

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS T 8107 : 2020

(JSAA/JSA)

**Test methods for protective and
occupational footwear**

ICS 13.340.50

Reference number : **JIS T 8107 : 2020 (E)**

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Date of Establishment: 2020-03-25

Date of Public Notice in Official Gazette: 2020-03-25

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Safety

JIS T 8107:2020, First English edition published in 2021-06

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

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Printed in Japan

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Foreword

This Japanese Industrial Standard has been established by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Safety Appliances Association (JSAA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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Test methods for protective and occupational footwear

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 20344:2011**, Edition 2, with some modifications of the technical contents of part of performance requirements so as to suit for use and management method of protective footwear and occupational footwear in Japan.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JB. Annex JA is unique to **JIS** and not given in the corresponding International Standard.

1 Scope

This Standard specifies methods for testing protective footwear and occupational footwear used in the workplaces of manufacturing industry, construction industry, transportation industry, food retailing industry, etc.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 20344:2011 *Personal protective equipment—Test methods for footwear (MOD)*

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 1501 *Rolling bearings—Balls*

JIS K 6250 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods*

JIS K 6251 *Rubber, vulcanized or thermoplastic—Determination of tensile stress-strain properties*

JIS K 6252-1 *Rubber, vulcanized or thermoplastic—Determination of tear strength—Part 1: Trouser, angle and crescent test pieces*

JIS K 6257 *Rubber, vulcanized or thermoplastic—Determination of heat ageing properties*

JIS K 6258 *Rubber, vulcanized or thermoplastic—Determination of the effect of liquids*

JIS K 6557-1 *Leather—Physical and mechanical tests—Determination of thickness*

JIS K 6557-10 *Leather—Physical and mechanical tests—Determination of distension and strength of surface (Ball burst method)*

JIS S 5037 *Sizing system for shoes*

JIS T 8010 *Testing method for withstand voltage of personal protective equipment and insulating devices*

JIS T 8101 *Protective footwear*

NOTE Corresponding International Standards: ISO 20345:2011 *Personal protective equipment—Safety footwear* and ISO 20346:2014 *Personal protective equipment—Protective footwear*

JIS T 8106 *Test method for slip resistance of protective and occupational footwear*

JIS T 8108 *Occupational footwear*

NOTE Corresponding International Standard: ISO 20347:2012 *Personal protective equipment—Occupational footwear*

JIS T 8125-3 *Protective clothing for users of hand-held chain-saws—Part 3: Test methods for footwear*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS T 8101** and **JIS T 8018** apply.

4 Sampling and conditioning

4.1 Sampling

The minimum number of samples to be tested in order to check compliance with the requirements specified in this Standard, together with the minimum number of test pieces taken from each sample, shall be in accordance with Table 1. Wherever possible and necessary to ensure the essential safety requirements, test pieces shall be taken from the whole footwear. If it is not possible to obtain a large enough test piece from the footwear, then a sample of the material from which the component has been manufactured may be used instead. This should be noted in the test report. This paragraph is applicable to all of Table 1. Unless otherwise specified, samples shall be taken from the footwear of the middle size for male (25.5, 26.0 or 26.5) specified in **JIS S 5037**.

4.2 Conditioning

All test pieces shall be conditioned in a standard atmosphere of $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \% \text{RH}$ before testing, unless otherwise stated in the test method. The time which shall elapse between removal from the conditioning atmosphere and the start of testing shall be as short as possible, unless otherwise stated in the test method.

4.3 Prerequisites on the testing procedure

Footwear shall be tested as it is intended to be used, unless otherwise specified in the test method.

For instance, if there is a removable insock, it shall be left in place to perform the tests.

If any abnormality occurs during the test, it shall be noted in the test report.

Table 1 Minimum number of samples and test pieces

	Test condition	Property under test		Subclause reference	Number of samples	Minimum number of test pieces per sample
		Final footwear or sample of component for manufacture of final footwear	Sample of component different from that used in final footwear			
Whole footwear	Upper/outsole bond strength	○		5.1	1 shoe	1 shoe
	Impact resistance	○		5.3	1 shoe	1 shoe
	Compression resistance	○		5.4	1 shoe	1 shoe
	Internal toecap length	○	○	5.2	1 pair of shoes	1 pair of shoes
	Corrosion resistance of metallic toecaps	○ ^{a)}	○ ^{a)}	5.2.3.1	1 pair of shoes	1 piece
	High heat resistance, low heat resistance, acid resistance, alkali resistance and resistance to fuel oil of non-metallic toecaps		○	5.2.3.2	See Table 2	
	Wearability	○		5.5	2 shoes	2 shoes
	Leakproofness	○		5.6	1 shoe	1 shoe
	Penetration resistance of footwear equipped with metallic penetration-resistant inserts	○		5.7.1	1 pair of shoes	1 piece
	Corrosion resistance of metallic penetration-resistant inserts		○	5.7.3.1	1 pair of shoes	1 piece
	Flex resistance of penetration-resistant insert		○	5.7.3.3	1 pair of shoes	1 piece
	Electrical insulating properties	○		5.8	1 shoe	1 shoe
	High-temperature thermal conductivity on sole	○		5.9.1	1 shoe	1 piece
	Low-temperature thermal conductivity on sole	○		5.9.2	1 shoe	1 piece
	Absorption of impact energy in seat region	○		5.10	1 shoe	1 piece
	Water resistance	○		5.11	1 piece	1 piece
	Impact resistance of metatarsal protector	○		5.12	1 piece	1 piece
	Cut resistance		○	5.13	1 shoe	1 piece
	Slip resistance	○		5.14	1 shoe	1 shoe

Table 1 (concluded)

	Test condition	Property under test		Subclause reference	Number of samples	Minimum number of test pieces per sample
		Final footwear or sample of component for manufacture of final footwear	Sample of component different from that used in final footwear			
Upper	Thickness	○	○	6.1	1 piece	1 piece
	Tensile properties	○	○	6.2	1 piece	1 piece
	Hydrolysis	○	○	6.3	2 pieces	2 pieces
	Grain crack	○	○	6.4	1 piece	1 piece
	Ageing resistance	○	○	6.5	2 pieces	2 pieces
	Resistance to fuel oil	○	○	6.6	1 piece	1 piece
Outsole	Thickness and cleat height	○		7.2	1 piece	1 piece
	Tear strength	○	○	7.3	1 piece	1 piece
	Tensile properties	○	○	7.4	1 piece	1 piece
	Hydrolysis	○	○	7.5	2 pieces	2 pieces
	Ageing resistance	○	○	7.6	2 pieces	2 pieces
	Resistance to fuel oil	○	○	7.7	1 piece	1 piece
	Resistance to hot contact	○	○	7.8	1 piece	1 piece
“○” indicates the object from which the samples are taken. If both columns under “Property under test” are marked with “○”, the sample can be taken from either one. Note ^{a)} The sample to be used for testing corrosion resistance of a metal protective toecap shall be final footwear or a sample of the component with which the final footwear has been manufactured in the case of Class II footwear, and a component of the same type as but different from what has actually been used in the manufacture of the final footwear in the case of Class I footwear.						

5 Test methods for whole footwear

5.1 Determination of upper/outsole bond strength

5.1.1 General

The force required to separate the upper from the outsole shall be measured. The test is not applicable when the bond has been made by grindery (using e.g. nails or screws) or stitching. In the case where the sole is multi-layered, the bond strength of the upper and the midsole shall be tested.

5.1.2 Test method

Carry out the test of upper/outsole bond strength with a tensile testing machine. After taking out the toecap of the toe region, clamp the test piece into the jaws of the tensile machine, using a pincer jaw to grip the toe tip of both the upper and the outsole, and pull from the toe part to the front of the shank part in the opposite direction to each other. Record the lowest 4 to 5 peak values and highest 4 to 5 peak values in the same number in the forepart region. Determine the average peeling load from these peak

values to give the bond strength. The jaw separation speed shall be (100 ± 20) mm/min. Use samples which have been left for at least 16 h after manufacture.

5.2 Test method for toecap

5.2.1 Determination of internal toecap length

Carefully extract the toecaps from an untested pair of protective footwear and remove all foreign materials adhering to them, or take a new pair of identical toecaps. First, draw a base line. Position the left toecap with its back edge in line with a base line and draw its outline. Repeat the exercise with the right toecap of the pair. Position the outlines in such a manner that the outlines at both the toe end of the toecaps and the base lines coincide (see Figure 1).

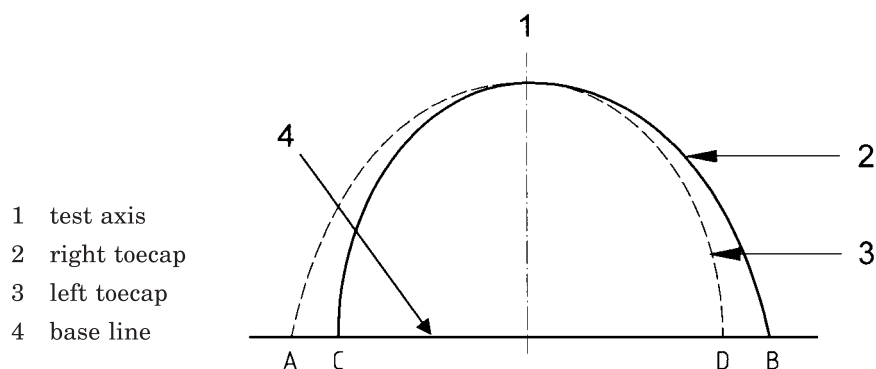


Figure 1 Determination of the test axis

NOTE If the length between the inner end and outer end of the toecap is 10 mm or more when visually observed, align the toecaps so that the back edge of the toecap is parallel to the base line, and then draw the outline.

Mark the four points A, B, C and D where the outlines of the left and right toecaps intersect on the base line. Erect the perpendicular from the base line at the midpoint of A-B or C-D. This constitutes the test axis of the toecap. Place the toecap, open side down, on a flat surface. Using an appropriate gauge, measure the internal length a along the test axis from the toe to the back edge at a distance between 3 mm and 10 mm above and parallel to the surface upon which the toecap rests (see Figure 2).

a is the maximum length which can be measured.

Unit: mm

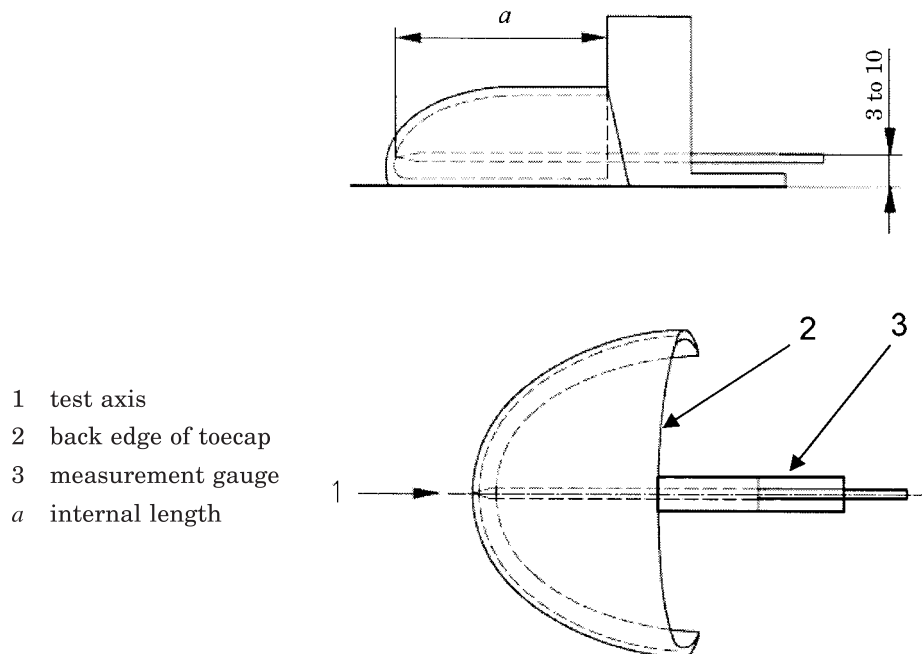


Figure 2 Example of gauge for the measurement of internal toecap length

5.2.2 Measurement of toecap height and width of horizontal base of folded part beneath the sole

Measure the internal length a in accordance with the test procedure in 5.2.1. At this measurement position, measure the inside dimension of the perpendicular drawn between the base line and the back edge of the toecap. This constitutes the toecap height b . The width of horizontal base of folded part beneath the sole c shall be measured at three positions, C1, C2 and C3, shown in Figure 3 in which the toecap is viewed from the bottom side.

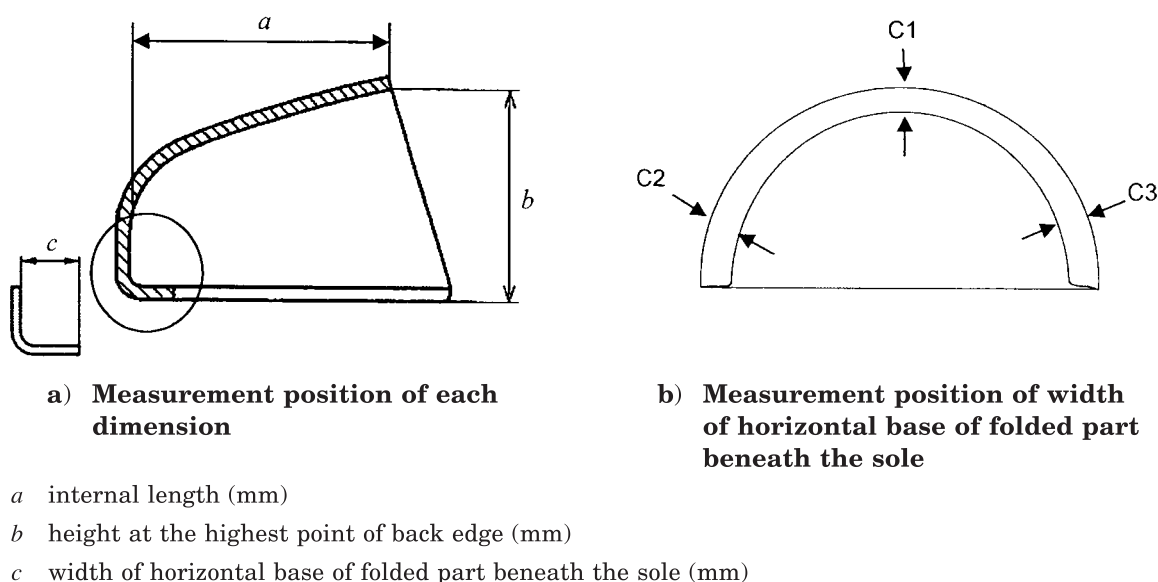


Figure 3 Example of measurement position of toecap height and width of horizontal base of folded part beneath the sole

5.2.3 High heat resistance, low heat resistance, acid resistance, alkali resistance, resistance to fuel oil and corrosion resistance test method of toecaps

5.2.3.1 Corrosion resistance test of metallic toecaps

5.2.3.1.1 General

Prepare the sample in accordance with Table 2. Use a mass fraction of 1 % aqueous solution of sodium chloride.

5.2.3.1.2 Protective footwear of Class I

Remove any grease, silicon wax or similar material attached to the toecap surface. Pour test solution 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 used as a lid. 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.

Place the toecap so that the entire width of the horizontal base of the toecap is in contact with the wetted area of the filter paper and the upper surface of the toecap is in contact with the filter paper (see Figure 4). Ensure that one end of the filter paper remains saturated throughout the test. After 48 h, remove the filter paper and examine for any evidence of corrosion of the toecap. When present, measure the longest distance across each area of corrosion and note the number of such areas.

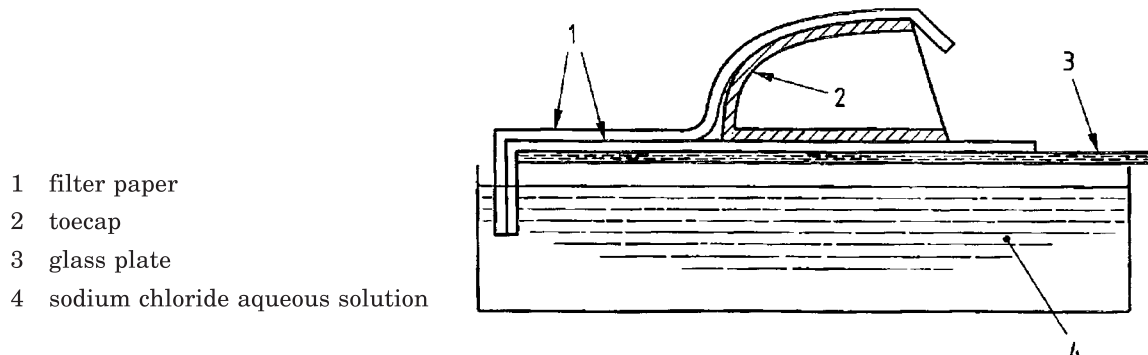


Figure 4 Corrosion resistance test of metallic toecaps

5.2.3.1.3 Protective footwear of Class II

Pour sufficient test solution into a test piece to fill it up in order to be sure that the toecap is under the level of the solution. Cover the top of the footwear with e.g. a polyethylene cover, to minimise evaporation. Leave for 7 days and then discard the test solution. Remove the toecap from the footwear and examine for any evidence of corrosion. When present, measure the longest distance across each area of corrosion and note the number of such areas.

5.2.3.2 Tests for high heat resistance, low heat resistance, acid resistance, alkali resistance and resistance to fuel oil of non-metallic toecaps

5.2.3.2.1 General

Prepare new sample of non-metallic toecap for each of the following five tests. Minimum number of samples and test pieces of toecaps shall be as specified in Table 2.

5.2.3.2.2 High heat resistance test

Place the toecap in the forced air circulation type oven maintained at $(60 \pm 2) ^\circ\text{C}$ for $4 \text{ h} \pm 10 \text{ min}$. Lower the temperature at $(45 \pm 2) ^\circ\text{C}$ and maintain this temperature for 18 h to 20 h. Remove the sample from the forced air circulation type oven and carry out immediately the impact test of toecap by the test method specified in Annex JA.

5.2.3.2.3 Low heat resistance test

Place the toecap in the chamber maintained at $(-20 \pm 2) ^\circ\text{C}$ for $4 \text{ h} \pm 10 \text{ min}$. Lower the temperature at $(-6 \pm 2) ^\circ\text{C}$ and maintain this temperature for 18 h to 20 h. Remove the sample from the chamber and carry out immediately the impact test of toecap by the test method specified in Annex JA.

5.2.3.2.4 Acid resistance test

Immerse the toecap in a sulfuric acid solution at a concentration of 1 mol/L maintained at $(23 \pm 2) ^\circ\text{C}$ for $24 \text{ h} \pm 15 \text{ min}$. Remove the toecap from the sulfuric acid solution, rinse off the acid adhering to it with water, store at $(23 \pm 2) ^\circ\text{C}$ for $24 \text{ h} \pm 1 \text{ h}$, and carry out the impact test of toecap by the test method specified in Annex JA.

5.2.3.2.5 Alkali resistance test

Immerse the toecap in a sodium hydroxide solution at a concentration of 1 mol/L maintained at $(23 \pm 2) ^\circ\text{C}$ for $24 \text{ h} \pm 15 \text{ min}$. Remove the toecap from the sodium hydroxide solution, rinse off the alkali adhering to it with water, store at $(23 \pm 2) ^\circ\text{C}$ for $24 \text{ h} \pm 1 \text{ h}$, and carry out the impact test of toecap by the test method specified in Annex JA.

5.2.3.2.6 Resistance to fuel oil test

Immerse the toecap in 2,2,4-trimethylpentane (isooctane) maintained at $(23 \pm 2) ^\circ\text{C}$ for $24 \text{ h} \pm 15 \text{ min}$. Remove the toecap from the 2,2,4-trimethylpentane (isooctane) solution, rinse off the liquid adhering to it with water, store at $(23 \pm 2) ^\circ\text{C}$ for $24 \text{ h} \pm 1 \text{ h}$, and carry out the impact test of toecap by the test method specified in Annex JA.

Table 2 Minimum number of samples and test pieces

Footwear	Type and number of samples	Type and number of test pieces per sample	Property under test
Class I metal toecap	<u>1 toecap</u>	1 toecap	New toecap
Class II metal toecap	<u>1 shoe</u>	1 shoe	Final footwear
Non-metal toecap	<u>5 toecaps</u>	<u>1 toecap</u> for each of the 5 treatments	New toecap

5.3 Test method for impact resistance

5.3.1 Impact test apparatus

The impact test apparatus shall be constructed to allow a steel striker of mass (20 ± 0.2) kg to drop freely along a vertical guide from a specified height to give a specified impact energy (see Figure 5).

The tip of the steel striker shall be wedge-shaped with an angle of $90^\circ \pm 1^\circ$, rounded to a radius of (3 ± 0.1) mm, with a minimum height of 40 mm and a minimum cutting length of 60 mm (see Figure 6).

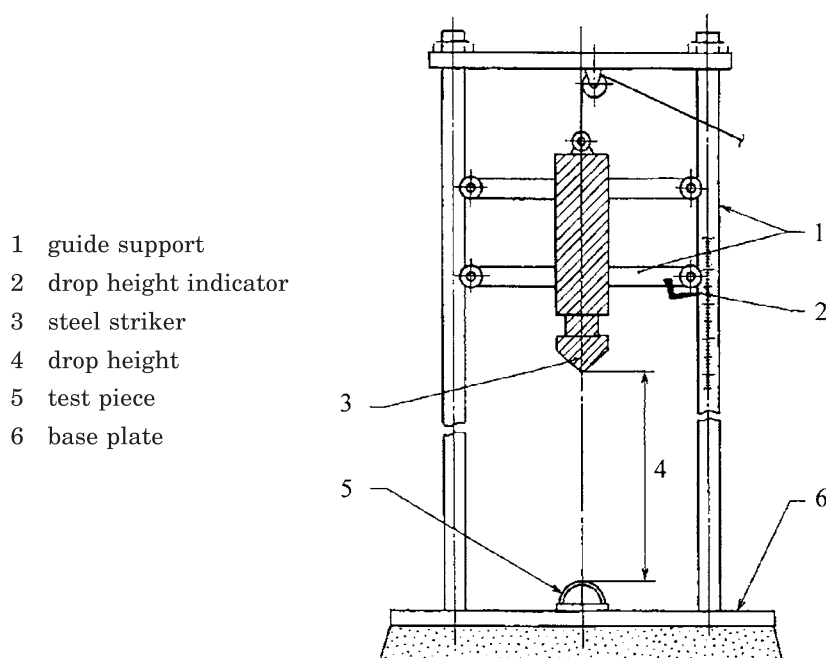


Figure 5 Example of impact test apparatus

Unit: mm

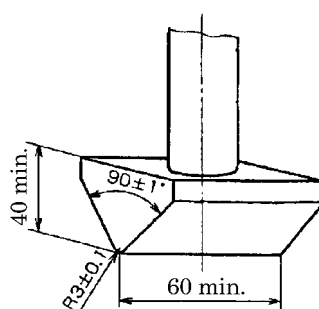


Figure 6 Detailed drawing of steel striker tip

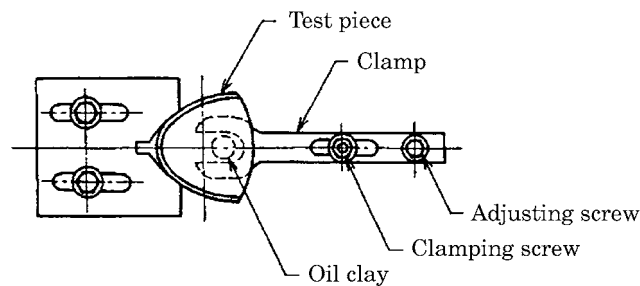


Figure 7 Example of clamping device

The clamping device shall consist of a smooth steel plate with a screw clamp for clamping the forepart of the insole/insock of the toe-end of the footwear under test to the plate in a way which will not restrict lateral expansion of the toecap during the impact test (see Figure 7).

5.3.2 Preparation of the test piece

Prepare the forepart of the footwear by cutting off the toe end about 30 mm behind the back edge of the toecap as shown in Figure 8.

If the footwear has been supplied with a removable insock, carry out the test with it in place.

Unit: mm

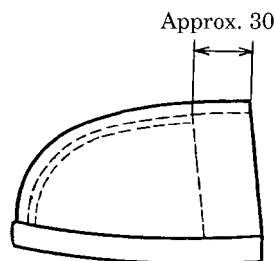


Figure 8 Example of sample for impact test

5.3.3 Test method

Clamp the sample with a clamping device so that it does not move due to impact, at a position where the steel striker of the impact test apparatus strikes the test axis of the footwear (see Figure 7). Adjust the clamp to rest on the insole, parallel to the base plate. Tighten the clamping screw by applying a torque of $(3 \pm 1) \text{ N} \cdot \text{m}$. Then, insert the oil clay in the shape of a cylinder of about 20 mm in diameter (hereafter referred to as 20 mm-cylindrical oil clay) between the insole and the highest part of the toecap at the back edge of the arch so that the back edge of the 20 mm-cylindrical oil clay coincides mostly with the back edge of the toecap. Allow the steel striker to drop from the appropriate height to give an impact energy given in Table 3. Remove the 20 mm-cylindrical oil clay and measure the height of the lowest part to the nearest 0.1 mm.