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ISO 13287

Second edition
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Personal protective equipment — Footwear — Test method for slip resistance

Équipement de protection individuelle — Chaussures — Méthode d'essai pour la résistance au glissement

Reference number
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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13287 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 161, *Foot and leg protectors*, in collaboration with ISO Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 3, *Foot protection*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 13287:2006), which has been restructured for ease of use, more precisely specified in many areas and technically revised. The main technical revisions are:

— Subclause 4.1.2 and Clause 6 allow the use of the footwear manufacturer's shoemaking last;

— Subclauses 4.5 and 8.9 and Annexes B and D introduce ceramic tile Eurotile 2 as a replacement for Eurotile 1 (Annex C);

— Subclause 6.2.4 changes a timing parameter in the test;

— Subclauses 7.1.6 and 7.2.4 limit the amount of use of footwear and floor specimens before requiring re-preparation;

— Annex E has been added, which amends and supersedes ISO 20344:2011, 5.11.2, including a technical change in E.4.6.

The Bibliography refers to an instructional video available to users of this International Standard.

Personal protective equipment — Footwear — Test method for slip resistance

1 Scope

This International Standard specifies a method of test for the slip resistance of PPE footwear. It is not applicable to special purpose footwear containing spikes, metal studs or similar.

NOTE For product development purposes, sole units or other soling components such as top pieces may be tested.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 4662, *Rubber, vulcanized or thermoplastic — Determination of rebound resilience*

3 Terms and definitions

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

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

NOTE The force includes the weight of the footwear, shoemaking last (4.1.1 or 4.1.2) or mechanical foot (4.1.3) and mounting.

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 initial contact of the footwear with the surface achieving a normal force of 50 N and the 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
floor
material (flooring), without contaminant (lubricant), to be used as the test surface

3.7
surface
floor, with or without contaminant (lubricant), against which the footwear is tested

3.8
calibration test value
CTV
coefficient of friction between the Slider 96[1)] and the test surface

4 Apparatus and materials

4.1 One or more of the following foot forms to hold the item of footwear to be tested.

4.1.1 Standard shoemaking last, conforming to Clause A.1.

4.1.2 Manufacturer's shoemaking last used to make the footwear sample to be tested, if required.

4.1.3 Mechanical foot, conforming to the dimensions given in Clause A.2.

4.2 Mechanism for lowering the item of footwear onto the surface and applying the required normal force at the required time in accordance with Clause 6.

4.3 Device for measuring the normal force between the footwear and surface when setting up the test and during the measurement period to an accuracy of 2 % or better.

4.4 Steel floor, consisting of a stainless steel plate.

NOTE 1 For example, steel Number 1.4301, Type 2G (cold rolled, ground) conforming to EN 10088-2:2005.

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 in accordance with ISO 4287. The overall mean value from all 10 locations shall be for R_z between 1,6 µm and 2,5 µm.

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 2 Grit sizes 100 to 600 can be suitable.

4.5 Pressed ceramic tile floor, as specified in either Annex C or Annex D. The tiles shall not be modified in any way, for example, by mechanical or chemical treatment.

4.6 Other floors, for example, wood, concrete, stone, polymeric flooring. The floor shall be characterized by determining the coefficient of friction in accordance with Annex E.

4.7 Mechanism for inducing movement between the footwear and the surface at a time and speed as specified in Clause 6.

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1) Slider 96 (formerly known as Four S rubber) is the trade name of a product supplied by Rapra (www.rapra.net). This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4.8 Device for measuring the frictional force between the footwear and surface during the measurement period to an accuracy of 2 % or better.

4.9 Silicon carbide paper, 400 grit size, mounted on a rigid block with a flat face measuring 100 mm × 70 mm and mass (1 200 ± 120) g.

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

4.10 Rigid wedges having a (7,0 ± 0,5)° angle as a suitable means of setting the contact angle. The tip of the wedge shall be truncated so that it is no more than 0,5 mm in height as judged by a graduated eyepiece. The width of the wedge should be sufficient to ensure that the full width of the heel or forepart shall be fully supported by the wedge. For the heel test, the length shall be sufficient to support the full length of the heel but shall not make contact with the forepart [see Figure 1a)]. For the forepart test, the length of the wedge shall be sufficient to support the whole of the heel and forepart of the shoe [see Figure 1b)].

4.11 Glycerol aqueous solution with a viscosity of (0,2 ± 0,1) Pa·s. At 23 °C this corresponds to an aqueous solution containing a mass fraction of approximately 85,6 % to 92,8 % glycerol. For other temperatures, see Table 1 (values for temperatures in the range given in Table 1 may be interpolated). The solution shall be replaced 30 min after exposure to the ambient atmosphere unless it can be shown to still comply with Table 1.

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 90,0 % to 92,5 % glycerol.

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		0,2 Pa·s		0,3 Pa·s	
	Mass fraction %	Refractive index	Mass fraction %	Refractive index	Mass fraction %	Refractive index
21,0	84,5	1,450 0	89,5	1,457 4	91,9	1,461 0
23,0	85,6	1,450 9	90,4	1,458 4	92,8	1,462 0
25,0	86,6	1,451 2	91,4	1,459 4	93,7	1,462 8

4.12 Detergent solution, containing a mass fraction of 0,5 % sodium lauryl sulfate (SLS) in demineralized water.

4.13 Ethanol solution, containing a mass fraction of (50 ± 5) % ethanol GPR (CAS 64-17-5), which may be prepared from industrial methylated spirits GPR containing minimum 90 % ethanol, in demineralized water.

5 Sampling and conditioning

5.1 Sampling

Unless otherwise specified, use a minimum of two samples of the same type of footwear of the same size.

NOTE The uncertainty of measurement may be assessed by one of the two following approaches:

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

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

5.2 Conditioning

The test items shall be conditioned prior to the test at (23 ± 2) °C and (50 ± 5) % RH for a minimum of 48 h. If necessary, the sample may be removed from this standard atmosphere provided that its temperature is

maintained at (23 ± 2) °C, that testing starts within 30 min after removal from this standard atmosphere and that the testing is carried out at (23 ± 2) °C.

6 Test method

6.1 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). Both the frictional force and normal force are measured and the dynamic CoF is calculated.

6.2 Test modes and test conditions

6.2.1 The footwear shall be tested in one or more of the following modes (see Figure 1):

a) forward heel slip at angled contact;

b) backward slip on the forepart;

c) forward flat slip.

NOTE The heel test mode is considered the most important test mode in relation to reducing the risk of pedestrian slip.

6.2.2 For the heel and forepart test modes, the footwear shall be fitted onto a shoemaking last (4.1.1 or 4.1.2). The inside tangent of the shoemaking last, as defined by a straight line placed against the heel and joint swell on the inside of the shoemaking last (line A-B in Figure 2), shall be aligned parallel to the direction of sliding movement (see Figure 2).

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 1a)], determined using a rigid wedge (4.10) placed on the floor. The shoemaking last, with the footwear mounted on it, shall be lowered onto the wedge under its own weight and adjusted until the footwear heel sits flat on the angled face of the wedge with 2 mm to 3 mm of the wedge extending beyond the rearmost contact point of the heel with the face of the wedge. The footwear forepart shall not contact the surface or the rigid wedge.

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)° [(see Figure 1b)] determined using a rigid wedge (4.10) placed on the floor. The shoemaking last (4.1.1 or 4.1.2), with the footwear mounted on it, shall be lowered onto the wedge under its own weight and adjusted until the footwear bottom sits flat on the angled face of the wedge with 2mm to 3 mm of the wedge extending beyond the foremost contact point of the forepart with the face of the wedge.

For the flat test mode, the footwear shall be fitted onto the mechanical foot (4.1.3) or the manufacturer's shoemaking last (4.1.2). The mechanical foot shall be orientated such that the longitudinal axis of the mechanical foot is aligned parallel to the direction of sliding movement. The footwear shall be fitted onto the mechanical foot with the heel contact plate placed centrally in the heel seat with a small gap between the back edge and sides of the insole and with the forepart contact plate positioned approximately central to the forepart (see Figure 3). If using a manufacturer's shoemaking last (4.1.2) in place of the mechanical foot (4.1.3), then the last shall be aligned such that the footwear attains the same orientation of the outsole tread pattern relative to the direction of slip as would be achieved if using a mechanical foot (4.1.3).

6.2.3 The normal force (3.1) for footwear of European size 40 (UK size 6,5, Mondopoint 255) and above shall be (500 ± 25) N. For footwear of European 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 approximately through the rear edge of the heel-floor contact area determined under the weight of the shoe, last and mounting [see Figure 1a)]. No additional force should be applied.

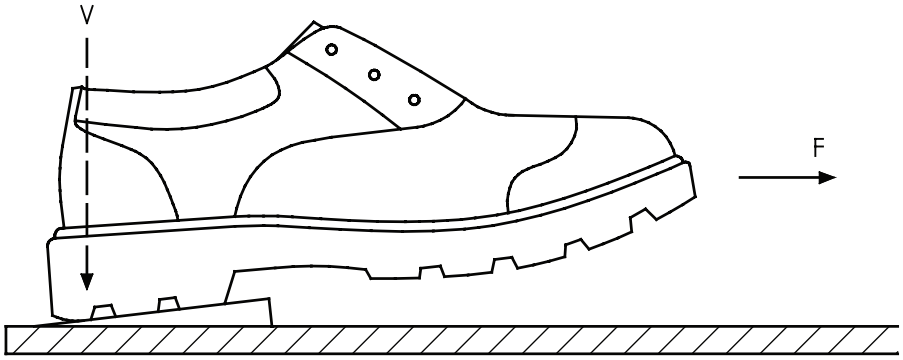
In the forepart test mode, the line of action of the normal force shall be aligned through a point approximately onethird of the length of the outsole measured back from the end of the toe [see Figure 1b)].

In the flat mode, the mechanical foot (4.1.3) determines the line of action of the normal force [see Figure 1c)]. If the manufacturer's shoemaking last (4.1.2) is used, the line of action of the normal force shall be through the approximate mid-point of the length of the footwear.

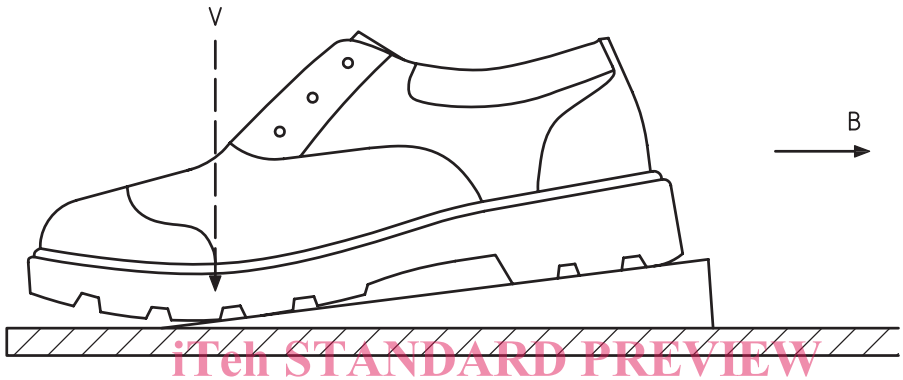
6.2.4 The static contact time shall be a maximum of 1,0 s from an initial contact force of 50 N to achieving full normal force and initiation of sliding movement. Sliding movement shall start within 0,3 s of achieving the full normal force (see Figure 4).

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

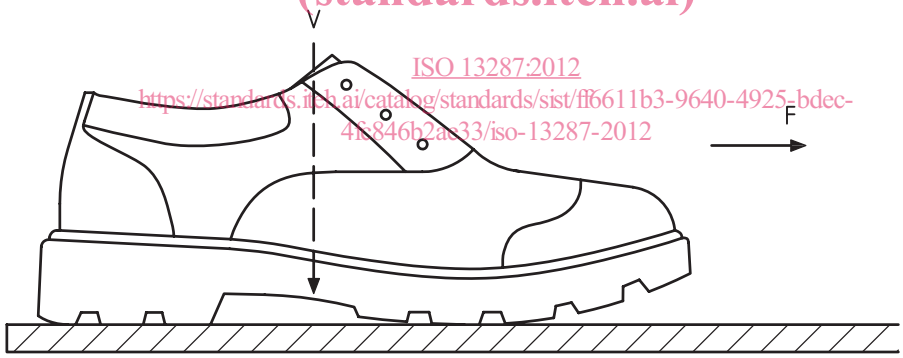
6.2.6 The mean frictional force shall be measured over the measurement period between (0,30 ± 0,02) s and (0,60 ± 0,02) s after the start of sliding movement, during which the full normal force (6.2.3) and sliding speed is maintained (see Figure 4).



a) Forward heel slip using standard or manufacturer's shoemaking last



b) Backward forepart slip using standard or manufacturer's shoemaking last



c) Forward flat slip using mechanical foot or manufacturer's shoemaking last

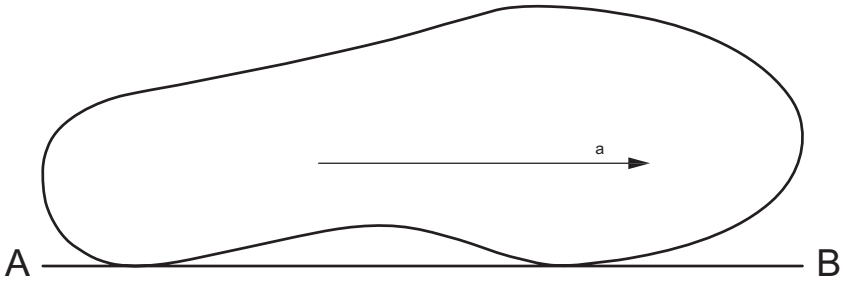
Key

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

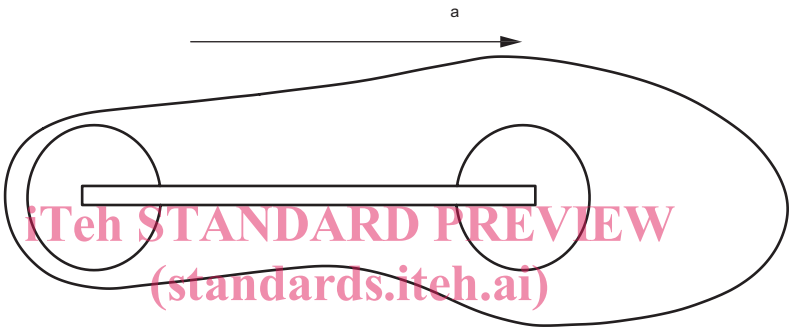


Key

A-B inside tangent

[a] direction of sliding movement

Figure 2 — Inside tangent of the standard or manufacturer's shoemaking last parallel to the direction of movement



Key

[a] direction of sliding movement

Figure 3 — Longitudinal axis of the mechanical foot parallel to the direction of movement