TECHNICAL REPORT

ISO TR 11220

First edition
1993-11-01

Footwear for professional use — Determination of slip resistance

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Chaussures à usage professionnel — Détermination de la résistance au glissement

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ISO/TR 11220:1993
https://standards.iteh.ai/catalog/standards/sist/abb3baeb-76ca-496a-8d78-9b0aeb24a980/iso-tr-11220-1993

Reference number
ISO/TR 11220:1993(E)

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

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— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

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— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 11220, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 94, *Personal safety – Protective clothing and equipment*, Sub-Committee SC 3, *Foot protection*.

For an explanation of the relationship of this Technical Report to the expected future International Standard, see the introduction.

This document is being issued in the type 2 Technical Report series of publications (according to subclause G.4.2.2. of part 1 of the ISO/IEC Directives, 1992) as a "prospective standard for provisional application" in the field of slip resistance of professional footwear because there is an

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International Organization for Standardization
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Printed in Switzerland

urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this type 2 Technical Report will be carried out not later than three years after its publication with the options of: extension for another three years; conversion into an International Standard; or withdrawal.

Annexes A and B of this Technical Report are for information only.

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Introduction

Resistance to slipping is a very important safety feature of footwear for professional use, or indeed of any footwear, but it is extremely difficult to measure objectively since there are so many variables which must be taken into account. WG 1 of ISO/TC 94/SC 3 was established in 1984 to investigate the problems and develop a method which could be standardized internationally. In the succeeding years, many meetings were held and much work undertaken, including two major international collaborative tests, resulting in the method described in this Technical Report. However, the Working Group was aware that this method is not completely satisfactory. An assessment of precision and validity based on the results obtained during the second collaborative test had shown that there was no correlation between coefficients of friction for different floor/lubricant combinations and that the interlaboratory reproducibility was extremely poor. Further details of both collaborative tests are given in annex A.

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Although further amendments were made to the method as a result of the second test work, ISO/TC 94/SC 3 felt that it would not be appropriate to publish it as an International Standard until all the outstanding technical points had been resolved and acceptable reproducibility between test laboratories had been established. It was therefore agreed that the method should be issued as a Technical Report, thus making it available for further study and application over a wider forum, in the hope that in due course the experience thus gained would enable a revised draft to be put forward as an International Standard.

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Attention is drawn especially to the following points which need further clarification.

a) **Artificial foot**

The artificial foot specified in this Technical Report is essentially identical to that specified in the French standard NF S 73-010, chosen primarily because it was easy to define. It does not, however, provide a close fit for the footwear, nor does it allow the measurement of the coefficient of friction of the heel alone. Some experts consider the dynamics of heel strike to be an important factor in the occurrence of slipping accidents and that it is therefore necessary to develop a method which takes this into account. Artificial feet used as prostheses, consisting of a wooden core and a rubber shell in the shape of a human foot, are available commercially in many different sizes and heel heights and if chosen correctly would provide a close fit for the footwear and thus could be used for measurements at different foot pitch angles. The Working Group hesitated to specify a commercial product but considered that such an artificial foot might prove to be the best choice for obtaining relevant measurements.

b) **Timing of measurements**

The time between lowering the footwear to the floor and beginning the measurements and the duration of each measurement are not specified, although there are indications that these might be relevant to the dynamics of slipping accidents and thus influence the results. However, in order to control these parameters, many laboratories would have to make substantial modifications to their equipment.

c) **Different floors and lubricants**

Glycerine on steel was chosen because it produced the least variance in results between different laboratories and could be defined with little ambiguity. It was also a model for the very slippery situations for which slip-resistant footwear should be designed. However, other combinations are also very relevant to the prevention of accidents due to slipping and might not yield the same rank order for different footwear.

d) **Wear of soles**

The slip resistance of some soles could change dramatically during wear. However, it is not clear how such behaviour could be taken into account when specifications are being set, since there is no standard method available for artificially wearing or ageing soles.

e) **Classification**

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The Working Group tentatively suggested that slip-resistant footwear could be divided into two classes:

1) Class I — footwear with a coefficient of friction from 0,15 to 0,25;

2) Class II — footwear with a coefficient of friction above 0,25.

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However, the relationship between the two classes and the requirements of the workplace has still to be defined.

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Footwear for professional use — Determination of slip resistance

1 Scope

This Technical Report describes a method for the determination of the slip resistance of footwear for professional use.

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2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements.*

3 Principle

Slip resistance, expressed as the coefficient of friction of the footwear, is determined by placing the footwear on the testing surface (floor), with glycerine present as lubricant, applying a given load and either moving the footwear horizontally in relation to the surface or moving the surface in relation to the footwear. The frictional forces are measured and the dynamic coefficient of friction is calculated.

4 Reagents

4.1 Ethanol, 50 % (*m/m*) ± 5 % (*m/m*) aqueous solution.

4.2 Glycerine, having a viscosity of 0,2 Pa·s ± 0,1 Pa·s (200 cP ± 100 cP) which at 20 °C corresponds to glycerol-water solutions containing 85,0 % (*m/m*) to 91,5 % (*m/m*) glycerol.

NOTE 1 Since glycerine containing about 90 % (*m/m*) glycerol is hygroscopic in air with a relative humidity of more than 32 %, it is advisable to use solutions containing about 89 % (*m/m*) to 91,5 % (*m/m*) glycerol and to renew the glycerine layer on the testing surface frequently during prolonged testing sessions if the relative humidity of the surrounding air exceeds 32 %.

5 Apparatus

5.1 General

The apparatus consists of a test machine designed to induce relative movement between the footwear and a horizontal testing surface (floor) (5.2), on which the sole of the footwear slides. The footwear is held by means of an artificial foot (5.3) and pressed onto the floor with a given load of 500 N ± 30 N.

NOTE 2 A mechanism to lower the footwear onto the floor within a defined period during the measuring cycle is recommended.

A device to measure the frictional force is connected either to the footwear or to the floor. A device for measuring the vertical load exerted on the footwear is also required, if this is not already known.

5.2 Testing surface (floor)

This consists of a sheet of smooth stainless steel of roughness R_z between 1,6 µm and 2,5 µm in accordance with ISO 468, measured at five locations parallel to the sliding movement with a sampling length of 0,8 mm.

5.3 Artificial foot

This is shown schematically in figure 1, for footwear of size 40 Paris points and above (Mondopoint 255 mm and above). For footwear of smaller sizes, the diameter of the contact plates is 40 mm and the distance between the centres of the contact plates to the central pivot is 70 mm.

Slipping between the device and the insole can be prevented by for example the use of two-sided adhesive tape or abrasive paper stuck to the contact plate.

6 Sampling

For each type of footwear being tested, take three pairs of different sizes as the test sample.

7 Test conditions

7.1 Atmosphere

The test atmosphere shall have a temperature of 20 °C ± 2 °C and a relative humidity of (50 ± 20) %.

7.2 Foot pitch angle

The foot pitch angle shall be 0° (i.e. the sole is placed flat on the testing surface).

7.3 Orientation of the footwear during measurement

The footwear shall be tested sliding forwards.

7.4 Sliding velocity during measurement

The velocity during measurement shall be 0,20 m/s to 0,25 m/s.

8 Procedure

8.1 Preparation of test sample

Clean and prepare the sole of the footwear before each test as follows.

Wash the sole with ethanol solution (4.1) and dry at ambient temperature.

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Dimensions in millimetres

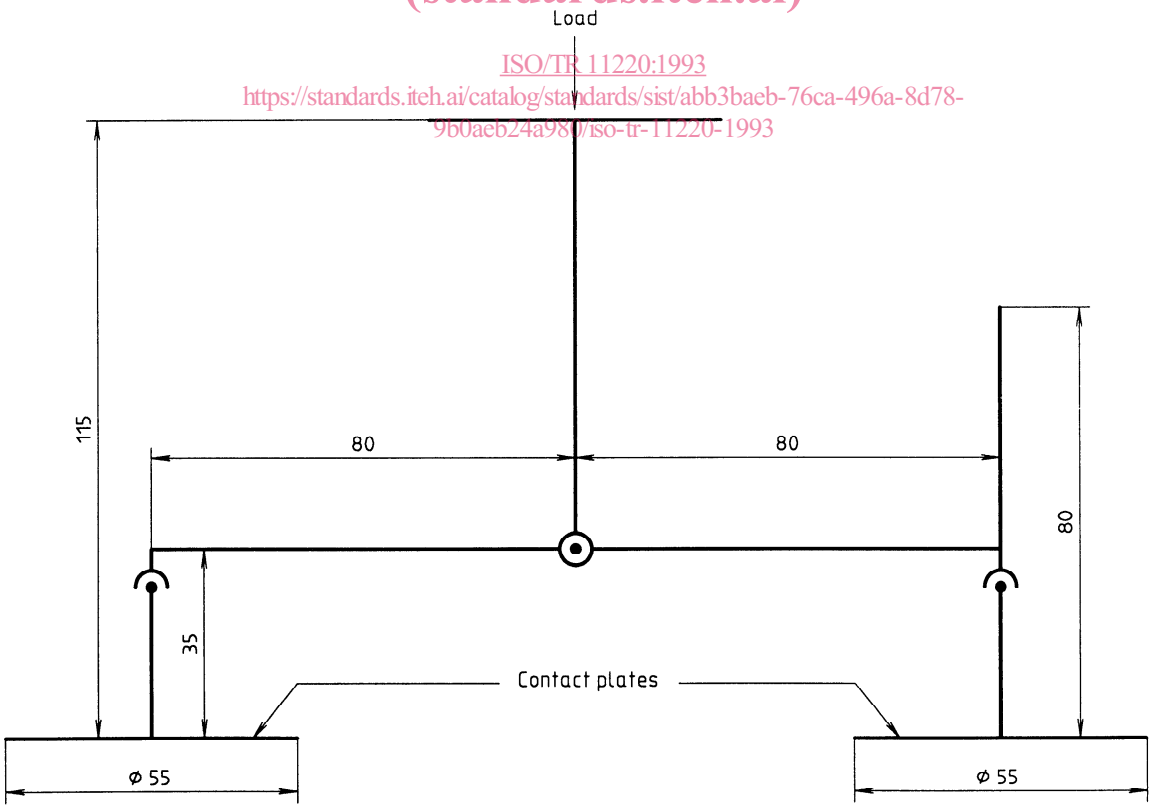

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Figure 1 — Schematic representation of the artificial foot

8.2 Application of lubricant

Apply the glycerine (4.2) on the testing surface such that it forms a uniform layer of at least 0,1 mm thickness (corresponding to at least 1 ml per 100 cm^2). Renew the layer before each test if sample tracks have been left from the previous test.

8.3 Mounting the footwear

Mount the footwear on the artificial foot and attach it to the testing machine. Bring the sole into contact with the lubricant for at least 1 min before starting the tests.

8.4 Measurements

Lower the footwear onto the testing surface, apply the load and induce relative movement under the conditions specified in clause 7. Carry out at least 10 such tests before making any measurements.

Record the mean frictional force and vertical load during the measurement period.

Ensure that the footwear is correctly positioned on the artificial foot between each measurement.

Make five measurements for each item of footwear, giving a total of 30 measurements for each test sample.

9 Calculation and expression of results

For each measurement, calculate the mean coefficient of friction by dividing the frictional force (horizontal force) by the vertical force (load).

Express the slip resistance of the footwear being tested as the arithmetic mean of the 30 values obtained for the coefficient of friction.

10 Classification

Footwear with a coefficient of friction of less than 0,15 shall be unclassified.

Footwear with a coefficient of friction in the range 0,15 to 0,25 shall be designated Class I slip-resistant footwear.

Footwear with a coefficient of friction above 0,25 shall be designated Class II slip-resistant footwear.

11 Test report

The test report shall include the following information:

a) all information necessary for the identification of the sample, the testing facility and the date of the test;

b) the method used by reference to this Technical Report;

c) the results obtained and, where appropriate, the classification of the footwear (see clause 10);

d) details of the test machine used and the temperature and relative humidity of the atmosphere in which the test was carried out;

e) details of any deviation from the procedures specified in this Technical Report.

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