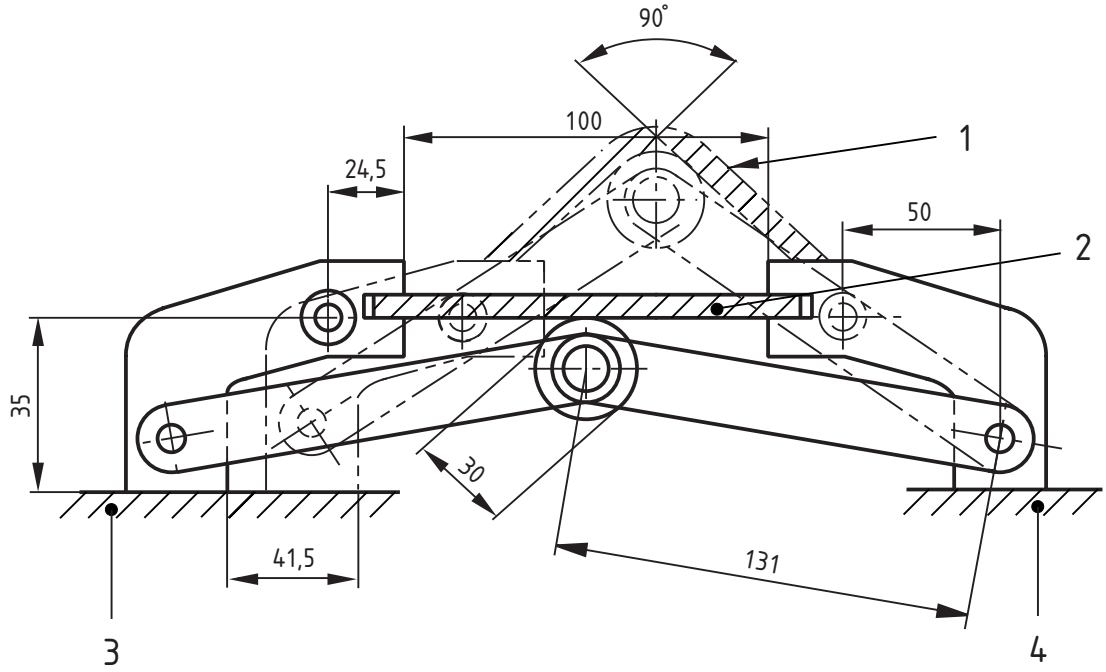
Figure 47 — Flexing angle

8.4.2 Flexing test

8.4.2.1 Apparatus

8.4.2.1.1 **Testing device**, as illustrated in figure 48. The test piece shall be guided in such a way that on one side it can be bent at an angle of 90° about a mandrel with a radius of 15 mm.

Dimensions in mm



1 Test piece at maximum flex position
2 Test piece at null flex position
3 Moveable bearing
4 Fixed bearing

Figure 48 — Testing device for flexing resistance of outsole

8.4.2.1.2 Cutting tool, as defined in figure C.2 of ISO 5423:1992.

8.4.2.1.3 Measuring magnifier, with an accuracy of 0,1 mm.

8.4.2.2 Preparation of test piece

Take the bottom of the footwear with the insole, separated from the upper, as the test piece.

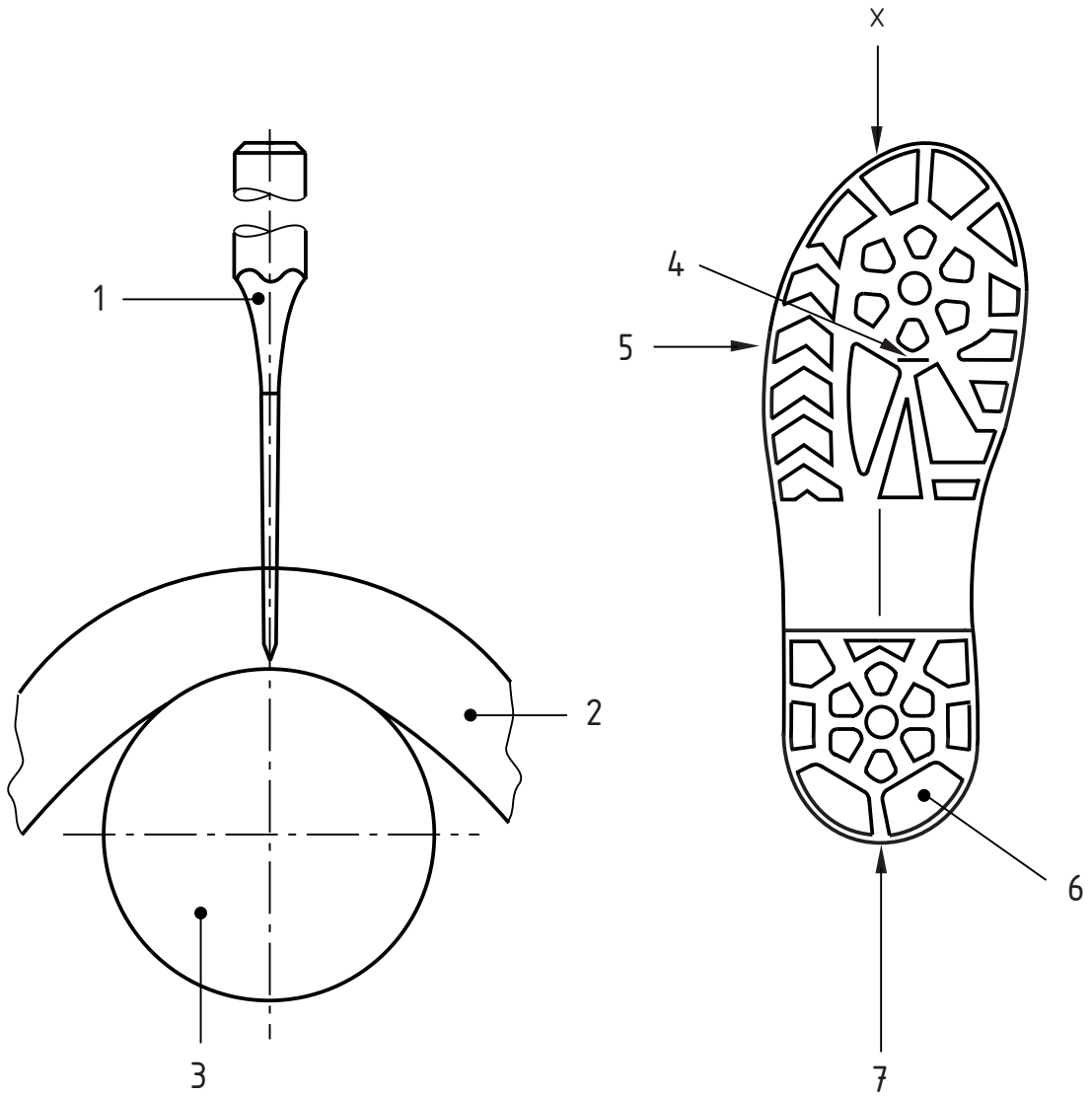
Define the flexing line according to 8.4.1.2.

Mark a point, for the later insertion of a cut, as follows:

Find the centre of the line AC, and then identify two adjacent cleats that are as close as possible to the centre of the line AC. Mark the sole midway between these cleats (see figure 49).

8.4.2.3 Procedure

Ensure that the testing device (8.4.2.1.1) is at the neutral flex position (see figure 48) and clamp the test specimen into the device in such a way that the flexing line AC is parallel with the central roller and the cut position marked 8.4.2.2 is directly above the centre roller. Manipulate the machine until the test specimen is in the maximum flexed, extended or stretched state. Make a single incision at the point marked in 8.4.2.2 with the blade of the cutting tool (8.4.2.1.2) parallel to the flexing line AC. The cutting device shall pass through the full thickness of the outsole and into the insole or equivalent layer.



1 Cutting tool
2 Test piece
3 Mandrel of the test machine, radius 15 mm
4 Single incision parallel to the line of maximum stress
5 Line of maximum stress (deformation) AC
6 Cleats
7 Longitudinal axis XY

Figure 49 — Sole incision

If there are several materials constituting the sole, another incision shall be made, but it is necessary to avoid the cut in a region of 15 mm from the edge of the sole.

Measure the initial length of the cut at the surface of the test specimen using the measuring magnifier (8.4.2.1.3).

Carry out 30 000 cycles starting from the maximum flexed, extended or stretched state, with the test specimen undergoing deformation at a constant rate value between 135 cycles/min and 150 cycles/min.

At completion of the 30 000 cycles, the testing device should not be left in the fully flexed position.

After 30 000 cycles, measure the final length of the cut at the surface of the test specimen using the measuring magnifier (8.4.2.1.3).

Cut growth = (final cut length) - (initial cut length).

8.5 Determination of resistance to hydrolysis of outsole

Determine the outsole hydrolysis according to annex C of ISO 5423:1992, after preparation and conditioning as described in annex E of that standard. The test pieces shall include any associated textile layer, have a thickness of (3 ± 0,2) mm and be preconditioned at (23 ± 2)°C, before testing.

8.6 Determination of resistance to fuel oil

8.6.1 General method

8.6.1.1 Test liquid

2,2,4-trimethylpentane, general purpose reagent.

8.6.1.2 Preparation of test specimen

Cut from the outsole two cylindrical pieces (16 ± 1) mm in diameter and (4 ± 0,5) mm in thickness and test both pieces at the same time.

For multilayered soles, if it is not possible to obtain a test piece of 4 mm thickness from the compact layer, cut a test piece which includes part of the expanded layer.

8.6.1.3 Test procedure

Follow the general procedure described in 8.2 of ISO 1817:1999.

Immerse the test piece in the test liquid (8.6.1.1) at a temperature of (23 ± 2)°C for a period of (22 ± 0,25) h. Determine the increase in volume of each test piece using the volumetric method.

If the test piece shrinks by more than 0,5% or increases in hardness by more than 10 Shore A hardness units, determined using the method described in EN ISO 868, take a further test piece, as described in 8.6.2.2 and test as described in 8.6.2.3.

8.6.2 Method for outsole materials which shrink or become hardened

8.6.2.1 Test liquid

As described in 8.6.1.1.

8.6.2.2 Preparation of test piece

Take a test piece of nominal width 25 mm and nominal length 150 mm from the outsole of the footwear and reduce the overall thickness to (3 ± 0,2) mm by roughing or scouring.

8.6.2.3 Test procedure

Immerse the test piece in the test liquid at a temperature of (23 ± 2)°C for a period of (22 ± 0,25) h.

Remove the excess liquid with absorbent paper and determine the cut growth in the specimen after 150 000 cycles in accordance with the method described in annex C of ISO 4643:1992.

8.7 Determination of resistance to hot contact

8.7.1 Apparatus

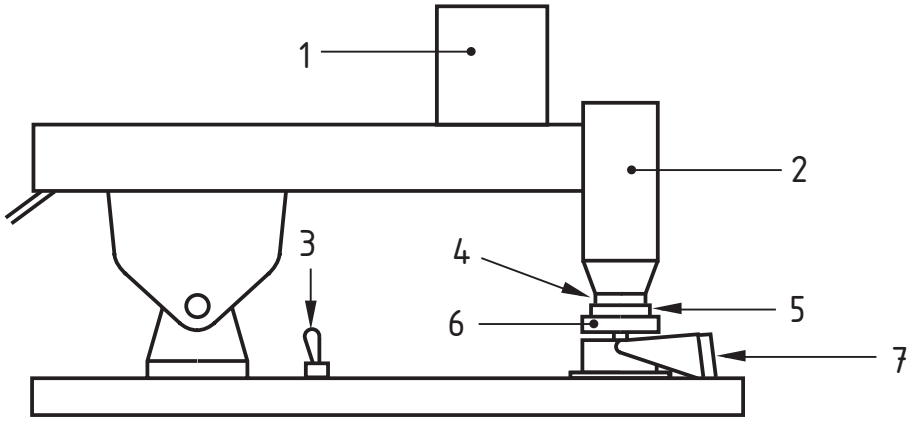
NOTE A general arrangement of the apparatus is illustrated in figure 50.

WARNING: As toxic fumes may be released from some soling during this test it is necessary to place the apparatus in a well ventilated area.

8.7.1.1 Cylindrical copper body, referred to as the bit, of mass (200 ± 20) g and with the lower end reduced to a flat square with sides of dimensions (25,5 ± 0,1) mm. The bit shall have a central longitudinal cavity of 6,5 mm diameter, extending to 4 mm from the outer working surface of the end square of the bit, to receive a temperature measuring device. The other dimensions of the bit shall be as shown in figure 51.

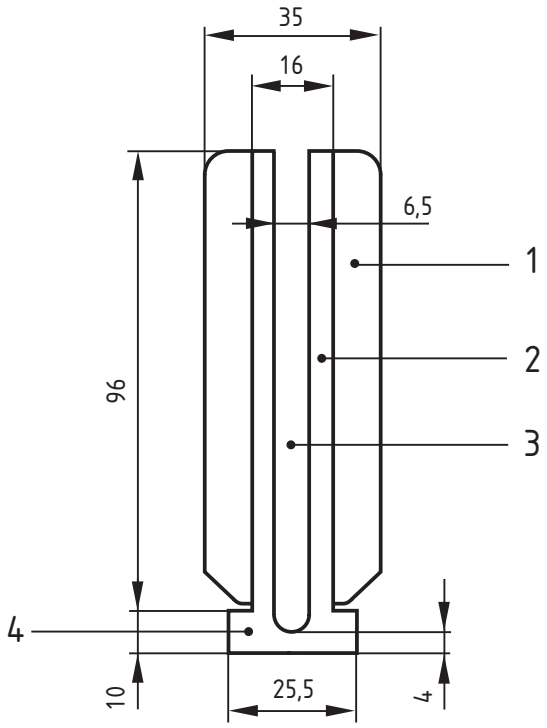
8.7.1.2 Metal heating block, of mass (530 ± 500) g, which surrounds the cylindrical part of the bit. The heating block shall contain an electrical resistance heating element and a means of control (an on/off switch is sufficient) to pre-heat the bit to any desired temperature up to a maximum of 400°C. The dimensions of the heating block shall be as shown in figure 51.

8.7.1.3 Measuring device, for the internal temperature of the bit close to its square end



1 Weight
2 Encased heating block including device for measuring temperature
3 On/off switch
4 Square end of copper bit
5 Soling test piece
6 Self-aligning test piece platform
7 Hinged insulated support

Figure 50 — Apparatus for resistance to hot contact



1 Metal heating block
2 Copper bit
3 Device for measuring the temperature
4 Square end of bit

Figure 51 — Bit and heating block

8.7.1.4 Means of raising and lowering the bit, together with the heating block, to bring its face into uniform contact with the test piece, in a horizontal plane and under a uniformly distributed pressure of (20 ± 2) kPa.

8.7.1.5 Self aligning platform, of suitable diameter, to receive the test piece and maintain uniform pressure on it.

8.7.1.6 Hinged support with thermally insulated face, on which the face of the bit rests during heating, and which can be moved aside to enable the bit to be lowered onto the test piece.

8.7.1.7 Mandrel, of (10 ± 1) mm diameter.

8.7.2 Preparation of test specimen

Cut a test piece of width (30 ± 2) mm and length 70 mm (minimum) from the sole and, where necessary, remove the cleats.

The test may be carried out in the waist region where there are normally no cleats. Where, however, the removal of the cleats would result in the removal of the wear layer, it is essential that the test piece is taken from the waist region.

8.7.3 Procedure

Switch on the heating block with the bit resting on the insulating support and place the test piece on the platform below with its wear side uppermost. Cover the test piece with aluminium foil to prevent contamination of the heated bit, using a new piece of foil for each test. When the bit temperature has just exceeded 300°C switch off the heating block and allow the temperature to fall to (300 ± 5) ° C, with the bit still resting on its insulating support. Then move the insulating support aside and immediately place the bit centrally on the test piece, so its sides are parallel to the side of the test specimen. Leave it in position for (60 ± 1) s without switching the heating block on again and then replace it on the support.

Remove the foil, allow the test piece to cool for at least 10 min and examine that part of its surface that had been heated as described in 8.7.4.

8.7.4 Method of assessment

Assess the surface of the test piece visually for damage such as melting, charring, cracking or crazing, both before and after bending it around the mandrel. Record the type and extent of the damage. For leather soles record whether charring or cracking is confined to the grain layer or whether any damage penetrates into the corium.

Annex A
(normative)

Determination of footwear slip resistance

A.1 Test parameters

The coefficient of friction of the footwear is determined according to ISO 13287:2006 under the test conditions given in Table A.1, ensuring that the 7° heel mode contact angle is set up with the shoemaking last holding the footwear lowered onto the 7° setting wedge under its own weight.

Table A.1 — Test conditions

Test condition	Foot position	Floor	Lubricant
A (forward heel slip)	ISO 13287:2006, 8.2 a)	ISO 13287:2006, 6.5	ISO 13287:2006, 5.2
B (forward flat slip)	ISO 13287:2006, 8.2 c)		
C (forward heel slip)	ISO 13287:2006, 8.2 a)	ISO 13287:2006, 6.4	ISO 13287:2006, 5.1
D (forward flat slip)	ISO 13287:2006, 8.2 c)		

A.2 Calibration procedure of ceramic tiles

A.2.1 General

Before performing a test on a ceramic tile, the tile shall be calibrated according the following procedure.

Only ceramic tiles giving test results in the range 0,18 to 0,22 shall be accepted for testing footwear. Tiles giving results outside this range shall be rejected.

A.2.2 Materials and apparatus

A.2.2.1 Material 'Slider 96' [1)], of calibrated hardness (96 ± 2) IRHD measured value at (23 ± 2) °C and resilience of (24 ± 2) % at 23 °C of specimen size: (25,4 ± 0,1) mm wide, at least 50 mm long and greater than 5 mm thick and with vertical walls and square edges.

Storage of Slider 96 rubber: storage temperature should be below 25 °C and preferably below 15 °C. Moist conditions should be avoided and conditions should be such that condensation does not occur. Protect from light, particularly direct sunlight and strong artificial light. Protect from circulating air by wrapping it in paper or polyethylene (but not plasticized PVC film such as clingfilm) or storing in an air tight container. It is recommended that Slider 96 sliders are discarded 12 months after issue.

1) "Slider 96" material (formerly known as "Four S rubber") can be obtained from: RAPRA Technology Ltd., Shrewsbury, Shropshire, UK, SY4 4NR, tel.: + 44 1939 250383, fax: + 44 1939 251118, email: info@rapra.net. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

〈A1〉
A.2.2.2 Means of cutting Slider 96. Slider 96 rubber (A.2.2.1) is supplied pre-moulded in a suitable size and form. However, if larger sheets of Slider 96 rubber are obtained then a means is required of cutting a rectangular test specimen such that it has vertical walls, square edges, is (25,4 ± 1,0) mm wide and at least 50 mm long. A means of trimming specimens parallel to the 25,4 mm edge while retaining a vertical wall and square edge can also be required (see A.2.3.5, Notes 1 and 2).

NOTE Cutting by some methods such as shoemaking press knives can produce concave walls.

A.2.2.3 Rigid, rectangular backing plate, with dimensions at least as wide as the specimen cut with the device and at least 50 mm long.

A.2.2.4 Means of securely attaching a specimen of Slider 96 rubber (A.2.2.1) **to the backing plate** (A.2.2.3). Suitable adhesives include: epoxy resins, cyanoacrylate or solvent-based contact adhesive. The face to be bonded should be lightly abraded with abrasive paper (A.2.2.6) then cleaned by blowing with clean air or by wiping with a suitable solvent such as methanol and allowing to dry in air before bonding.

NOTE Double-side tape can be suitable at the low level of coefficient of friction expected when testing on ceramic tile with detergent solution.

A.2.2.5 Means of attaching the specimen backing plate (A.2.2.3) to the test apparatus at the required contact angle.

NOTE A rectangular metal box of dimensions 180 mm × 90 mm × 90 mm can be used to replace the shoemaking last described in ISO 13287 and the backing plate (A.2.2.3) attached to it.

A.2.2.6 400 grit silicon carbide abrasive paper, mounted on a flat, rigid surface.

A.2.2.7 Dry, absorbent paper towel.

A.2.2.8 Ceramic tile as specified in ISO 13287.

A.2.2.9 Test machine as specified in ISO 13287.

A.2.3 Preparation of test slider and ceramic tile

A.2.3.1 If necessary, cut to size a specimen of Slider 96 rubber (A.2.2.1) using the cutting device (A.2.2.2) and clean using distilled water then dry in air. Do not use the Slider 96 specimen that is used for calibration purposes for any other purpose or with any other lubricant.

A.2.3.2 Attach the specimen of Slider 96 rubber (A.2.2.1) to the backing plate (A.2.2.3) using adhesive (A.2.2.4).

A.2.3.3 Holding the specimen by the backing plate (A.2.2.3) and applying a light, evenly distributed pressure, abrade the surface of the rubber against the abrasive paper (A.2.2.6) until a visually even level of abrasion is achieved and the surface is parallel with the backing plate. For this procedure alternately use a backward and forward linear movement in a direction parallel to the long side of the specimen, and a side to side movement in a perpendicular direction with the final direction of abrasion parallel to the long side.

A.2.3.4 Remove any debris from the test slider surface by lightly brushing with dry paper towel (A.2.2.7).

A.2.3.5 Clean the ceramic tile (A.2.2.8) in accordance with ISO 13287.

The condition of the Slider 96 test slider should be restored at intervals as repeated use will cause edges to become rounded or a concave chamfer can develop across the tested edge. Either use the abrasion method described above to restore the slider to the correct condition and/or cut away the affected end section of material, providing at least 50 mm length remains and the new cut edge is vertical and flat.

NOTE 1 Both ends of the slider can be used provided that the end used is in the correct condition. 〈A1〉

A1
NOTE 2 When the thickness of the slider has been reduced to 5 mm by repeated use, it is advisable to replace it.

A.2.4 Calibration test procedure

A.2.4.1 Condition the ceramic tile and the test slider (A.2.3) for at least 3 h at the test atmosphere.

A.2.4.2 Attach the test slider (A.2.3) to the test machine so that the 25,4 mm edge is perpendicular to the direction of sliding movement and the line of action of the vertical force passes through the Slider 96 rubber/floor contact area.

A.2.4.3 Set the face of the test slider at a contact angle of (7 ± 0,5)° to the surface of the ceramic tile (see Figure A.1).

A.2.4.4 Mount the tile and lubricate with detergent solution in accordance with ISO 13287.

A.2.4.5 Apply the test conditions specified in ISO 13287 for the forward heel slip mode, applying a 500 N normal force.

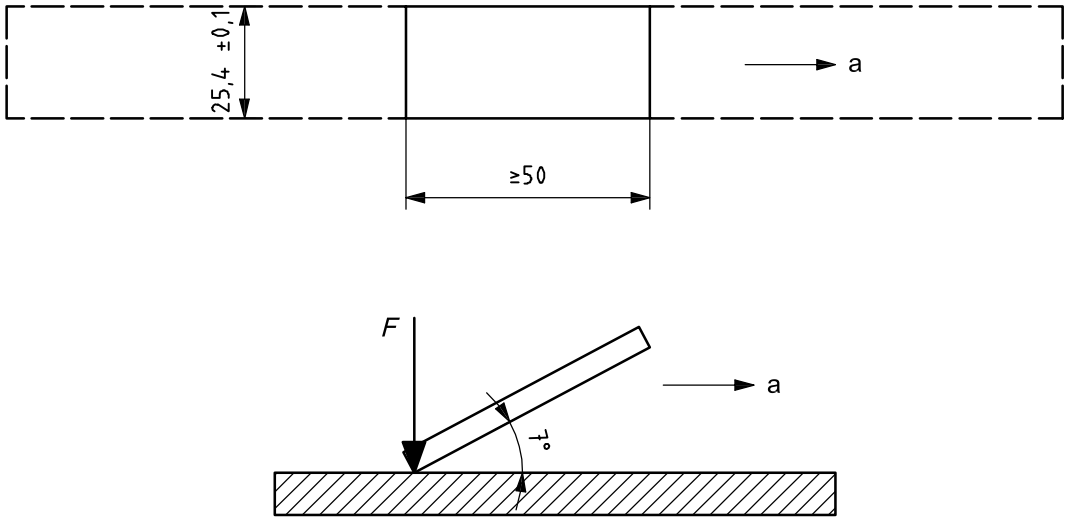
A.2.4.6 Carry out the test procedure defined in ISO 13287 and determine the coefficient of friction of the tile in a single test run.

A.2.4.7 If the coefficient of friction is outside the specified range (0,18 to 0,22), reject the tile.

A.2.4.8 If the coefficient of friction is within specified range, accept the tile and record the values obtained.

A.2.4.9 Clean (A.2.3.1) and dry the Slider 96 specimen in air before returning to storage.

Dimensions in millimetres



Key

F normal force

a Sliding direction.

Figure A.1 — Orientation and contact angle of Slider 96 test slider A1

Annex ZA
(Informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of the EU Directive 89/686/EEC.

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Table A1 shows the relationship between relevant requirements of the Directive 89/686 EEC and the clauses of this standard.

TABLE ZA.1 - Correspondence between this European Standard and EU Directives

EU Directive 89/686 EEC, Annex II	**Clauses of this European Standard**
All requirements	The clauses of this European Standard specify test methods for the relevant requirements for safety, protective and occupational footwear to support the applicable requirements of Directive 89/686/EEC annex II

Annex ZB
(normative)

Corresponding International and European Standards for which equivalents are not given in the text

At the time of publication of this edition of EN ISO 20344, the editions of the following documents were valid. Members of ISO and IEC maintain registers of currently valid International Standards.

EN 388:1994	No ISO equivalent
EN 12568:1998	No ISO equivalent
EN 50321:1999	No ISO equivalent
EN ISO 868	ISO 868
EN ISO 4044	ISO 4044
EN ISO 4045:1998	ISO 4045
EN ISO 20345	ISO20345: 2004
EN ISO 20346	ISO 20346: 2004
EN ISO 20347	ISO 20347: 2004
EN ISO 17249	ISO 17249: 2004
ISO 34-1:1994	No EN equivalent
ISO 1817:1999	No EN equivalent
ISO 2023:1994	No EN equivalent
ISO 3290	No EN equivalent
EN ISO 3376:2002	ISO 3376:2002
EN ISO 3377-2	ISO 3377-2: 2002
EN ISO 3696	ISO 3696: 1987
ISO 4643:1992	No EN equivalent
ISO 4648:1991	No EN equivalent
ISO 4649:2002	No EN equivalent
ISO 4674-1:2003	EN ISO 4674-1:2003
ISO 5423:1992	No EN equivalent

Bibliography

[1] Martindale machine : J. Text . Inst. 1942 : 33, T151

[2] ISO 5725-2, Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method

[3] ENV 13005, Guide to the uncertainty of measurement (GUM)

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

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