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# Foot and leg protectors — Requirements and test methods for footwear components —

## Part 1: Metallic toecaps

*Protecteurs du pied et de la jambe — Exigences et méthodes d'essais pour les composants de chaussure —*

*Partie 1: Embouts métalliques*



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# Foreword

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This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 3, *Foot protection*.

A list of all parts in the ISO 22568 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This corrected version of ISO 22568:2019 incorporates the following correction:

— In 5.3.2, the last three paragraphs have been added.



# Introduction

ISO 20345, ISO 20346 and ISO 20347[2] are related to safety, protective and occupational footwear which define the performance and required properties of the footwear. On introducing these standards all national standards relating to safety toecaps were withdrawn leaving the manufacturers of these items with no means of demonstrating the performance of their products. This document has been prepared to allow manufacturers to demonstrate the performance level of the toecaps before being inserted into the footwear.

Metallic toecaps complying with the requirements of this document are suitable components of “PPE footwear”.

# Foot and leg protectors — Requirements and test methods for footwear components —

## Part 1: Metallic toecaps



## 1 Scope

This document specifies requirements and test methods for metallic toecaps, intended to function as components of PPE footwear (e.g. as described by ISO 20345 and ISO 20346).

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 20345, *Personal protective equipment — Safety footwear*

ISO 20346, *Personal protective equipment — Protective footwear*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20345, ISO 20346 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

**3.1**
**internal metallic toecap**
metallic toecap intended to be incorporated underneath the upper of footwear intended to provide protection against mechanical impact and compression

Note 1 to entry: External toecaps were used in the past, they are not used anymore and they are not covered by the present document.

## 4 Requirements for metallic toecaps

### 4.1 General

This document defines two types of metallic toecaps (type A and type B) to cover the various types of footwear constructions.

For each of the required measurements performed in accordance with this document, a corresponding estimate of the uncertainty of measurement should be evaluated. One of the following approaches should be used:

— statistical method, e.g. that given in ISO 5725-2[1];

— mathematical method, e.g. that given in ISO/IEC Guide 98-3[3];

— uncertainty and conformity assessment as given in ISO/IEC Guide 98-4[4];

— JCGM 100:2008[5].

**Table 1 — Summary of requirements and number of samples**

| Property | Subclause | Number of samples |
|---|---|---|
| Finishing | 4.2 | 1 sample each size right and left |
| Internal length | 4.3.1 | 1 sample each size right and left |
| Width of flange | 4.3.2 | 1 sample each size right and left |
| Impact resistance | 4.4 | 1 sample each size right and left |
| Compression resistance | 4.5 | 1 sample each size right and left |
| Corrosion resistance | 4.6 | 3 samples of different sizes (left or right) |
| NOTE 1 For details, see 4.2 to 4.6. | | |
| NOTE 2 The provisions of 4.2, 4.3, 4.4, 4.5 and 4.6 do not exclude a metallic toecap design incorporating perforations. | | |

## 4.2 Finishing

Metallic toecaps shall be finished so as to be free from surface marks or defects and shall be free from burrs and sharp edges.

## 4.3 Dimensions

### 4.3.1 Internal length

When measured in accordance with the method described in 5.2.1, the internal length of metallic toecaps shall be not less than the appropriate value given in Table 2.

**Table 2 — Minimum internal length of metallic toecaps**

| Metallic toe cap size | Minimum internal length<br>mm |
|---|---|
| ≤5 | 34 |
| 6 | 36 |
| 7 | 38 |
| 8 | 39 |
| 9 | 40 |
| ≥10 | 42 |
| NOTE The above sizing system for toecaps is not identical to any sizing system for footwear. | |

### 4.3.2 Width of flange

If metallic toecaps are formed with a flange, the inside width of the flange, *e*, shall be not greater than 12 mm using the test method given in 5.2.2.

## 4.4 Impact resistance

When metallic toecaps are tested in accordance with the method described in 5.3 at an energy level of either (100 ± 2) J (metallic toecaps intended for protective footwear), or (200 ± 4) J (metallic toecaps



intended for safety footwear), the clearance under the toecap during the impact shall be not less than the appropriate value given in Table 3. In addition, the metallic toecap shall not develop sharp edges or any cracks passing through the material (i.e. through which light can be seen). During the assessment of the metallic toecap designed with perforations the criteria whether light can be seen shall not be applied to the perforations.

**Table 3 — Minimum clearance under metallic toecaps at impact and compression**

| Metallic toecap number | Internal metallic toecap minimum clearance Type A<br>mm | Internal metallic toecap minimum clearance Type B<br>mm |
|---|---|---|
| ≤5 | 19,5 | 23,5 |
| 6 | 20,0 | 24,0 |
| 7 | 20,5 | 24,5 |
| 8 | 21,0 | 25,0 |
| 9 | 21,5 | 25,5 |
| ≥10 | 22,0 | 26,0 |
| NOTE The above sizing system for toecaps is not identical to any sizing system for footwear. | | |



### 4.5 Compression resistance

When metallic toecaps are tested in accordance with the method described in 5.4, the clearance under the metallic toecap at a compression load of either (10 ± 0,1) kN (metallic toecaps intended for protective footwear) or (15 ± 0,15) kN (metallic toecaps intended for safety footwear) shall not be less than the appropriate value given in Table 3. In addition, the metallic toecap shall not develop sharp edges or any cracks passing through the material (i.e. through which light can be seen). During the assessment of the metallic toecap designed with perforations the criteria whether light can be seen shall not be applied to the perforations.

### 4.6 Corrosion resistance

Both before and after testing metallic toecaps in accordance with the method described in 5.5, they shall exhibit not more than three areas of corrosion, none of which shall measure more than 2 mm in any direction.

## 5 Test methods for metallic toecaps

### 5.1 General

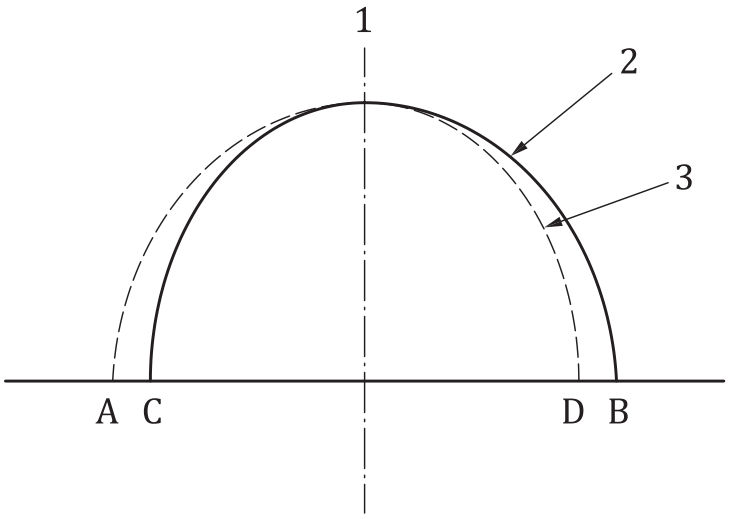
One sample each size right and left shall be tested. Exceptions are made for some properties, as specified in Table 1.

### 5.2 Determination of dimensions

#### 5.2.1 Internal metallic toecap length

##### 5.2.1.1 Determination of the test axis

Position the left metallic toecap with its rear edge in line with a base line and draw its outline. Repeat the exercise with the right metallic toecap of the pair, positioning it at the same base line in such a manner that the outlines at the toe end of the metallic toecaps coincide (see Figure 1).




**Key**

| | |
|---|---|
| 1 | test axis |
| 2 | right toecap |
| 3 | left toecap |
| A, B, C, D | points where the outlines of the right and left metallic toecaps intersect on the base line |

**Figure 1 — Determination of test axis (schematic illustration)**

Mark the four points A, B, C and D where the outlines of the right and left metallic toecaps intersect on the base line. Construct the perpendicular from the base line at the midpoint of AB or CD. This constitutes the test axis of both metallic toecaps.

#### 5.2.1.2 Procedure

Place the metallic toecap, open side down, on a flat surface. With an appropriate gauge, measure the internal length *l*, along the test axis from the front inside to the vertical projection of the back edge between 3 mm and 10 mm above and parallel to the surface upon which the metallic toecap rests, taking the longest distance as the length *l* (see Figure 2).

### 5.2.2 Width of flange

Determine the inside width of the flange, *e*, as shown in Figure 3.

### 5.2.3 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 22568-1:2019;

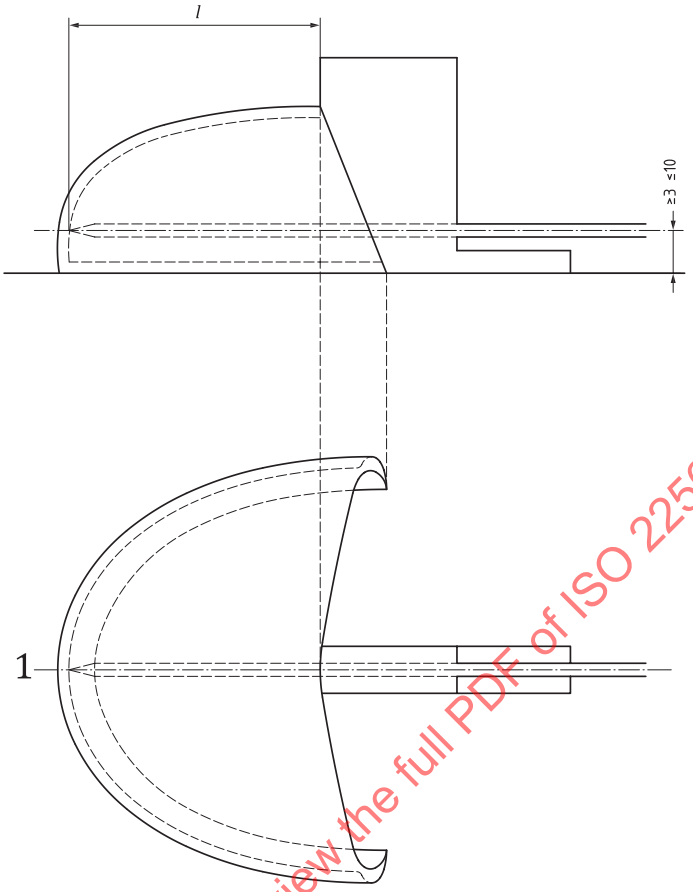
b) all the details concerning the necessary information for the samples identification;

c) the internal lengths determined according to 5.2.1 for each sample of measured metallic toecap;

d) the width of flange determined according to 5.2.2 for each sample of measured metallic toecap;

e) any deviation by agreement or otherwise from the present test method.

Dimensions in millimetres

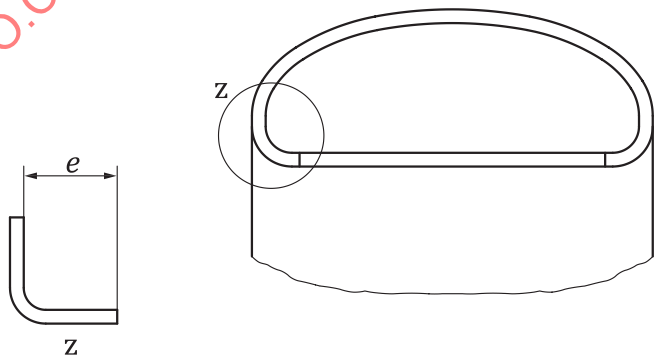



**Key**

1 test axis

*l* internal length of the metallic toecap

**Figure 2 — Measurement of internal metallic toecap length**




**Key**

*e* width of the metallic toecap flange

**Figure 3 — Illustration of width, *e*, of the metallic toecap flange**

## 5.3 Determination of impact resistance

### 5.3.1 Apparatus

**5.3.1.1 Impact apparatus,** incorporating a steel striker of mass (20 ± 0,2) kg adapted to fall freely on vertical guides from a predetermined height to give the required impact energy.

The striker (see Figure 4) shall be made of steel with Rockwell hardness min. 60 HRC and shall consist of a wedge at least 60 mm long, the rectangular faces of which are at least 40 mm in height and 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 ±2° to the base of the clamping device.

The base of the apparatus shall be of compact design, avoiding elastic structures as far as possible. It shall have a mass of at least 600 kg and a metal block of dimensions at least 400 mm × 400 mm × 40 mm deep shall be bolted to it.

The apparatus shall be free standing on a flat and level floor which is sufficiently large and rigid to support the test equipment. Provision shall be made for a mechanism to catch the striker after the first impact so that the test specimen will be hit only once.

Dimensions in millimetres

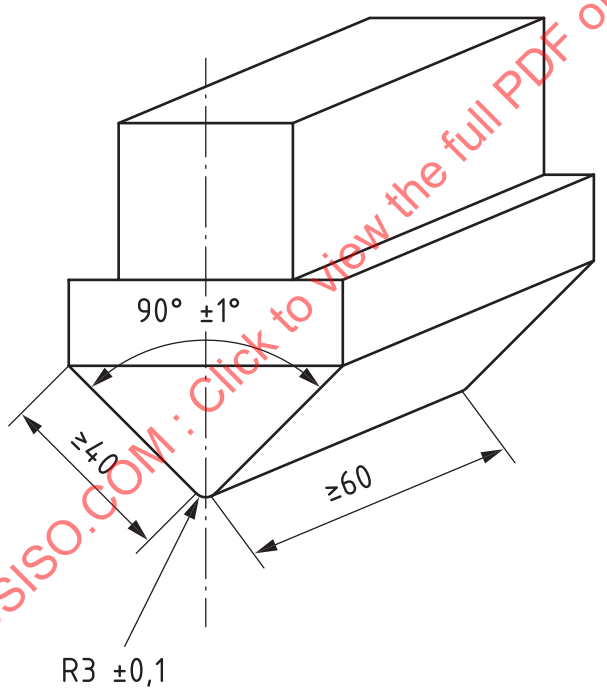



**Figure 4 — Impact striker**



**5.3.1.2 Clamping device,** consisting of a steel platen at least 19 mm thick and 150 mm × 150 mm in area and of minimum hardness 60 HRC with provision for lightly clamping a metallic toecap in a way which will not restrict any lateral deformation of the toecap during the impact test.

An example of a suitable clamping device is shown in Figure 5.

The metallic toecap shall be held in position at the front end with a forked clamp which is fixed with a screw into one of the threaded holes, depending on the size of the metallic toecap.

The metallic toecap shall be held at the rear end with a curved plate which is screwed to a sliding rail. The radiused plate lies over the flange at the back edges of the cap and pushes the cap against the forked clamp with a load of 100 N to 200 N.

The sliding rail is sprung such that when the metallic toecap is hit by the striker it can move back along its axis against the spring. To change the metallic toecap the curved plate is retracted by releasing the clamping handle.

**5.3.1.3 Cylinders of modeling clay**, with a diameter (25 ± 2) mm; the height shall be (28 ± 2) mm for type A metallic toecaps, and (30 ± 2) mm for type B metallic toecaps. The flat ends of the cylinder shall be covered with aluminium foils (about 0,01 mm) to prevent from sticking to either the test piece or the test equipment.

The modelling clay shall fulfil the requirements given in Annex A.

**5.3.1.4 Dial gauge**, with an accuracy of 0,1 mm, working in a vertical sense, with a flat base to place the clay cylinder on, and a hemispherical upper sensor of (3,0 ± 0,2) mm radius exerting a vertical force not greater than 250 mN.

### 5.3.2 Procedure

Determine the test axis as described in 5.2.1.1.

Use the metallic toecap as the test piece.

Hold the test piece in the clamping device (5.3.1.2) so that when the striker hits it, the striker will project over the front and back of the metallic toecap.

Position a cylinder (5.3.1.3) under the rear upper edge of the test piece in such a way that approximately 2/3 of its diameter is within the test piece and 1/3 of its diameter is protruding behind the rear edge and the centre of the cylinder matches the test axis as closely as possible (see Figure 6). At the time of the test, the temperature of the modelling clay shall be between 18 °C and 25 °C.

Allow the striker to drop onto the test axis from the appropriate height to give an impact energy of (200 ± 4) J for metallic toecaps designed for safety footwear or (100 ± 2) J for metallic toecaps to be used in protective footwear.

Measure, to the nearest 0,5 mm, the lowest height to which the cylinder has been compressed, using the dial gauge (5.3.1.4). This value is the clearance at the moment of impact.

The number of tests to be performed is stated in Table 1.

### 5.3.3 Test report

The report shall include the following information:

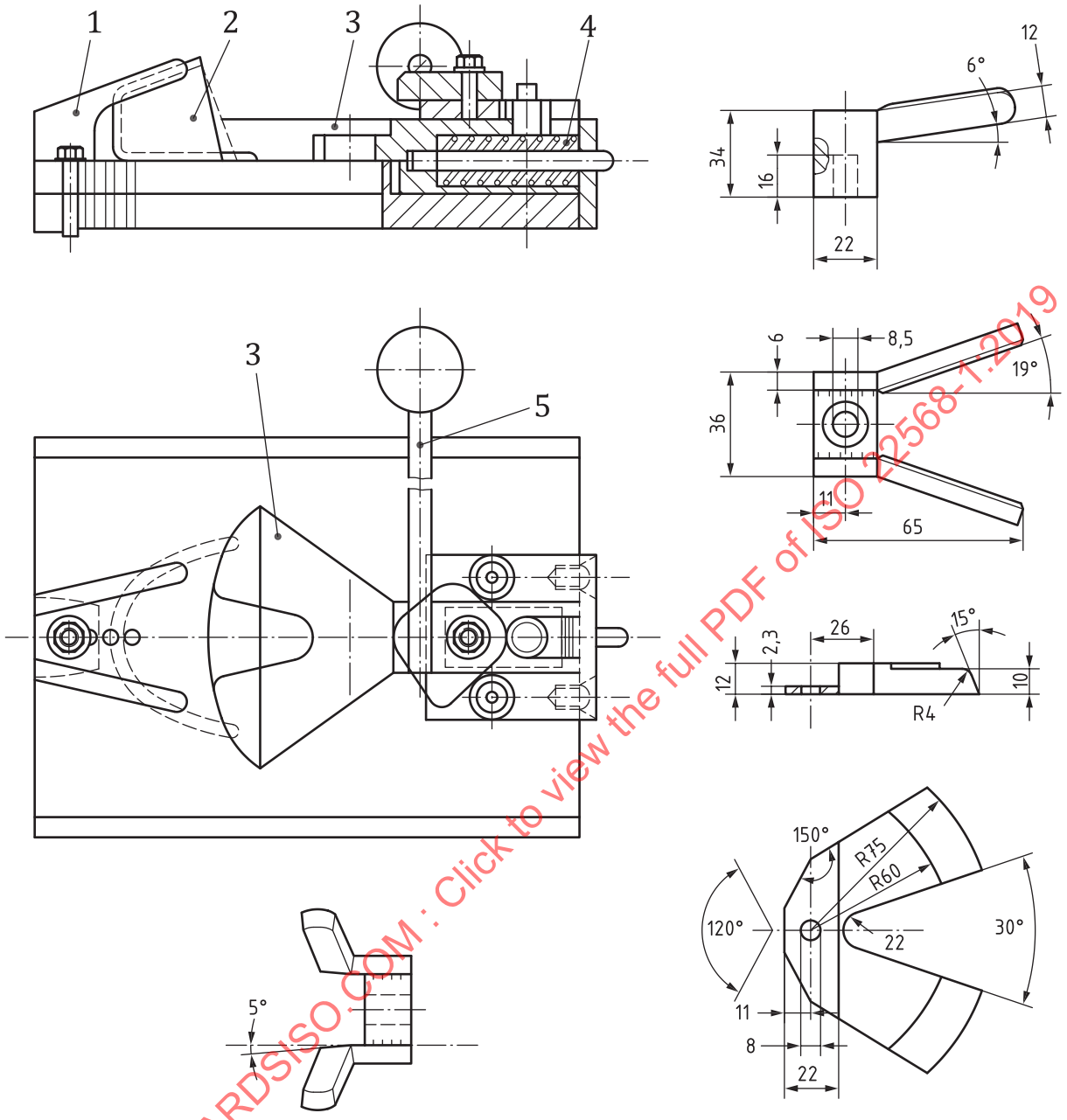
a) a reference to this document, i.e. ISO 22568-1:2019;

b) all the details concerning the necessary information for the samples identification;

c) the height determined according to 5.3.2 for each size (right and left) of tested metallic toecap;

d) any deviation by agreement and otherwise from the present test method.

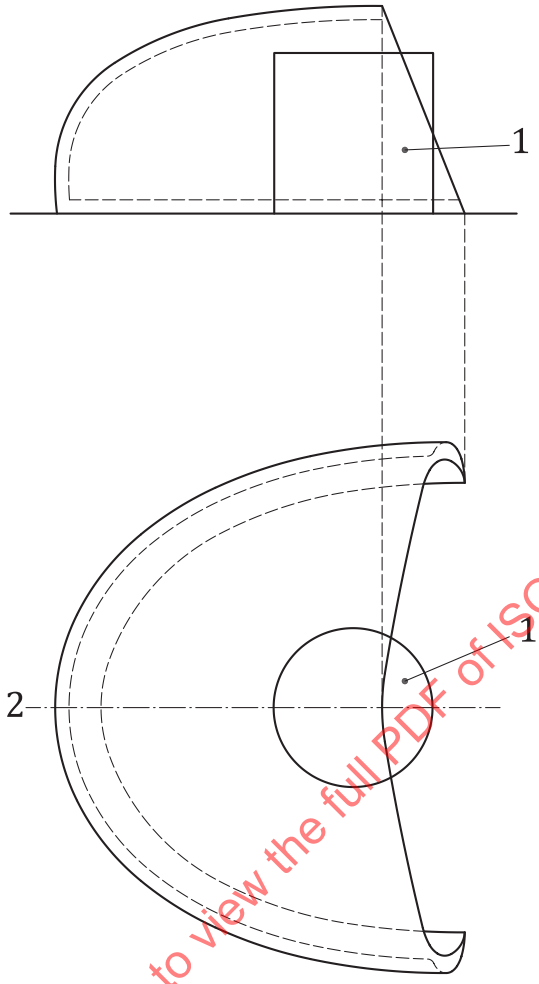
Dimensions in millimetres




**Key**

| | | | |
|---|---|---|---|
| 1 | forked clamp | 4 | spring |
| 2 | metallic toecap | 5 | clamping handle |
| 3 | radiused plate | | |

**Figure 5 — Example of suitable design of metallic toecap clamp**




**Key**

1 modeling clay cylinder

2 test axis

**Figure 6 — Position of cylinder for impact or compression testing of metallic toecaps**



## 5.4 Determination of compression resistance

### 5.4.1 Equipment

**5.4.1.1 Compression testing machine,** capable of subjecting the test piece to a force of at least 20 kN (to a tolerance of ±1 %) between two plain platens, by moving one of those at a speed of (5 ± 2) mm/min.

The lower plate shall cover at least an area of diameter 150 mm and the upper plate at least 90 mm. Both platens shall have a minimum hardness of 60 HRC and shall remain parallel during the application of the load. Any effect of eccentrically applied forces to the measurement shall be excluded as far as possible.

**5.4.1.2 Cylinders of modeling clay,** as described for the impact test (see 5.3.1.3).

**5.4.1.3 Dial gauge,** as described for the impact test (see 5.3.1.4).

### 5.4.2 Procedure

Determine the test axis as described previously (see 5.2.1.1).

Use the metallic toecap as the test piece.

Position the test piece centrally between the platens of the compression machine (5.4.1.1). A cylinder (5.4.1.2) is positioned under the rear upper edge of the test piece in a way that approximately 2/3 of its diameter is within the test piece and 1/3 is protruding behind the rear edge and the centre of the cylinder matches the test axis as closely as possible (see Figure 6). At the time of the test, the temperature of the modeling clay shall be between 18 °C and 25 °C.

Compress the test specimen to a load of either (15 ± 0,15) kN for metallic toecaps to be used for safety footwear or (10 ± 0,1) kN for metallic toecaps to be used for protective footwear (see Figure 7).

Reduce the load, remove the cylinder and measure, to the nearest 0,5 mm, the lowest height to which the cylinder has been compressed, using the dial gauge described in 5.4.1.3.

NOTE This value is the compression clearance at the moment of highest compression.

The number of tests to be performed is stated in Table 1.

### 5.4.3 Test report

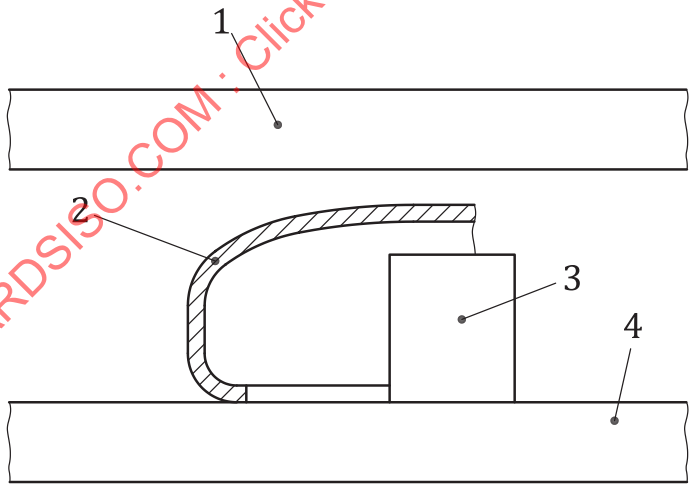
The report shall include the following information:

a) a reference to this document, i.e. ISO 22568-1:2019;

b) all the details concerning the necessary information for the samples identification;

c) The height determined according to 5.4.2 for each size (right and left) of tested metallic toecap;

d) Any deviation by agreement and otherwise from the present test method.




**Key**

1 upper platen
2 metallic toecap
3 modeling clay cylinder
4 lower platen

**Figure 7 — Apparatus for compression test**

## 5.5 Determination of corrosion resistance

### 5.5.1 Preliminary examination

Examine the metallic toecap visually inside and outside for signs of corrosion under the coating and for corrosion occurring where the coating has broken down.

Measure the longest distance across each area of corrosion and note the number of such areas.

### 5.5.2 Corrosion test procedure

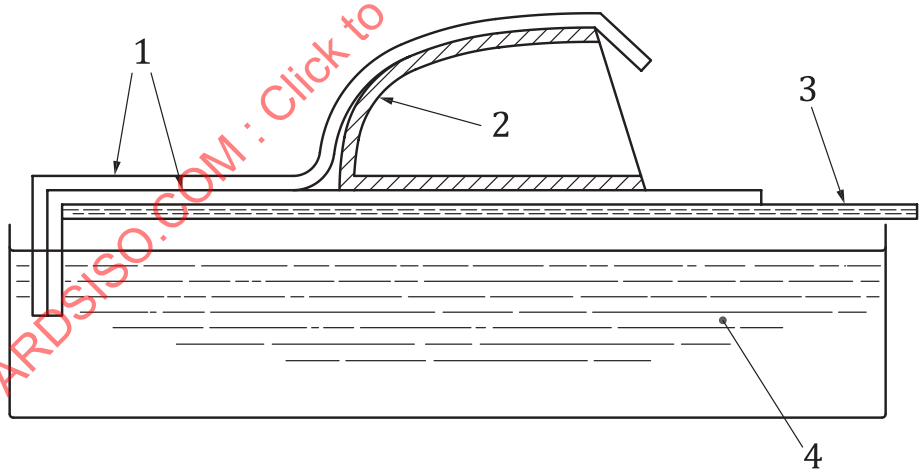
Remove any grease, silicone, wax or similar material which might be present on the surface with soft paper or textile, with ethanol if needed.

Prepare at least 300 ml of a 1 % (mass fraction) aqueous solution of sodium chloride as the test solution. Pour it into a dish sized at least 100 mm × 160 mm. The depth of the solution shall be ≥15 mm and it shall fill the dish up to a height of ≤10 mm from the glass plate. Cover the dish with a glass plate leaving a small opening.

Dip two strips of white filter paper of dimensions at least 100 mm wide and 150 mm long into the test solution at one end so that the strips of filter paper become saturated with solution, the other ends being laid on the glass plate.

Lay the metallic toecap to be tested flange down over the free end of one filter paper so that the whole flange is in contact with the wetted area and lay the other filter paper over the metallic toecap so that the greatest possible area of the nose of the toecap and its upper surface is in contact with the filter paper (see Figure 8). Ensure that the filter paper remains saturated throughout the test.

After 48 h remove the filter paper and examine the metallic toecap for signs of corrosion. Measure the longest distance across each area of corrosion and note the number of such areas.




**Key**

1 filter paper
2 metallic toecap
3 glass plate
4 sodium chloride aqueous solution

**Figure 8 — Schematic view of the corrosion test on metallic toecaps**

### 5.5.3 Test report

The report shall include the following information:

a) a reference to this document, i.e. ISO 22568-1:2019;

b) all the details concerning the necessary information for the samples identification;

c) the signs of corrosion determined according to 5.5.2 for each tested metallic toecap;

d) any deviation by agreement and otherwise from the present test method.

## 6 Marking

Metallic toecaps shall be clearly and permanently marked with the following information:

a) metallic toecap size (see Tables 2 and 3);

b) identification of left or right;

c) manufacturer's identification mark;

d) module's type designation;

e) **S** or **200 J** (metallic toecaps designed for safety footwear), A or B (to define the type) **P** or **100 J** (metallic toecaps designed for protective footwear), A or B (to define the type);

NOTE Example of acceptable markings: S-A, P/B.

f) number of this document and year of publication.

# Annex A
(normative)

# Impact and compression test, modelling clay check method

## A.1 Scope

This annex describes the requirements and test methods for selecting a modelling clay material suitable to be used as an auxiliary material for the testing of toecaps according to 5.3.1.3.

A list of the possible suppliers of the modelling clay is given in A.5.

## A.2 Requirements

### A.1.1 Static test

When tested in accordance with the method described in A.3., the modelling clay shall fulfil the following requirements:

— the energy absorption, $E_A$, shall be not higher than 0,80 J;

— the elastic recovery, $E_R$, shall be between 0 % and 5 %.

### A.1.2 Dynamic test

When tested in accordance with the method described in A.4, the modeling clay height after the impact shall not be less than 15 mm.

## A.3 Static test

### A.3.1 Equipment

**A.3.1.1** A compression machine equipped with two parallel plane plates, a load cell with a measuring range of between 500 N and 5 000 N and suitable means of measuring the amount of energy absorbed by the modelling clay cylinder during the test.

**A.3.1.2** A stable spacer, capable of stopping the movement of the compression machine when the two plates have reached a distance of 15 ± 1 mm. A steel ring with an inner diameter, $d \geq 10$ mm and an outer diameter $D \geq 50$ mm is suitable.

**A.3.1.3** A mould press or other suitable device for preparing modelling clay cylinders of the required dimensions (see A.3.2).

**A.3.1.4** A dial gauge conforming to ISO 20344:2011, 5.4.1.4., with exception of the “anvil”, which has to be flat.

### A.3.2 Test pieces

The modelling clay test piece shall be cylindrical with both height and diameter of (25 ± 1) mm. The two flat surfaces shall be covered with an aluminium foil of ≤0,05 mm thickness. For each determination, at least three test pieces shall be tested.