BRITISH STANDARD

BS EN
13287:2004

Personal protective equipment — Footwear — Test method for slip resistance

The European Standard EN 13287:2004 has the status of a British Standard

ICS 13.340.50

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13287:2004. It supersedes DD ENV 13287:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PH/1, Safety, protective and occupational footwear, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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 does not of itself confer immunity from legal obligations.

This British Standard, was published under the authority of the Standards Policy and Strategy Committee on 10 May 2004

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 17 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 43748 5

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13287

March 2004

ICS 13.340.50

Supersedes ENV 13287:2002

English version

Personal protective equipment - Footwear - Test method for slip resistance

Equipement de protection individuelle - Chaussures - Méthode d'essai pour déterminer la résistance au glissement

Persönliche Schutzausrüstung - Schuhe - Prüfverfahren zur Bestimmung der Rutschhemmung

This European Standard was approved by CEN on 2 February 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of 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.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13287:2004: E

Contents

page

Foreword ... 3

1 Scope ... 4

2 Normative references ... 4

3 Terms and definitions ... 4

4 Principle ... 5

5 Reagents ... 5

6 Apparatus ... 5

7 Sampling ... 6

8 Test conditions ... 6

9 Preparation of the sole ... 9

10 Procedure ... 10

11 Test report ... 11

Annex A (normative) **Shoemaking last and artificial foot for testing the slip resistance of footwear** ... 12

Annex B (normative) **Uncertainty of measurement and interpretation of results** ... 14

Annex ZA (informative) **Clauses of this European Standard addressing essential requirements or other provisions of EU Directives** ... 16

Bibliography ... 17

Foreword

This document (EN 13287:2004) has been prepared by Technical Committee CEN/TC 161 “Foot and leg protectors”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2004 and conflicting national standards shall be withdrawn at the latest by September 2004.

This document supersedes ENV 13287:2002.

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.

Annexes A and B are normative.

This document includes a Bibliography.

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

1 Scope

This European Standard specifies a method of test for the slip resistance of conventionally soled safety, protective and occupational footwear. It is not applicable to special purpose footwear containing spikes, metal studs or similar.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 20344, *Personal protective equipment – Test methods for footwear (ISO 20344:2003).*

EN ISO 4287, *Geometrical product specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters (ISO 4287:1997).*

3 Terms and definitions

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

3.1
normal force
force applied to the footwear, perpendicular (90°) to the surface

3.2
frictional force
force parallel to the surface and against the direction of movement arising when footwear slides over a surface

3.3
coefficient of friction (CoF)
ratio of the frictional force divided by the normal force

3.4
static contact time
time between first contact of the footwear with the surface at 50 N normal force and beginning of movement

3.5
measurement period
time interval during which the frictional force measurement is taken and during which the test conditions are satisfied

3.6
surface
floor, with or without contaminant (lubricant), against which the footwear is tested

3.7
test cycle
consists of 5 measurements of footwear in one mode according to 8.2

4 Principle

The item of footwear to be tested is put on a surface, subjected to a given normal force, and moved horizontally relative to the surface (or the surface is moved horizontally relative to the item of footwear). The frictional force is measured and the dynamic coefficient of friction is calculated.

The uncertainty of measurement for coefficient of friction in this standard shall be assessed according to annex B.

5 Reagents

5.1 Glycerol, aqueous solution with a viscosity of (0,2 ± 0,1) Pa·s {(200 ± 100) cP}. At 20 °C this corresponds to an aqueous solution containing a mass fraction of approximately 84,0 % to 91,4 % glycerol. For other temperatures see Table 1 (values for temperatures in the range given in the table may be interpolated).

NOTE As a solution containing a mass fraction of approximately 90 % glycerol is hygroscopic in air with a relative humidity of more than 32 %, it is advisable to use solutions with a mass fraction of approximately 89,0 % to 91,5 % glycerol and to renew the solution layer on the testing surface frequently during prolonged testing sessions if the relative humidity of the surrounding air exceeds 32 %. The concentration of the glycerol needs to be checked regularly, e.g. by measuring the refractive index.

Table 1 - Approximate concentrations of glycerol in water for different temperatures and viscosities

Temperature °C	Concentration and refractive index of glycerol in water for					
	0,1 Pa·s (100 cP)		0,2 Pa·s (200 cP)		0,3 Pa·s (300 cP)	
	Mass fraction %	Refractive index	Mass fraction %	Refractive index	Mass fraction %	Refractive index
17,5	82,7	1,4481	87,8	1,4555	90,2	1,4595
20,0	84,0	1,4494	89,0	1,4568	91,4	1,4606
22,5	85,3	1,4508	90,2	1,4581	92,6	1,4618
25,0	86,6	1,4512	91,4	1,4594	93,7	1,4628

5.2 Detergent solution, containing a mass fraction of 0,5 % sodium lauryl sulphate in demineralized water.

5.3 Ethanol solution, containing a mass fraction of (50 ± 5) % ethanol in water.

6 Apparatus

6.1

a) Shoemaking last , conforming to A.1 to hold the item of footwear.

b) Artificial foot, conforming to dimensions given in A.2 to hold the item of footwear.

6.2 Mechanism, for lowering the item of footwear onto the surface and applying the required normal force at the required time according to clause 8.

6.3 Device, for measuring the normal force exerted on the item of footwear.

6.4 Steel floor, consisting of a stainless steel plate, such as steel Number 1.4301, Type 2G (cold rolled, ground) conforming to EN 10088-2: 1995. [1)]

Surface roughness shall be measured in the area where the slip measurements are actually made. Measurements shall be made at 10 locations within this area and in the direction parallel to the sliding movement. At each location measurements shall be made with a sampling length of 0,8 mm, taking five sampling lengths per location (evaluation length 4,0 mm).

The average roughness R_z shall be measured according to EN ISO 4287. The overall mean value from all 10 locations shall be for R_z between 1,6 µm and 2,5µm.

When the roughness parameter does not conform to the above specifications, the steel shall be prepared using silicon carbide abrasive paper or cloth for polishing in a succession of reducing grit sizes. The polishing direction of each operation shall be perpendicular to the preceding operation with the final direction being in the test direction. The preparation shall continue until the roughness parameter falls within the above specifications.

NOTE Grit sizes 100 to 600 can be suitable.

6.5 Pressed ceramic tile floor, of roughness R_z, measured according to 6.4, having an overall mean value of R_z from all 10 locations of between 14µm and 18µm.[2)]

6.6 Mechanism, for inducing movement between the footwear and the surface at a time and speed according to clause 8.

6.7 Frictional force measuring device, connected to either footwear or surface.

6.8 Silicon carbide paper, 400 grit size, mounted on a rigid block with a flat face 100 mm × 70 mm and mass (1200 ± 120) g.

NOTE This can be achieved using steel to make a block 22 mm thick.

7 Sampling

When testing in accordance with EN ISO 20344 test at least one item of footwear of each of the smallest, middle and largest sizes in the manufacturer's size range.

For other applications a minimum of three samples of the same type of footwear should be tested unless otherwise specified.

8 Test conditions

8.1 The test items shall be conditioned prior to the test at (23 ± 2) °C and (50 ± 5)% rh in accordance with EN ISO 20344 and the test shall be performed within 30 min after removal from that standard atmosphere. The climatic conditions during the test shall be a temperature of (23 ± 2) °C.

---

1) Details of a source of suitable steel can be obtained from the Secretariat of CEN/TC 161.

2) Details of a source of suitable ceramic tiles can be obtained from the Secretariat of CEN/TC 161.

8.2 The footwear shall be tested in at least one of three modes (see Figure 1):

a) Forward heel slip at angled contact;

b) Backward slip on the forepart;

c) Forward flat slip.

8.3 For the heel and forepart test modes the footwear shall be fitted onto the shoemaking last (6.1). The inside tangent of the shoemaking last shall be aligned parallel to the direction of movement.

In the heel test mode the footwear moves forward in the heel to toe direction. The contact angle between the bottom of the heel and the floor shall be (7,0 ± 0,5)° (see Figure 1).

In the forepart test mode the footwear moves backwards in the toe to heel direction. The contact angle between the bottom of the shoe and the floor shall be (7,0 ± 0,5)º (see Figure 1).

For the flat test mode the footwear shall be fitted onto the artificial foot (6.1).

NOTE A rigid wedge having a (7,0 ± 0,5)º angle and of minimum dimensions 80 mm wide by 120 mm long can provide a suitable means of setting the contact angle. The shoemaking last holding the footwear is lowered onto the wedge under its own weight and adjusted until the footwear heel sits flat on the angled face of the wedge.

8.4 The normal force for footwear of Paris points size 40 (English size 6,5) and above shall be (500 ± 25) N. For footwear of Paris points size below 40 the normal force shall be (400 ± 20) N.

In the heel test mode the line of action of the normal force shall be aligned within the heel-floor contact area.

In the forepart test mode the line of action of the normal force shall be aligned through the approximate centre of the forepart-floor contact area.

In the flat mode, the artificial foot (6.1) determines the line of action of the normal force.

8.5 The static contact time shall be a maximum 1,0 s from an initial contact force of 50 N to achieving full normal force and initiation of sliding movement. Sliding movement should start within 0,5 s of achieving the full normal force (see Figure 2).

8.6 The sliding velocity during the measurement period shall be (0,3 ± 0,03) m/s.

8.7 The mean frictional force shall be measured between 0,30 s and 0,60 s after the start of sliding movement when both the full normal force (8.4) and sliding speed (8.6) have been achieved (see Figure 2). The result of the measurement is the mean value during the measurement period.

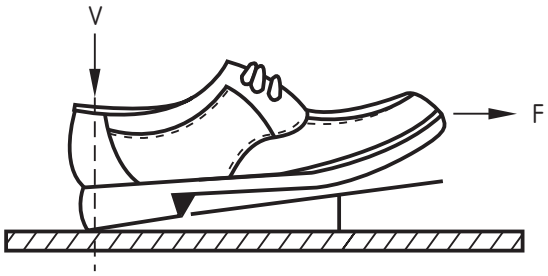


Figure 1a – Forward heel slip

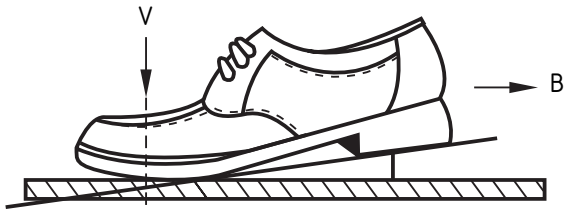


Figure 1b – Backward forepart slip

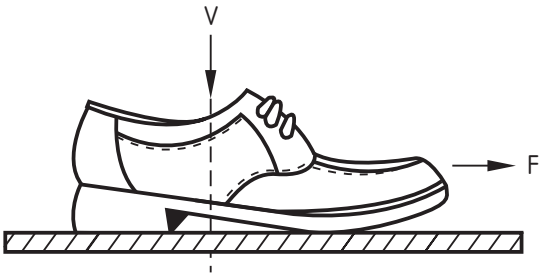
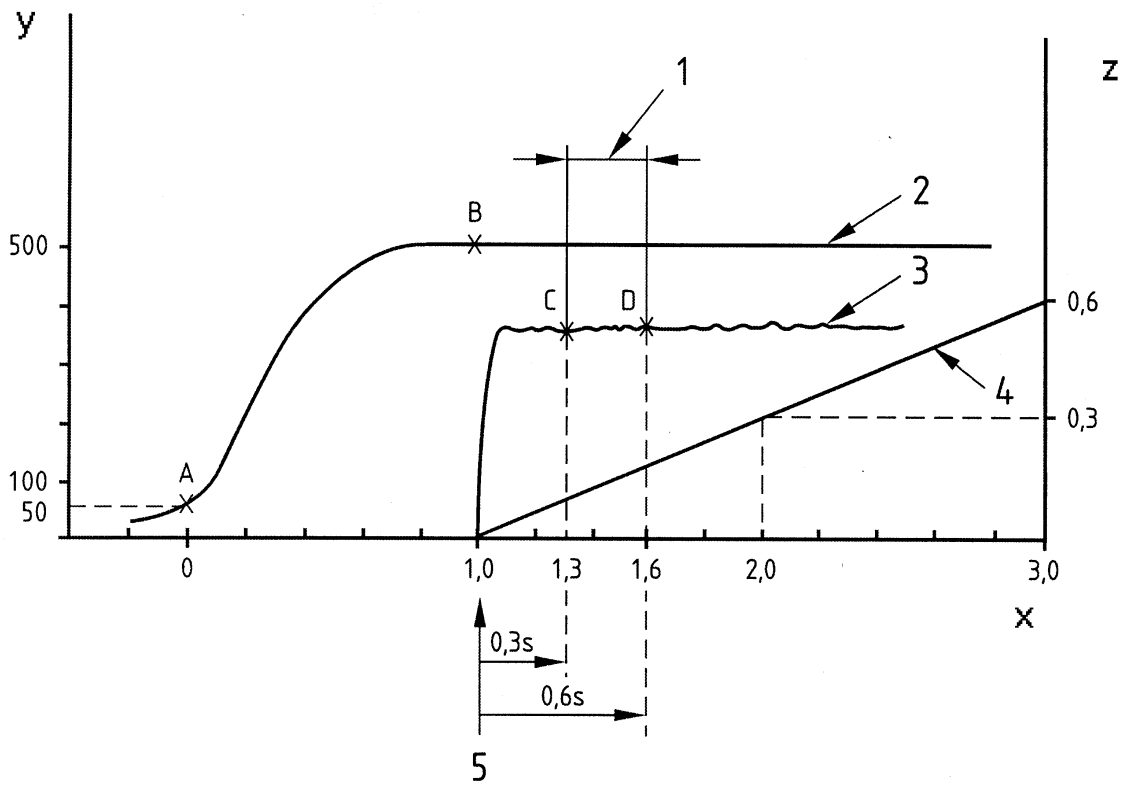


Figure 1c – Forward flat slip

Key

V Normal force
F Forward movement of shoe relative to surface
B Backward movement of shoe relative to surface

Figure 1 - Three test modes showing line of action of the normal force with respect to the sole-floor contact area



Key

x Time (s)
y Force (N)
z Displacement (m)
1 Measurement period
2 Normal force
3 Frictional force
4 Displacement
5 Maximum static contact
A Initial contact defined by 50 N normal force
B Start of movement occurring at a maximum of 1,0 s after initial contact (point A) and within 0,5 s of achieving the required full normal force (400 N or 500 N)
C-D Measurement period between 0,30 s and 0,60 s after start of movement.

Figure 2 — Illustrative test trace

9 Preparation of the sole

9.1 Clean and prepare the sole (heel and forepart) of the item of footwear to be tested before each test by the following procedure.

Wash the sole with an ethanol solution (5.3) and dry at ambient temperature.

9.2 Unless otherwise required, abrade the sole of the shoe by rubbing it with silicon carbide paper wrapped around a rigid block (6.8) exerting minimal pressure (see Figure 3).

Any debris should be removed by suitable means such a clean compressed air or a clean dry soft brush.

NOTE It is intended that only superficial abrasion should be applied that does not significantly change the tread pattern nor the surface texture of the sole, and that produces a final visually uniform appearance over the whole area of the sole that will be in contact with the floor during the test.

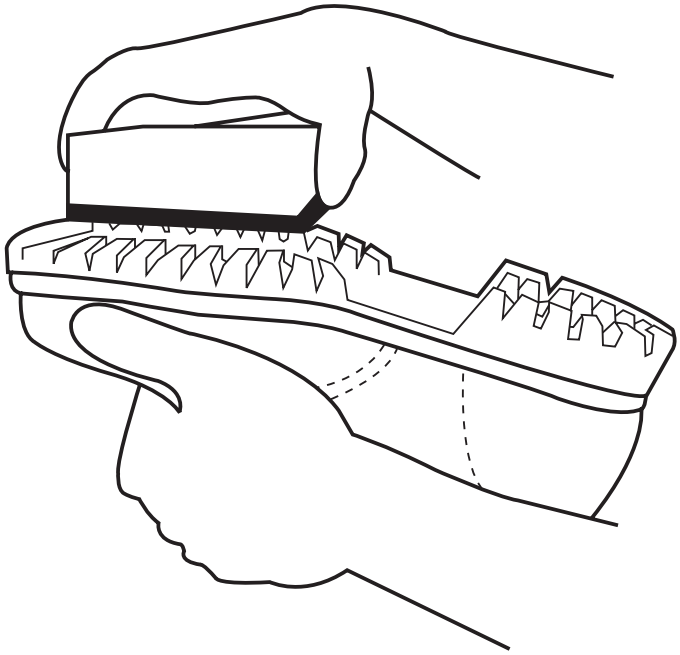


Figure 3 - Preparation of sole by abrasion

10 Procedure

Prior to use and before applying a new lubricant the surface shall be cleaned using an ethanol solution (5.3).

Apply the lubricant (5.1 or 5.2) to the surface (6.4 or 6.5) such that it forms a continuous layer of at least 1 mm thickness (corresponding to at least 10 ml/100 cm^2). Before each test ensure that the layer conforms to this requirement.

NOTE A trough or similar device can be used to entrap lubricant within the footwear/surface contact area to ensure that the required minimum depth of lubricant is reached.

Mount the item of footwear securely on the shoemaking last or artificial foot (6.1) and attach it to the testing machine. If slippage is found to occur between the last and the footwear during testing, prevent it by appropriate means, e.g. place some paper or cloth in the tip of the footwear and/or apply two-sided adhesive tape or abrasive paper stuck to the underside of the last or artificial foot. If there is a removable insock, it shall be taken out. The upper of the footwear may be cut in order to facilitate its mounting.

Lower the item of footwear onto the surface and record the frictional force with the force measuring device (6.7) in accordance with the conditions given in clause 8. Determine the mean frictional force during the measurement period (8.7) and calculate the mean coefficient of friction.

Take at least five measurements on each item of footwear for each floor (6.4, 6.5)/lubricant (5.1,5.2) combination used. Calculate the arithmetic mean of the coefficient of friction for each item of footwear for each condition and round to two decimal places. If the five consecutive results of the measurements show a systematic increase or decrease, discard these results and repeat the measurements. If the same item of footwear is to be tested with different lubricants, use water with detergent (5.2) first, and wash the sole in accordance with 9.1 before continuing.

11 Test report

The test report shall contain the following information:

a) identification or description of the footwear tested;

b) reference to this European Standard;

c) mean value of the coefficient of friction for each item of footwear, specifying the test combination chosen (floor and lubricant) and test mode;

d) temperature of the test atmosphere;

e) date of test;

f) any deviation from the method given in this European Standard.

Annex A
(normative)

Shoemaking last and artificial foot for testing the slip resistance of footwear

A.1 Shoemaking last

Plastic shoemaking last, type M3601. [3)]

A.2 Artificial foot [4)]

The dimensions in Figure A.1 are valid for footwear of Paris points size 40 and above. For footwear of Paris points size below 40 the following changes shall be made:

- diameter of the contact plates: 40 mm (instead of 55 mm)
- distance of the centres of the contact plates: 2 times 70 mm (instead of 2 times 80 mm)

3) Details of the source of this last can be obtained from the Secretariat of CEN/TC 161.

4) Details of sources of the artificial foot can be obtained from the Secretariat of CEN/TC 161.

Dimensions in mm

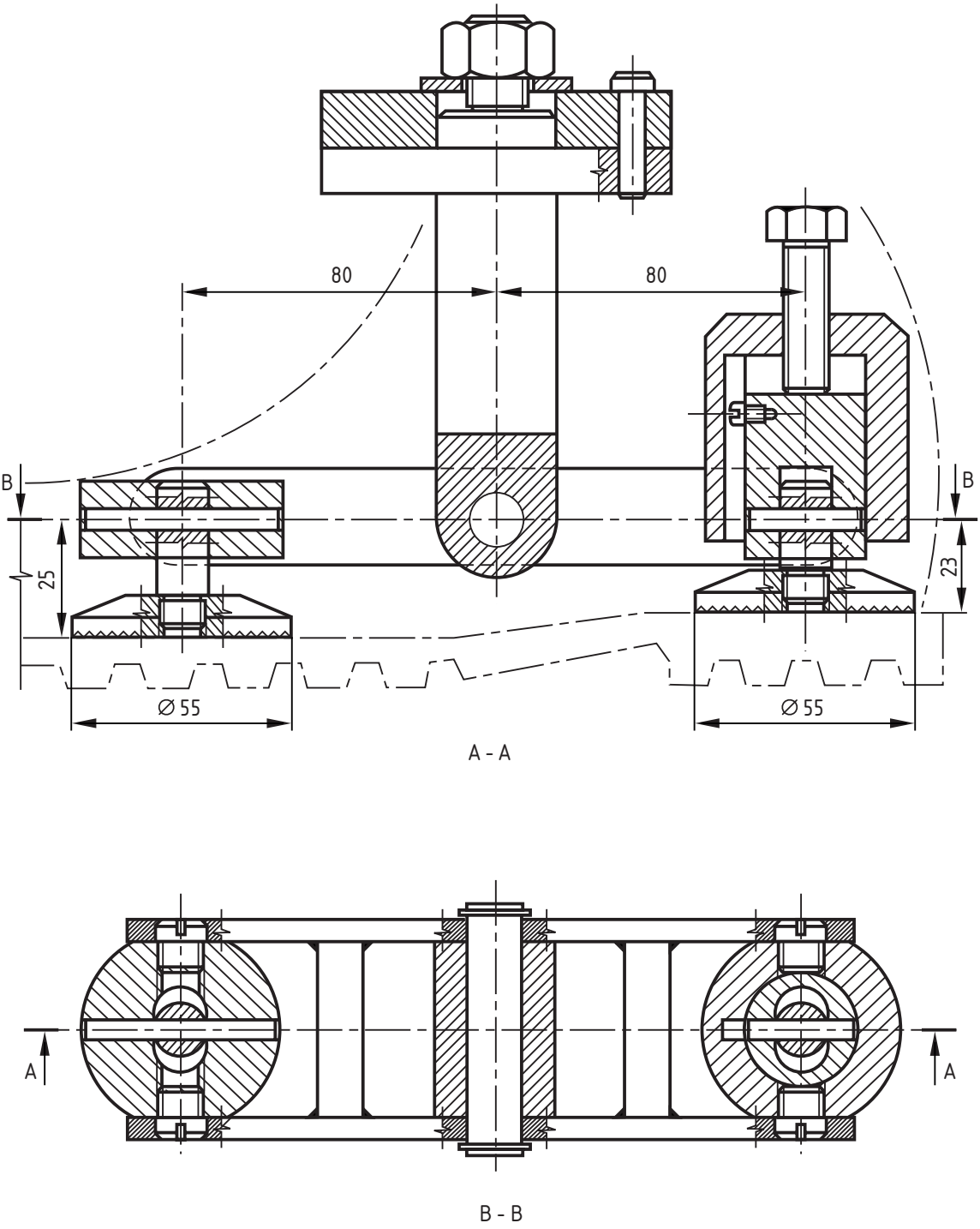


Figure A.1 - Example of a suitable artificial foot

Annex B
(normative)

Uncertainty of measurement and interpretation of results

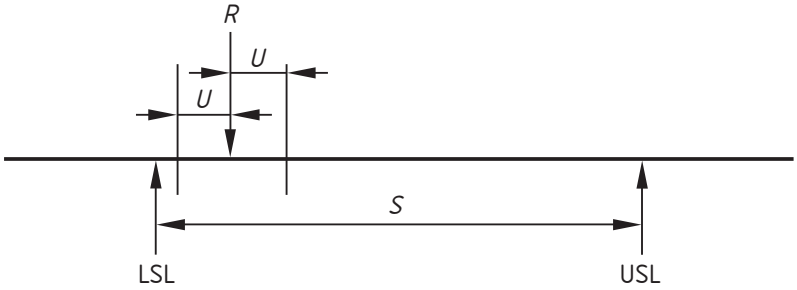
B.1 Uncertainty of measurement

For each of the measurements performed in accordance with this standard, a corresponding estimate of the uncertainty of measurement *U* shall be calculated. This estimate of uncertainty shall be applied in accordance with B.2 and stated when reporting test results, in order to enable the user of the test report to assess the reliability of the data.

B.2 Interpretation of results

The following protocol with regard to uncertainty of measurement shall be applied to test results:

If the mean value of the coefficient of friction calculated from the test data plus/minus the uncertainty of measurement *U* falls between the upper and lower limiting values for the coefficient of friction specified in the appropriate product performance guidelines then the result shall be deemed to be a straightforward pass (see Figure B.1)

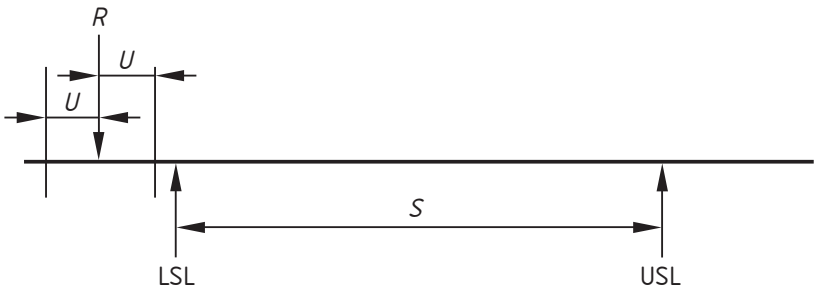


Key

R Result of a measurement
S Specified performance guidelines
LSL Lower specified limit
USL Upper specified limit
U Uncertainty of measurement

Figure B.1 — Result pass

If the mean value of the coefficient of friction calculated from the test data plus/minus the uncertainty of measurement *U* falls outside of the upper or lower limiting values for the coefficient of friction specified in the appropriate product performance guidelines then the result shall be deemed to be a straightforward fail (see Figure B.2).

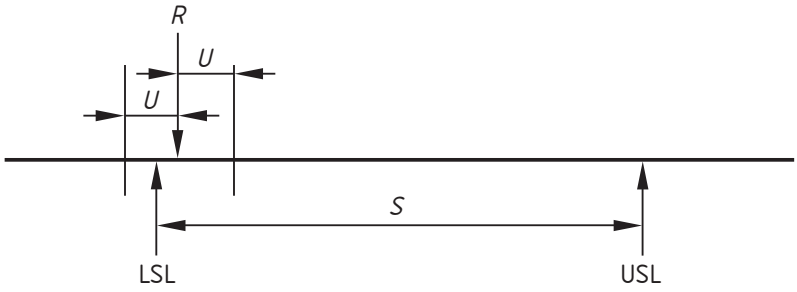


Key

R Result of a measurement
S Specified performance guidelines
LSL Lower specified limit
USL Upper specified limit
U Uncertainty of measurement

Figure B.2 — Result fail

If the mean value of the coefficient of friction calculated from the test data falls within the specified limits for the coefficient of friction given in the appropriate product performance guidelines but the uncertainty of measurement *U* falls outside of the upper or lower limiting values, then the result shall be deemed a fail (see Figure B.3)



Key

R Result of a measurement
S Specified performance guidelines
LSL Lower specified limit
USL Upper specified limit
U Uncertainty of measurement

Figure B.3 — Result fail

B.3 Calculation of uncertainty of measurement

The uncertainty of measurement shall be calculated. The two following approaches can be used:

- statistical method, for example that given in ISO 5725-2
- mathematical method, for example that given in ENV 13005 (GUM).

Annex ZA
(informative)

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

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 the EU Directive 89/686/EEC.

Compliance with this Standard provides one means of conforming with the specific essential requirements of the Directives concerned and associated EFTA Regulations.

WARNING: Other requirements and other EU Directives may be applicable to the products falling within he scope of this Standard.

The clauses of this European Standard specify a test method for the relevant requirement of safety, protective or occupational footwear to support the essential requirement 3.1.2.1 of Directive 89/686/EEC, Annex II.

Bibliography

[1] 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.*

[2] EN 10088-2: 1995, *Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip for general purposes.*

[3] ENV 13005 *Guide to the expression of uncertainty in measurement.*

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.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL