
**Foot and leg protectors —
Requirements and test methods for
footwear component —**

**Part 2:
Non-metallic toecaps**

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

Partie 2: Embouts non métalliques



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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 procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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.

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 On introducing these standards all national standards relating to safety toecaps were withdrawn leaving the manufacturers of these items with no means of demonstrating the performance of their products.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.

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

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Foot and leg protectors — Requirements and test methods for footwear component —

Part 2: Non-metallic toecaps

1 Scope

This document specifies requirements and test methods for non-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*

ISO 22568-1:2019, *Foot and leg protectors — Requirements and test methods for footwear component assessment — Part 1: Metallic toecaps*

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 non-metallic toecap

toecap produced from material other than metal and 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 non-metallic toecaps

4.1 General

This document defines two types of non-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	Sub clause	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
Stability against ageing and environmental influence	4.6	1 pair right and left for each treatment
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 non-metallic toecap design incorporating perforations.		

4.2 Finishing

Non-metallic toecaps shall be finished so as to be free from surface marks or defects and shall be free from burrs and sharp edges and defects of splitting or delaminating between material layers.

4.3 Dimensions

4.3.1 Internal length

When measured in accordance with the method described in [5.2.1](#), the internal length of non-metallic toecaps shall be not less than the appropriate value given in [Table 2](#).

Table 2 — Minimum internal length of non-metallic toecaps

Non-metallic toe cap size	Minimum internal length 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 non-metallic toecaps are formed with a flange, the inside width of the flange, e , shall be not greater than 15 mm using the test method given in 5.2.2.

4.4 Impact resistance

When non-metallic toecaps are tested in accordance with the method described in 5.3 at an energy level of either (100 ± 2) J (non-metallic toecaps intended for protective footwear), or (200 ± 4) J (non-metallic toecaps intended for safety footwear), the clearance under the toecap at the moment of impact shall be not less than the appropriate value given in Table 3. In addition, the non-metallic toecap shall not develop sharp edges or any cracks passing through the material (i.e. through which light can be seen) or delamination. During the assessment of the non-metallic toecap designed with perforations the criteria whether light can be seen shall not be applied to the perforations.

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

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

4.6 Stability against ageing and environmental influence

When non-metallic toecaps are subject to each single one of the treatments described in 5.5 and thereafter tested in accordance with the method described in 5.3 at an energy level of either (100 ± 2) J (toecaps intended for protective footwear) or (200 ± 4) J (toecaps intended for safety footwear), the clearance under the toecap at the moment of impact shall be not less than the appropriate value given in Table 3. In addition, the non-metallic toecap shall not develop sharp edges or any cracks passing through the material (i.e. through which light can be seen) or delamination. During the assessment of the non-metallic toecap designed with perforations the criteria whether light can be seen shall not be applied to the holes.

5 Test methods for non-metallic toecaps

5.1 General

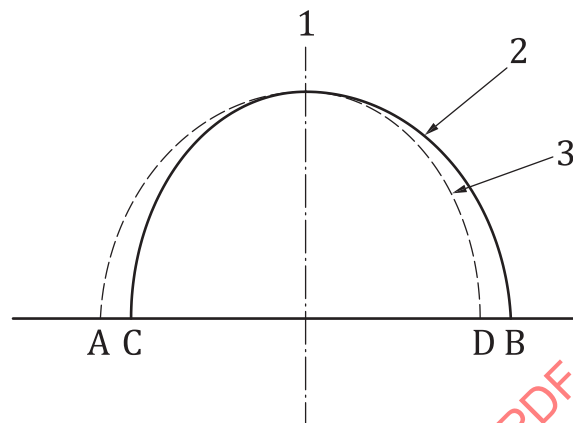
One pair of samples of each size shall be tested. Exceptions are made for some properties, as specified in Table 1.

5.2 Determination of dimensions

5.2.1 Determination of internal non-metallic toecap length

5.2.1.1 Determination of the test axis

Position the left non-metallic toecap with its rear edge in line with a base line and draw its outline. Repeat the exercise with the right non-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 non-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 non-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 non-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 non-metallic toecaps.

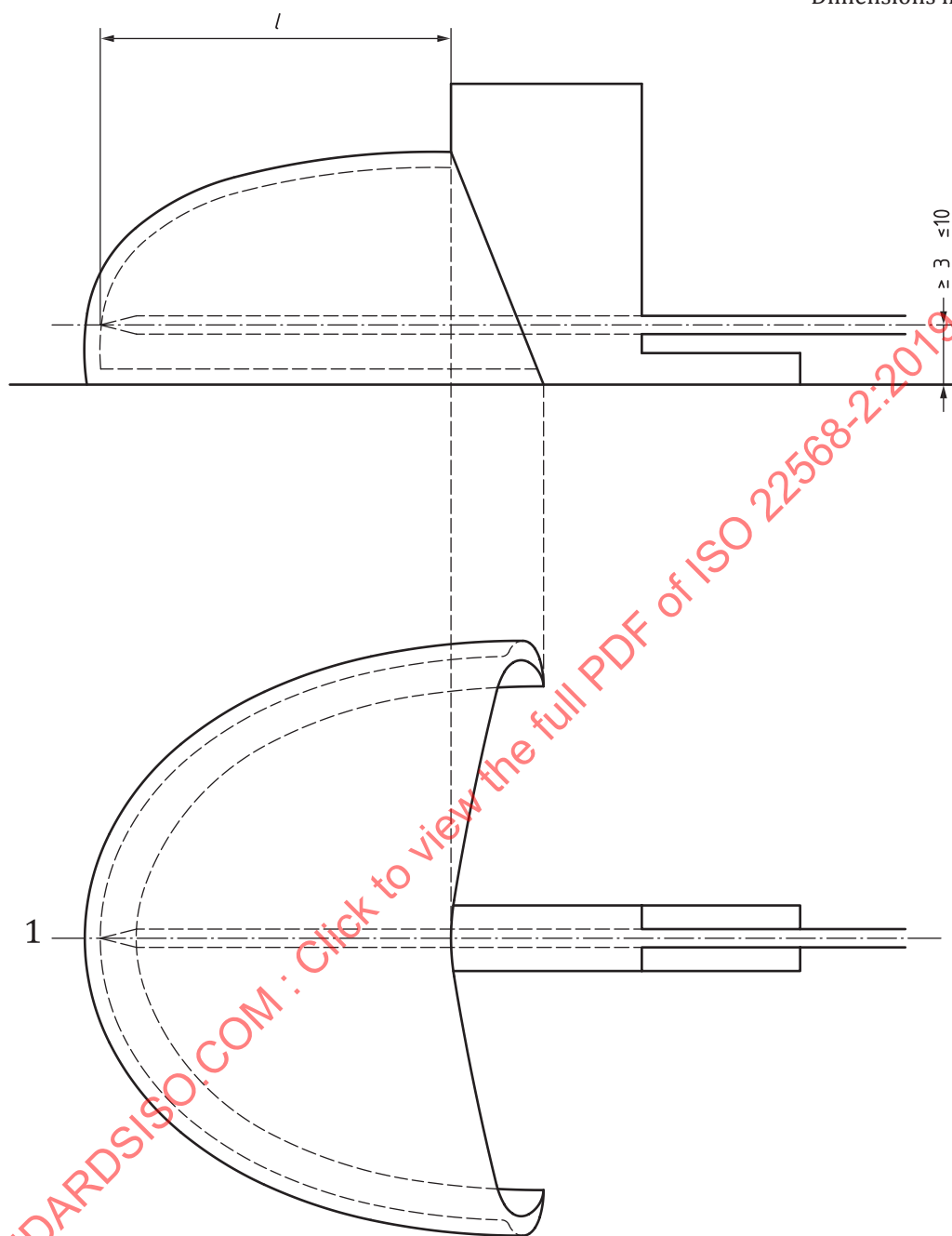
5.2.1.2 Procedure

Place the non-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 non-metallic toecap rests, taking the longest distance as the length, l (see [Figure 2](#)).

5.2.2 Width of flange

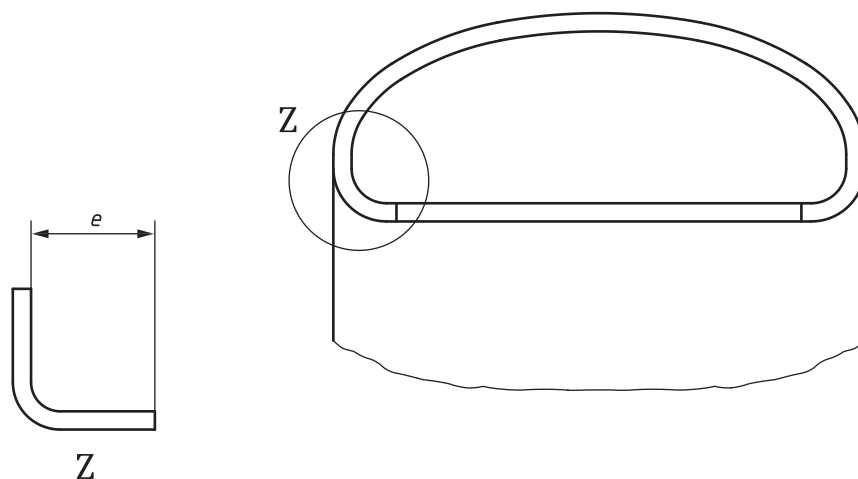
Determine the inside width of the flange, e , as shown in [Figure 3](#).

Dimensions in millimetres

**Key**

- 1 test axis
 l internal length of the non-metallic toecap

Figure 2 — Measurement of internal non-metallic toecap length



Key

e width of the non-metallic toecap flange

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

5.2.3 Test report

The report shall include the following indications:

- a) a reference to this document, i.e. ISO 22568-2:2019;
- 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 non-metallic toecap;
- d) the width of flange determined according to 5.2.2 for each sample of measured non-metallic toecap;
- e) any deviation by agreement and otherwise from the present test method.

5.3 Determination of impact resistance

5.3.1 Apparatus

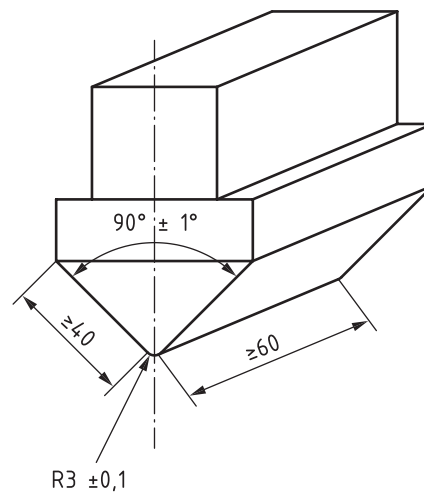
5.3.1.1 Impact apparatus, incorporating a steel striker of mass $(20 \pm 0,2)$ kg adapted to fall freely on vertical guides from a predetermined height to give the required impact energy.

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 $(90 \pm 1)^\circ$. The apex where the faces meet shall be rounded to a $(3 \pm 0,1)$ mm radius. During the test the apex shall be parallel within $\pm 2^\circ$ 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.

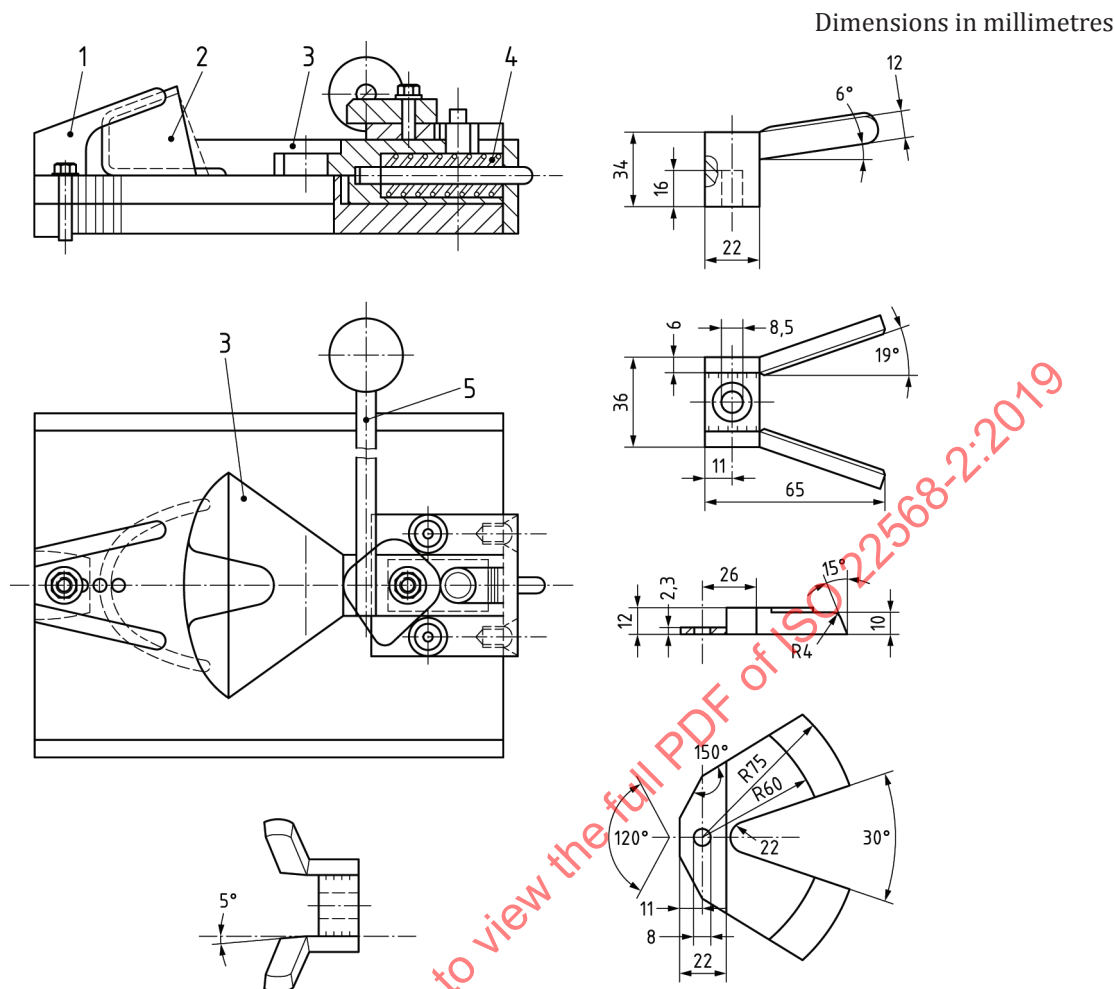
The apparatus shall be free standing on a flat and level floor which is sufficiently large and rigid to support the test equipment. Provision shall be made for a mechanism to catch the striker after the first impact so that the test specimen will be hit only once.

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 non-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](#).

**Key**

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

Figure 5 — Example of suitable design of non-metallic toecap clamp

The non-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 non-metallic toecap.

The non-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 toecap and pushes the toecap against the forked clamp with a load of 100 N to 200 N.

The sliding rail is sprung such that when the non-metallic toecap is hit by the striker it can move back along its axis against the spring. To change the non-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 non-metallic toecaps, and (30 ± 2) mm for type B non-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 ISO 22568-1:2019, 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 $(3,0 \pm 0,2)$ 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 non-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 non-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 non-metallic toecaps designed for safety footwear or (100 ± 2) J for non-metallic toecaps to be used in protective footwear.

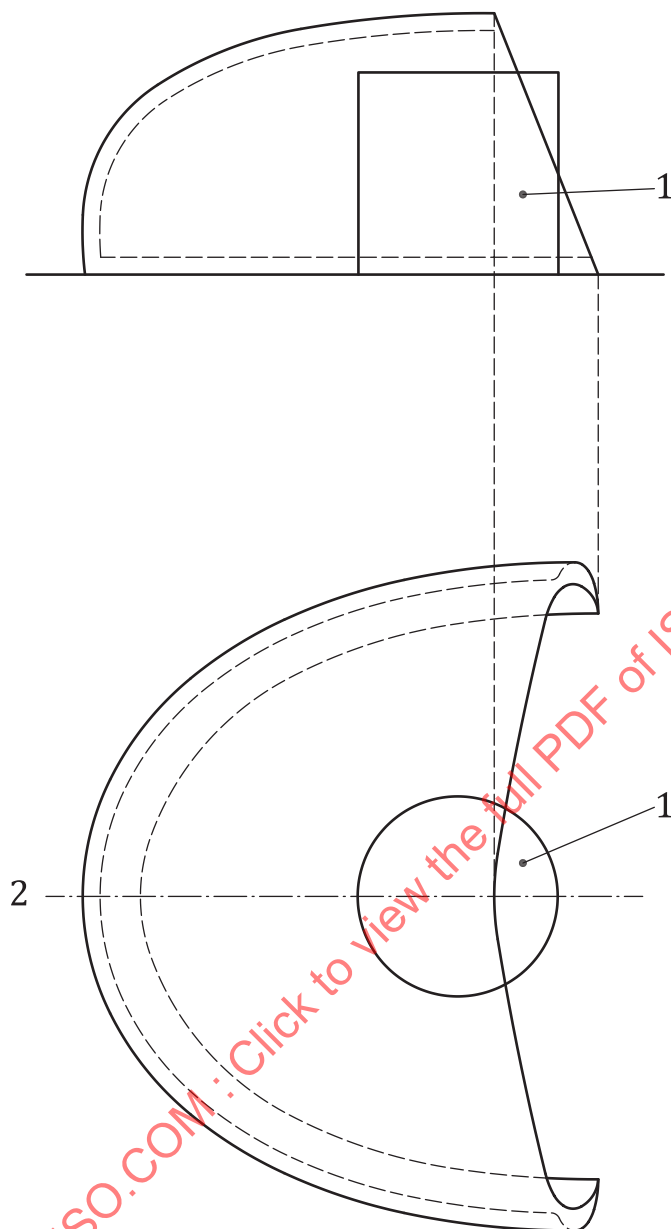
Measure, to the nearest 0,5 mm, the lowest height to which the cylinder has been compressed, using the dial gauge ([5.3.1.4](#)). This value is the clearance at the moment of impact.

The number of tests to be performed is stated in [Table 1](#).

5.3.3 Test report

The test report shall include the following indications:

- a) a reference to this document, i.e. ISO 22568-2:2019;
- b) all the details concerning the necessary information for the samples identification;
- c) the height determined according to [5.3.2](#) for each size (left and right) of tested non-metallic toecap;
- d) any visible degradation (cracking, delamination,...);
- e) any deviation by agreement and otherwise from the present test method.



Key

- 1 modelling clay cylinder
- 2 test axis

Figure 6 — Position of cylinder for impact or compression testing of non-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 $\pm 1\%$) 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 modelling 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](#)).

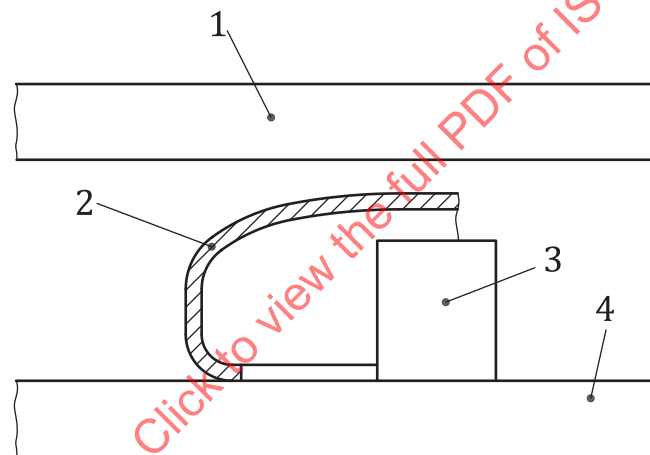
5.4.2 Procedure

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

Use the non-metallic toecap as the test piece.

Position the test piece 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 modelling clay shall be between 18 °C and 25 °C.

Compress the test specimen to a load of either $(15 \pm 0,15)$ kN for non-metallic toecaps to be used for safety footwear or $(10 \pm 0,1)$ kN for non-metallic toecaps to be used for protective footwear (see [Figure 7](#)).



Key

- 1 upper platen
- 2 non-metallic toecap
- 3 modelling clay cylinder
- 4 lower platen

Figure 7 — Apparatus for compression test

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 the following indications:

- a) a reference to this document, i.e. ISO 22568-2:2019;
- 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 non-metallic toecap;