# BUREAU OF INDIAN STANDARDS

# भारतीय मानक ब्यूरो

## METALLURGICAL ENGINEERING DEPARTMENT

## धातुकर्म यांत्रिकी विभाग

- Bureau of Indian Standards is the National Standards body of India.

- One of the main activities of this Bureau is the development of National Standards which is spread over 16 divisions, out of which Metallurgical Engineering Division Council (MTDC) is one of the Divisions.

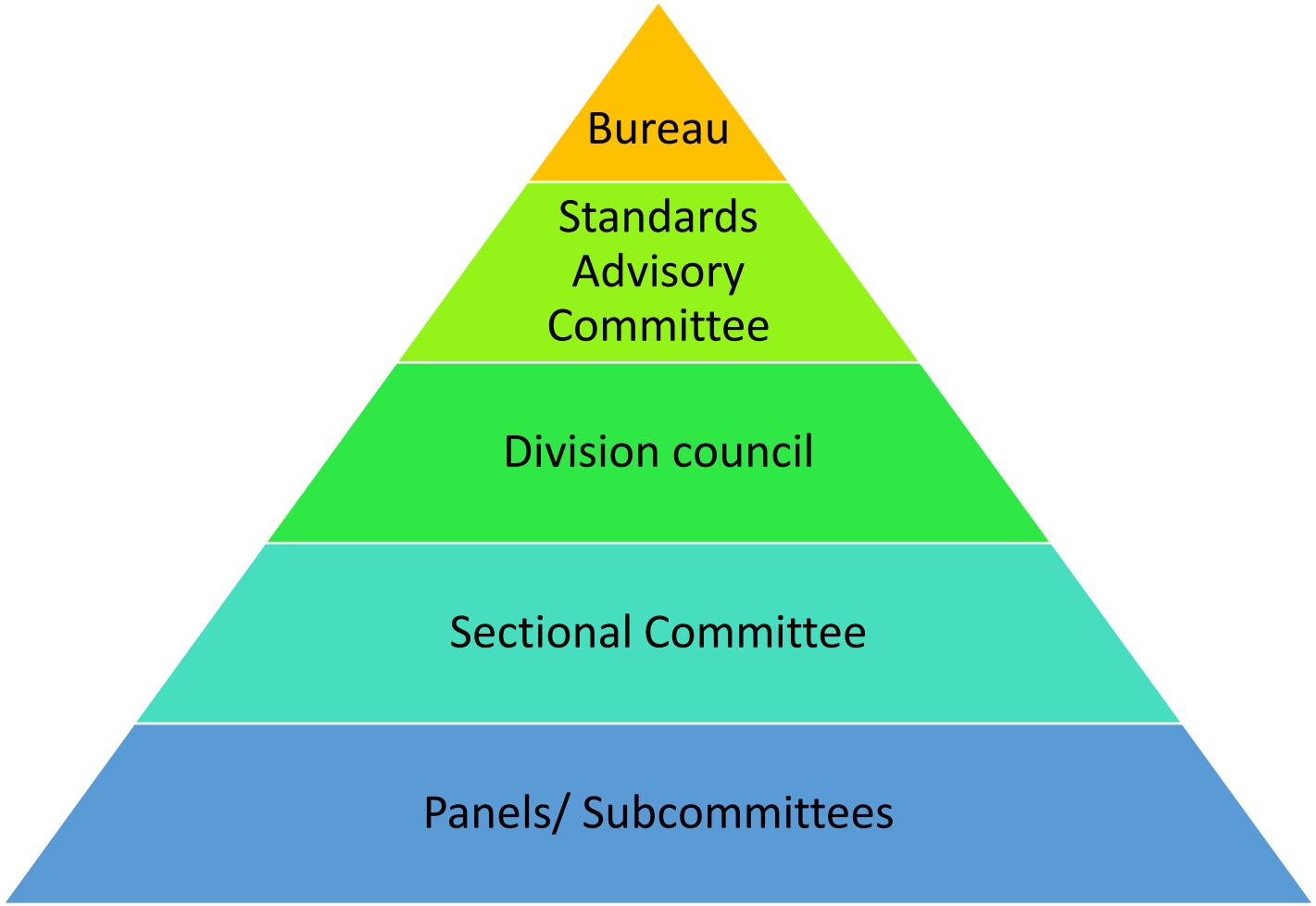
- BIS formulates Indian Standards through sectional committees under a Division Council, which are set up to deal with specific group of subjects. The committee structure is so designed to bring together all those with substantial interest in a particular field, so that standards are developed keeping in view the balance of interests among the relevant stakeholders.

- Under MTDC, there are 20 Sectional Technical Committees.
- Total published standards under purview of MTDC : 1682
- MTD 3, Mechanical testing of metals Sectional Committee , deals with ‘Standardization in the field of mechanical testing of metals.'
- BIS, is also a founder member of International Standards Organization(ISO) and the committee MTD 3 is liasoning with ISO TC 164 , Mechanical Testing of Metals.

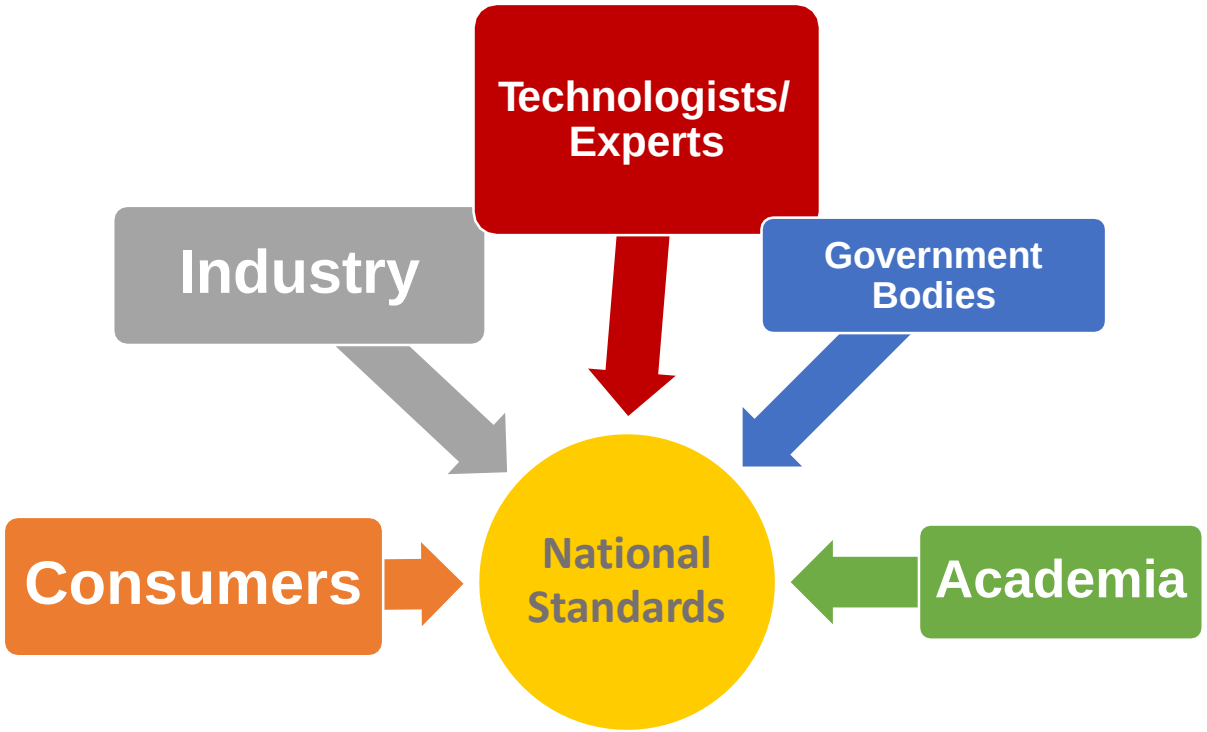
# What is aim of formulating a Standard?

- Provision of means of communication amongst all interested parties;
- Promotion of economy in human effort, materials and energy in the production and exchange of goods
- Protection of consumer interests through adequate and consistent quality of goods and services;
- Promotion of the quality of life, safety, health and the protection of environment;
- Promotion of trade by removal of barriers caused by differences in national practices

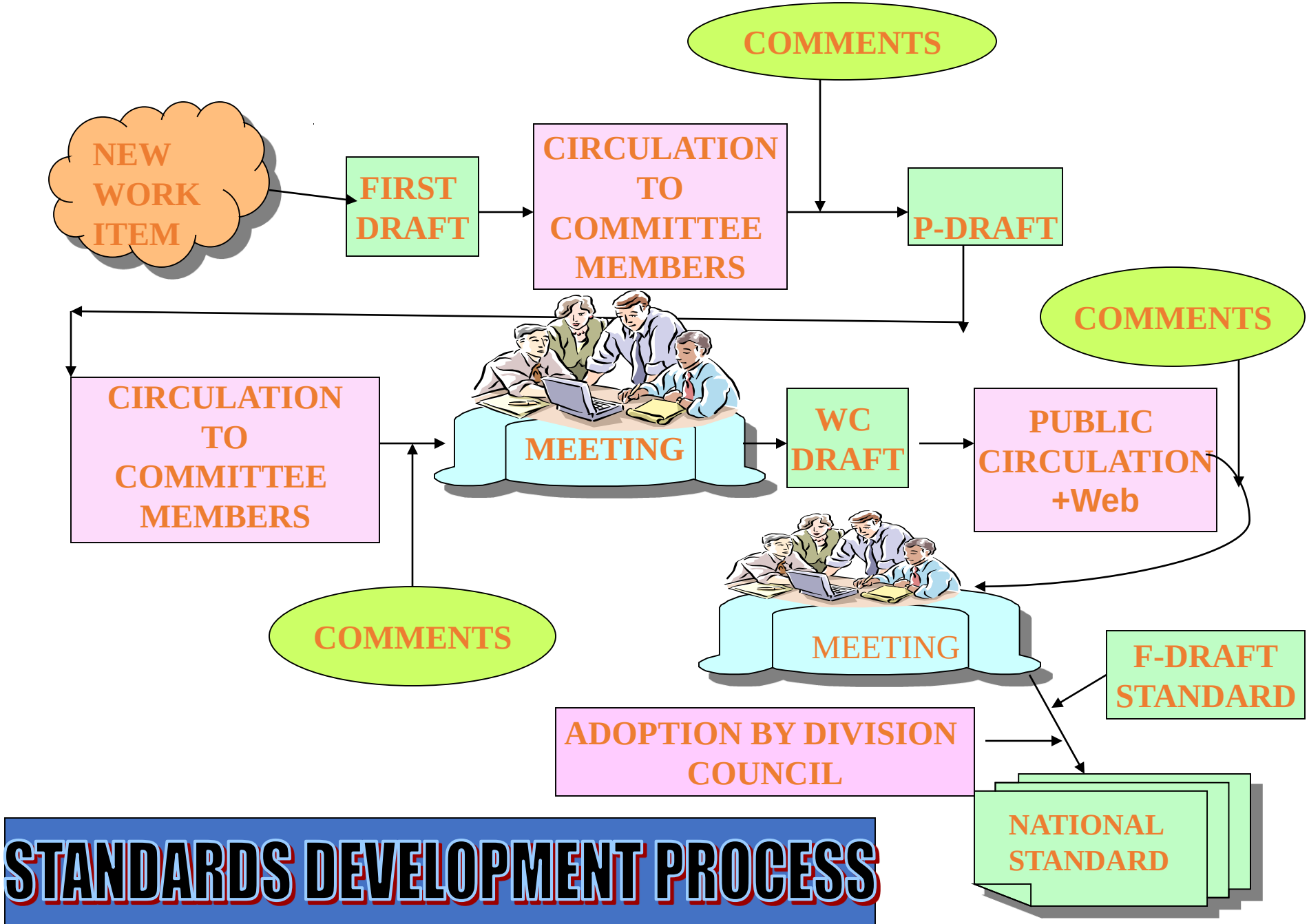
# Standardization at BIS



# National Standards Development




**BIS provides secretariat for standards formulation**


COMMENTS
NEW WORK ITEM
FIRST DRAFT
CIRCULATION TO COMMITTEE MEMBERS
P-DRAFT
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CIRCULATION TO COMMITTEE MEMBERS
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WC DRAFT
PUBLIC CIRCULATION +Web
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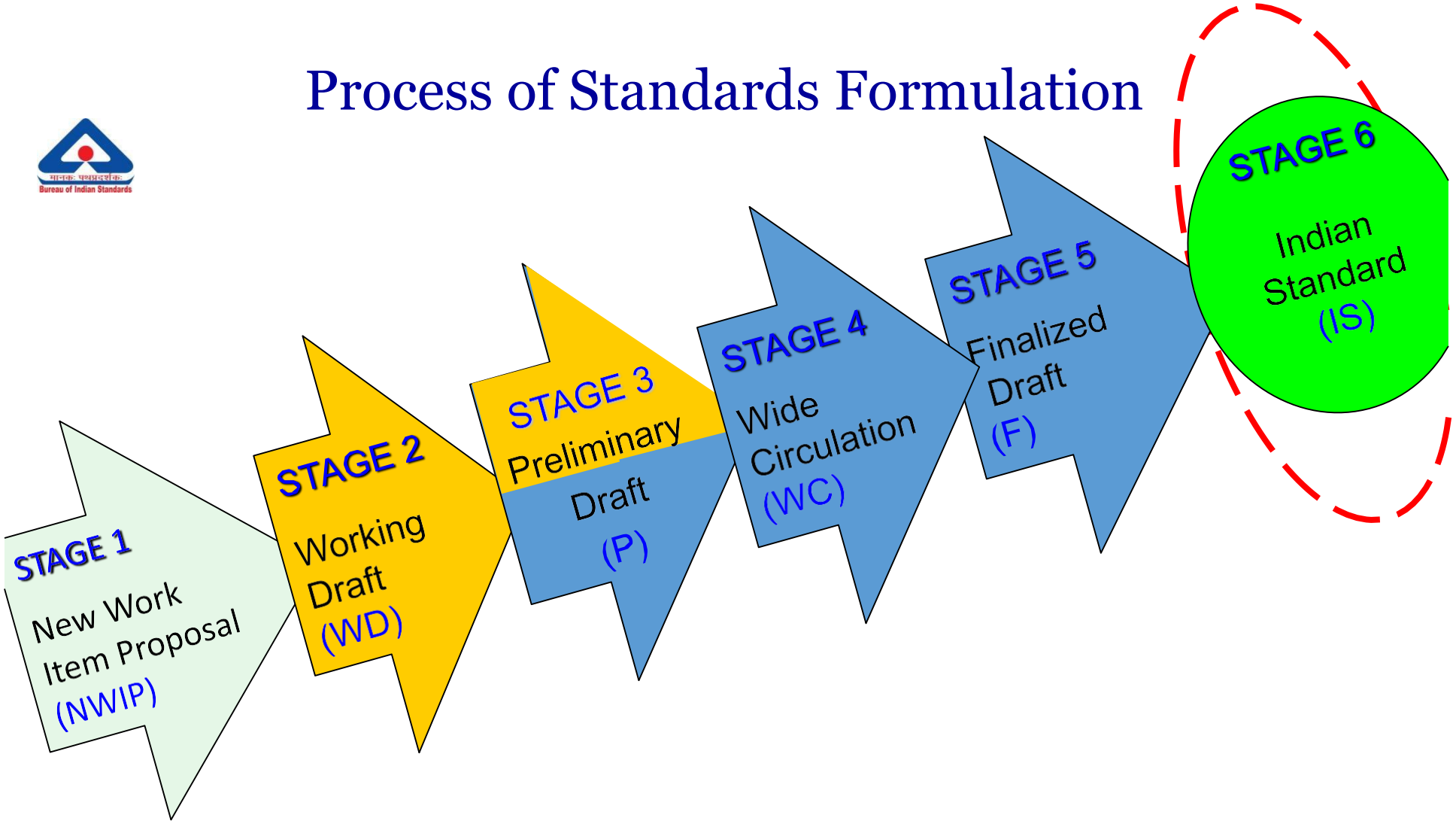
MEETING
F-DRAFT STANDARD
ADOPTION BY DIVISION COUNCIL
NATIONAL STANDARD
STANDARDS DEVELOPMENT PROCESS

# Process of Standards Formulation




Stage 2-3: Building consensus among panel/ committee members

Stage 3-5: Building national consensus

# MECHANICAL TESTING OF METALS

# INDIAN STANDARDS ON MECHANICAL TESTING OF METALS

## ❖*Tensile Testing*

- IS 1608 (Part 1) : 2018/ ISO 6892 -1:2016 - Metallic materials - Tensile testing: Part 1 method of test at room temperature (Fourth Revision)
- IS 1608 (Part 2) : 2020/ ISO 6892 -2:2018 - Metallic Materials - Tensile Testing Part 2 Method of Test at Elevated Temperature ( Fourth Revision)
- IS 1608 (Part 3) : 2018/ ISO 6892 -3:2015 - Metallic materials - Tensile testing: Part 3 method of test at low temperature

## ❖*Hardness Testing*

- ***Brinell's Hardness Test***
  - IS 1500 (Part 1) : 2019/ISO 6506-1 : 2014- Metallic materials - Brinell hardness test: Part 1 test method (Fifth Revision)
  - IS 1500 (Part 2) : 2021/ISO 6506-2 : 2017 - Metallic materials -- Brinell hardness test -- Part 2: Verification and calibration of testing machines
  - IS 1500 (Part 3) : 2019/ISO 6506-3 : 2014 - Metallic materials - Brinell hardness test: Part 3 calibration of reference blocks (Fifth Revision)
  - IS 1500 (Part 4) : 2019/ISO 6506-4 : 2014 – Metallic materials - Brinell hardness test: Part 4 table of hardness values (Fifth Revision)

# INDIAN STANDARDS ON MECHANICAL TESTING OF METALS

- ***Rockwell Hardness Test***
  - IS 1586 (Part 1) : 2018/ ISO 6508-1 : 2016 - Metallic materials - Rockwell hardness test: Part 1 test method (Fifth Revision)
  - IS 1586 (Part 2) : 2018/ ISO 6508-2:2015 - Metallic materials - Rockwell hardness test: Part 2 verification and calibration of testing machines and indenters (Fifth Revision)
  - IS 1586 (Part 3) : 2018/ ISO 6508-3:2015 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST PART 3 CALIBRATION OF REFERENCE BLOCKS
- ***Knoop Hardness Test***
  - IS 6885 (Part 1) : 2020 / ISO 4545-1:2017- Metallic Materials — Knoop Hardness Test Part 1 Test Method ( Second Revision )
  - IS 6885 (Part 2) : 2020/ISO 4545-2:2017- Metallic Materials — Knoop Hardness Test Part 2 Verification and Calibration of Testing Machines ( Second Revision )
  - IS 6885 (Part 3) : 2020/ISO 4545-3:2017 - Metallic Materials — Knoop Hardness Test Part 3 Calibration of Reference Blocks ( Second Revision )
  - IS 6885 (Part 4) : 2020/ISO 4545-4:2017 - Metallic Materials — Knoop Hardness Test Part 4 Tables of Hardness Values ( Second Revision )

# INDIAN STANDARDS ON MECHANICAL TESTING OF METALS

- **Vicker's Hardness Test**
  - IS 1501 (Part 1) : 2020/ISO 6507-1:2018 - Metallic Materials — Vickers Hardness Test Part 1 Test Method ( Fifth Revision )
  - IS 1501 (Part 2) : 2020/ISO 6507-2 : 2018 - Metallic Materials — Vickers Hardness Test Part 2 Verification and Calibration of Testing Machines ( Fifth Revision )
  - IS 1501 (Part 3) : 2020/ISO 6507-3 : 2018 - Metallic Materials — Vickers Hardness Test Part 3 Calibration of Reference Blocks ( Fifth Revision )
  - IS 1501 (Part 4) : 2020/ISO 6507-4 : 2018 - Metallic Materials — Vickers Hardness Test Part 4 Tables of Hardness Values ( Fifth Revision )

## ❖Impact Tests

- Charpy V-notch Test
  - IS 1757 (Part 1) : 2020/ISO 148-1:2016- Metallic Materials — Charpy Pendulum Impact Test Part 1 Test Method ( Fourth Revision )
  - IS 1499:1977 Method for charpy impact test (U - Notch) for metals (First Revision)

- Izod Impact
  - IS 1598 : 1977 (Reaffirmed : 2020) - Method for izod impact test of metals (First Revision)

# INDIAN STANDARDS ON MECHANICAL TESTING OF METALS

- Vocabulary
  - IS 5069 : 2018 / ISO 23718 Metallic Materials - Mechanical Testing - Vocabulary (Second Revision)

- Bend Tests
  - IS 1599 : 2019/ ISO 7438 : 2016 - Metallic materials - Bend test (Fourth Revision)
  - IS 2329 : 2005/ ISO 8491:1998 Metallic materials - Tube (In Full Section) - Bend test (Second Revision)

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

# PARTS & SCOPE

This standard has three parts:

1. **Part 1 Method of test at room temperature.**
   - ***Scope*** *:* This part of ISO 6892 specifies the method for tensile testing of metallic materials and defines the mechanical properties which can be determined at room temperature

2. **Part 2 Method of Test at Elevated Temperature**
   - ***Scope*** *:* This document specifies a method of tensile testing of metallic materials at temperatures higher than room temperature.

3. **Part 3 method of test at low temperature**
   - ***Scope*** *:* This part of ISO 6892 specifies a method of tensile testing of metallic materials at temperatures between +10 °C and -196 °C.

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

# IMPORTANT TERMS AND DEFINITIONS

1. **Gauge Length(L)**
2. **Elongation**
3. Percentage permanent elongation
4. Percentage elongation after fracture
5. Extensometer gauge length
6. Percentage extension
7. Percentage plastic extension at maximum force(Ag)
8. **Strain rate**
9. Crosshead separation rate
10. Maximum Force
11. **Tensile strength**
12. **Yield strength**
13. **Upper yield strength**
14. **Lower yield strength**
15. Proof strength

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

## SPECIMEN SHAPE AND DIMENSIONS

- The test piece is usually obtained by machining a sample from the product or a pressed blank or casting.
- However, products of uniform cross-section (sections, bars, wires, etc.) and also as-cast test pieces (i.e. for cast iron and non-ferrous alloys) may be tested without being machined.
- Preferred test pieces have a direct relationship between the **original gauge length, Lo,** and the original cross-sectional area, So, expressed by the formula **$L_o = k\sqrt{S_o}$** where K is coefficient of proportionality, internationally adopted value for **k is 5.65**
- When the cross-sectional area of the test piece is **too small** for this requirement to be met with, k =5.65 a higher **value (preferably 11.3)** or a non-proportional test.

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

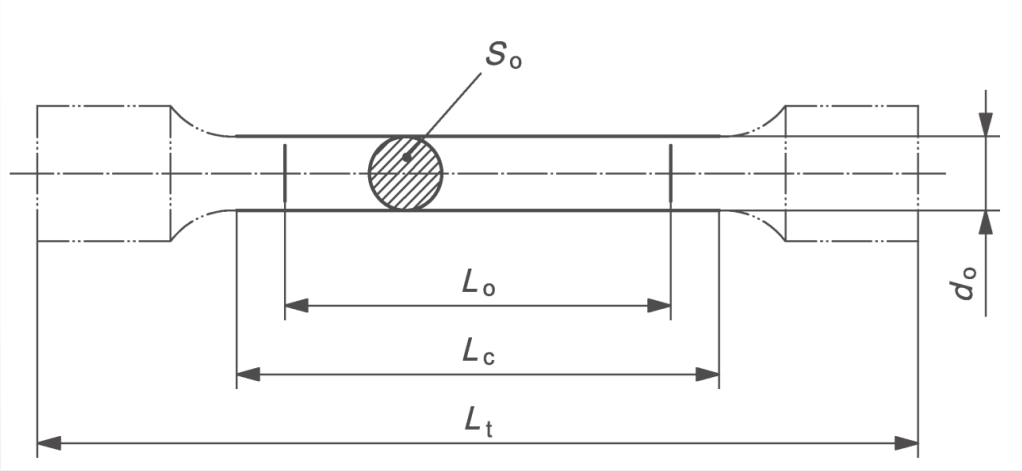
# TYPES OF TEST PIECES ACCORDING TO PRODUCT TYPE

| Type of product | | Corresponding Annex |
|---|---|---|
| **Sheets – Plates – Flats** | Wire – Bars – Sections | |
|  |  | |
| **Thickness** $a$ | Diameter or side | |
| **0,1 ≤ $a$ < 3** | – | B |
| **–** | < 4 | C |
| **$a$ ≥ 3** | ≥ 4 | D |
| **Tubes** | | E |

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

Example :

Standard specimen dimension for circular cross section test pieces (Machined) :




| Coefficient of proportionality k | Diameter d (mm) | Original gauge length $L_0 = k\sqrt{S_0}$ (mm) | Minimum parallel length $L_c$ (mm) |
|---|---|---|---|
| 5.65 | 20 | 100 | 110 |
| | 14 | 70 | 77 |
| | 10 | 50 | 55 |
| | 5 | 25 | 28 |

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

**Example of some specimen :**

# IS 1608 - METALLIC MATERIALS - TENSILE TESTING

## TEST REPORT

The test report shall contain at least the following information, unless otherwise agreed by the parties concerned:

a) reference to this part of ISO 6892, extended with the test condition information specified in 10.3.4,
e.g. ISO 6892-1:2016 A224;

b) identification of the test piece;

c) specified material, if known;

d) type of test piece;

e) location and direction of sampling of test pieces, if known;

f) testing control mode(s) and testing rate(s) or testing rate range(s) (see 10.3.1) if different from the recommended methods and values given in 10.3.2 and 10.3.3;

g) test results:

— results should be rounded (according to ISO 80000-1) to the following precisions or better, if not otherwise specified in product standards: strength values, in megapascals, to the nearest whole number;

— percentage yield point extension values, Ae, to the nearest 0,1 %;

— all other percentage extension and elongation values to the nearest 0,5 %;

— percentage reduction of area, Z, to the nearest 1 %.

# IS 1500 / ISO 6506 - METALLIC MATERIALS – BRINELL HARDNESS TEST

# PARTS & SCOPE

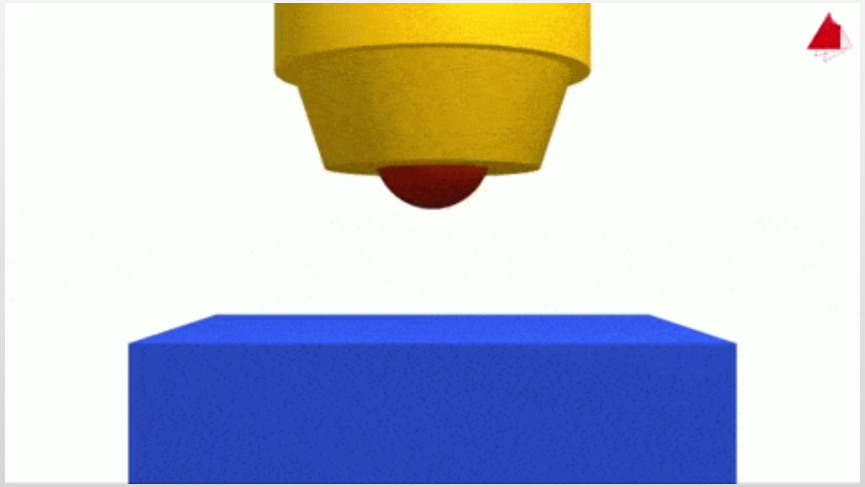
***This standard has four parts:***

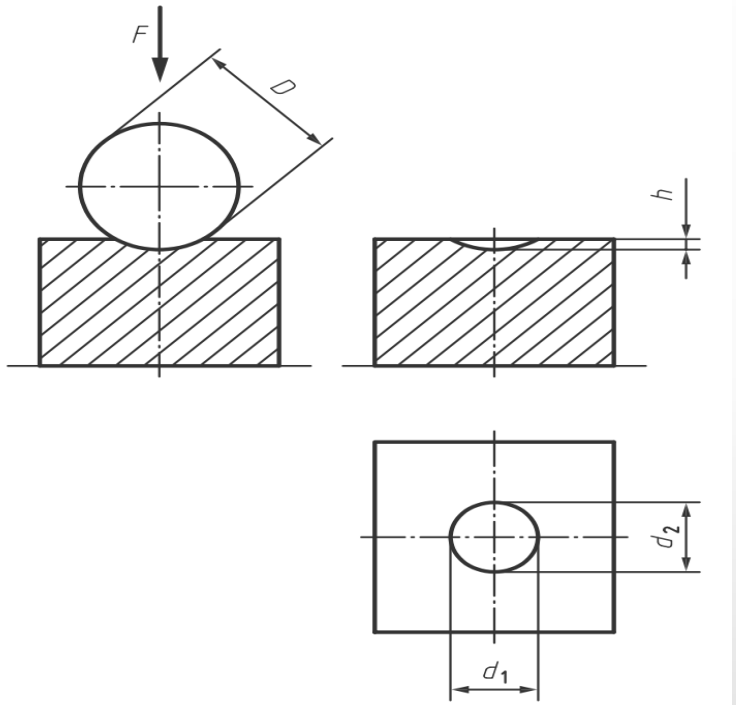
1. **Part 1 Test method**
   - **Scope :** This part of ISO 6506 specifies the method for the Brinell hardness test for metallic materials. It is applicable to both fixed location and portable hardness testing machines.
2. **Part 2 Verification and calibration of testing machines**
   - **Scope :** This document specifies methods of direct and indirect verification of testing machines used for determining Brinell hardness in accordance with ISO 6506-1 and also specifies when these two types of verification have to be performed.
3. **Part 3 Calibration of reference blocks**
   - **Scope :** This part of ISO 6506 specifies a method for the calibration of reference blocks to be used in the indirect verification of Brinell hardness testing machines as described in ISO 6506-2.
     The procedures necessary to ensure metrological traceability of the calibration machine are also specified
4. **Part 4 Table of hardness values**
   - **Scope :** This part of ISO 6506 gives a table of the Brinell hardness values for use in tests on flat surfaces.

# IS 1500 / ISO 6506 - METALLIC MATERIALS – BRINELL HARDNESS TEST

## PRINCIPLE

- The Brinell hardness is proportional to the quotient obtained by dividing the test force by the curved surface area of the indentation. The indentation is assumed to take the shape of the unloaded ball indenter, and its surface area is calculated from the mean indentation diameter and the ball diameter, using the formula given in Table(next slide).






| Symbol | Definition | Unit |
|---|---|---|
| D | Diameter of the ball | mm |
| F | Test force | N |
| D | Mean diameter of the indentation $d = \frac{d_1 + d_2}{2}$ | mm |
| $d_1, d_2$ | Indentation diameters measured at approximately 90° | mm |
| h | Depth of indentation $h = \frac{D}{2}\left(1 - \sqrt{1 - \frac{d^2}{D^2}}\right)$ | mm |
| HBW | Brinell Hardenss = $constant(see\ NOTE)\ \frac{Test\ Force}{Idealized\ Surface\ area\ of\ indentation}$ <br> HBW = 0.102 * $\frac{2F}{\pi D^2\left(1-\sqrt{1-\frac{d^2}{D^2}}\right)}$ | mm |
| 0.102 F/D² | Force – diameter index | |

***Note*** Constant = $0.102 \approx \frac{1}{9.80665}$, where 9.80665 is the conversion factor from kgf to N.

# IS 1500 / ISO 6506 - METALLIC MATERIALS – BRINELL HARDNESS TEST

Can anyone tell what does the following designation represents:

**600 HBW 1/30/20**

# IS 1500 / ISO 6506 - METALLIC MATERIALS – BRINELL HARDNESS TEST

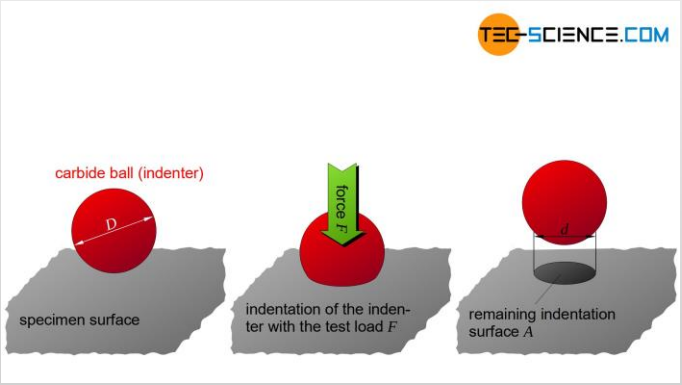
| | |
|---|---|
| 600 | Brinell Hardness Value |
| HBW | Hardness Symbol |
| 1 | Ball Diameter in mm |
| 30 | Approximate kgf equivalentof applied test force where 30kgf= 2942N |
| 20 | Duration time of test force (20s) if not within specified range (10s to 15s) |

# IS 1500 / ISO 6506 - METALLIC MATERIALS – BRINELL HARDNESS TEST

# PROCEDURE

- The test shall be carried out on a surface ***which is smooth and even***; free from oxide scale, foreign matter, and, in particular, free from lubricants.
- The test piece shall have a surface finish that will allow an accurate measurement of the diameter of the indentation.

  ***Note***- For indentations made with the smaller ball indenters, it might be necessary to polish or lap the surface prior to making the indentation.
- Preparation shall be carried out in such a way that any *alteration of the surface*, for example, due to excessive heating or cold-working, *is minimized*.
- The thickness of the test piece shall be at least eight times the depth of indentation. Values for the minimum thickness of the test piece in relation to the mean diameter of indentation are to be referred from Annex B of IS 1500 part 1.
- Visible deformation at the back of the test piece can indicate that the test piece is too thin.



# IS1586/ ISO 6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

# PARTS & SCOPE

***This standard has three parts:***

1. **Part 1 Test method**
   - **Scope :** This part of ISO 6508 specifies the method for Rockwell regular and Rockwell superficial hardness tests for scales A, B, C, D, E, F, G, H, K, 15N, 30N, 45N, 15T, 30T, and 45T for metallic materials and is applicable to stationary and portable hardness testing machines.
2. **Part 2 Verification and calibration of testing machines and indenters**
   - **Scope :** This part of ISO 6508 specifies two separate methods of verification of testing machines (direct and indirect) for determining Rockwell hardness in accordance with ISO 6508-1:2015, together with a method for verifying Rockwell hardness indenters.
3. **Part 3 Calibration of reference blocks**
   - **Scope :** This part of ISO 6508 specifies a method for the calibration of reference blocks to be used for the indirect and daily verification of Rockwell hardness testing machines, as specified in ISO 6508-2:2015.

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

# PRINCIPLE

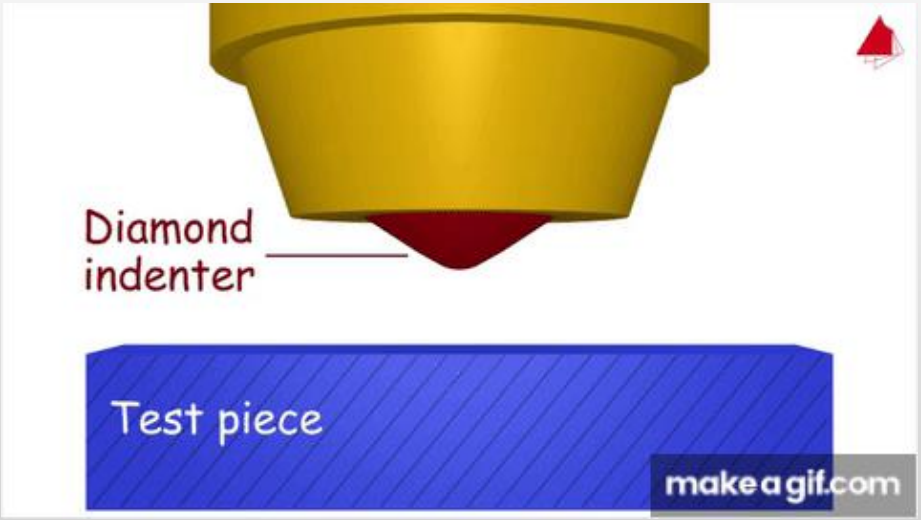
- The Rockwell hardness value is derived from the difference, h, in final and initial indentation depths and the two constants N and S

$$\text{Rockwell hardness} = N - \frac{h}{S}$$

N – Full range constant

h – Permanent depth of indentation under preliminary test force after removal of additional test force (permanent indentation depth) (mm)

S – Scaling constant (mm)



# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

# PRINCIPLE

| Rockwell Regular hardness scale | Hardness symbol Unit | Type of indenter | Preliminary force $F_0$ | Total force $F$ | Scaling Constant $S$ | Full Range Constant $N$ | Applicable range of application (Rockwell Regular hardness scales) |
|---|---|---|---|---|---|---|---|
| A | HRA | Diamond cone | 98,07 N | 588,4 N | 0,002 mm | 100 | 20 HRA to 95 HRA |
| B | HRBW | Ball 1,587 5 mm | 98,07 N | 980,7 N | 0,002 mm | 130 | 10 HRBW to 100 HRBW |
| C | HRC | Diamond cone | 98,07 N | 1,471 kN | 0,002 mm | 100 | 20 HRC[a] to 70 HRC |
| D | HRD | Diamond cone | 98,07 N | 980,7 N | 0,002 mm | 100 | 40 HRD to 77 HRD |
| E | HREW | Ball 3,175 mm | 98,07 N | 980,7 N | 0,002 mm | 130 | 70 HREW to 100 HREW |
| F | HRFW | Ball 1,587 5 mm | 98,07 N | 588,4 N | 0,002 mm | 130 | 60 HRFW to 100 HRFW |
| G | HRGW | Ball 1,587 5 mm | 98,07 N | 1,471 kN | 0,002 mm | 130 | 30 HRGW to 94 HRGW |
| H | HRHW | Ball 3,175 mm | 98,07 N | 588,4 N | 0,002 mm | 130 | 80 HRHW to 100 HRHW |
| K | HRKW | Ball 3,175 mm | 98,07 N | 1,471 kN | 0,002 mm | 130 | 40 HRKW to 100 HRKW |

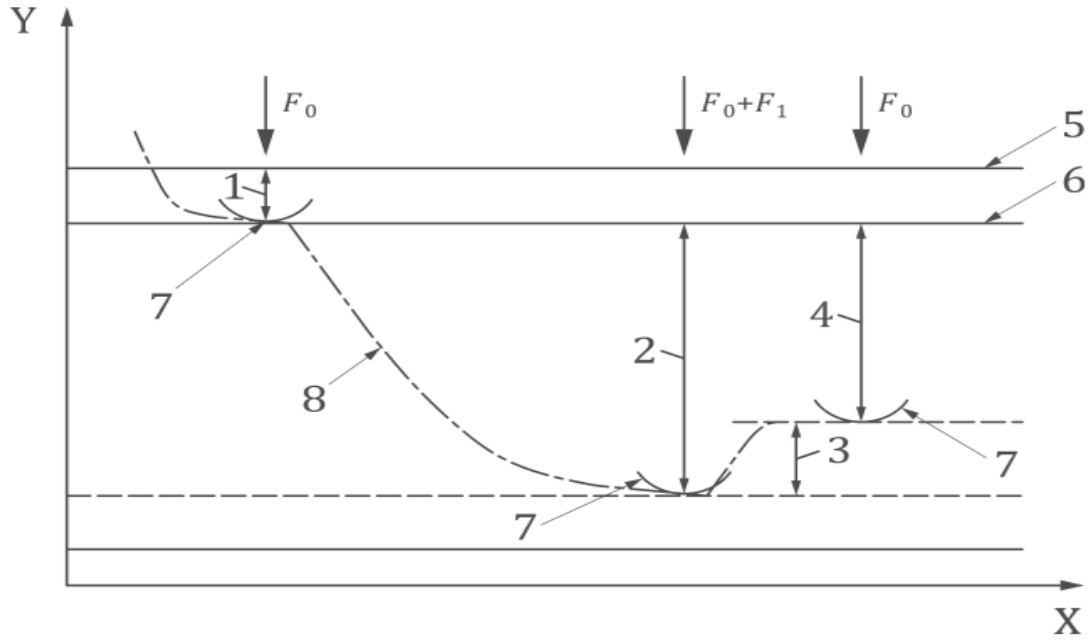
[a] The applicable range of application can be extended to 10 HRC if the surfaces of the diamond cone and spherical tip are polished for a penetration depth of at least 0,4 mm.

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

# PRINCIPLE

| Symbol | Definition | Unit |
|---|---|---|
| $F_0$ | Preliminary test force | N |
| $F_1$ | Additional test force (total force minus preliminary force) | N |
| F | Total test force | N |
| S | Scaling constant, specific to the scale | mm |
| N | Full range constant, specific to the scale | - |
| h | Permanent depth of indentation under preliminary test force after removal additional test force (permanent indentation depth) | mm |
| HRA<br>HRC<br>HRD | Rockwell Regular hardness = $100 - \frac{h}{0.002}$ | |
| HRBW<br>HREW<br>HRFW<br>HRGW<br>HRHW<br>HRKW | Rockwell Regular hardness = $130 - \frac{h}{0.002}$ | |
| HRN<br>HRTW | Rockwell Superficial hardness = $100 - \frac{h}{0.002}$ | |

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST




| Total force $F = F_0+F_1$ |
|---|
| $F_0$ preliminary test force |
| $F_1$ additional test force |

| Key | |
|---|---|
| X time | 4 permanent indentation depth, h |
| Y indenter position | 5 surface of specimen |
| 1 indentation depth by preliminary force, F0 | 6 reference plane for measurement |
| 2 indentation depth by additional test force, F1 | 7 position of indenter |
| 3 elastic recovery just after removal of additional test force, F1 | 8 indentation depth vs. time curve |

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

**Can anyone interpret following designations -**

- 70 HRC
- 80 HRBW

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

| | |
|---|---|
| 80 | Rockwell hardness value |
| HR | Rockwell Hardness Symbol |
| B | Rockwell scale symbol |
| W | Indication of type of ball used<br>W= Tugstun Carbide Composite |

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

## TEST PIECE

- The thickness of the test piece, or of the layer under test (minimum values are given in Annex B), shall be at least 10 times the permanent indentation depth for diamond indenters and 15 times the permanent indentation depth for ball indenters, unless it can be demonstrated that the use of a thinner test piece does not affect the measured hardness value.
- In general, no deformation should be visible on the back of the test piece after the test, although not all such marking is indicative of a bad test.

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

# PROCEDURE

- Temperature requirement of 10 °C to 35 °C.
- The daily verification as defined in standard shall be performed before the first test of each day for each scale to be used
- The test piece shall be placed on a rigid support and supported in such a manner that the surface to be indented is in a plane normal to the axis
- Bring the indenter into contact with the test surface and apply the preliminary test force, $F_{0,}$ without shock, vibration, oscillation, or overload. The preliminary force application time should not exceed 2 s. The duration of the preliminary test force, $F_{0,}$ shall be 3 $^{+1}_{-2}$
- Measure the initial indentation depth.
- Apply the additional force F1 without shock, vibration, oscillation, or overload to increase the force from $F_0$ to the total force, F
- The total test force, F, shall be maintained for a duration of 5 $^{+1}_{-3}$S. Remove the additional test force, F1, and while the preliminary test force, $F_0$, is maintained, after 4 $^{+1}_{-3}$ s, the final reading shall be made
- Measure the final indentation depth while the preliminary test force is applied
- The distance between the centres of two adjacent indentations shall be at least three times the diameter of the indentation. The distance from the centre of any indentation to an edge of the test piece shall be at least two and a half time the diameter of the indentation

# IS1586/ ISO6508 - METALLIC MATERIALS - ROCKWELL HARDNESS TEST

# TEST REPORT

- The laboratory shall record at least the following information and that information shall be included in the test report, unless agreed by the parties concerned:

  a) a reference to this part of ISO 6508, i.e. ISO 6508-1;

  b) all details necessary for the complete identification of the test piece, including the curvature of the test surface;

  c) the test temperature, if it is not within the limits of 10 °C to 35 °C;

  d) the hardness result in the format defined in *clause* 4.2;

  e) all operations not specified in this part of ISO 6508, or regarded as optional;

  f) details of any occurrence which might have affected the result;

  g) the actual extended total force duration time used, if greater than the 6 s allowed by the tolerances;

  h) the date the test was performed;

  i) if conversion to another hardness scale is also performed, the basis and method of this conversion shall be specified (see ISO 18265[12]).

# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

# PARTS & SCOPE

***This standard has four parts:***

1. **Part 1 Test method**
   - **Scope :** This document specifies the Vickers hardness test method for the three different ranges of test force for metallic materials including hard metals and other cemented carbides.
2. **Part 2 Verification and Calibration of Testing Machines**
   - **Scope** : This document specifies the method of verification and calibration of testing machines for determining Knoop hardness for metallic materials in accordance with ISO 4545-1. A direct method of verification and calibration is specified for the testing machine, indenter, and the diagonal length measuring system. An indirect verification method using reference blocks is specified for the overall checking of the machine.
3. **Part 3 Calibration of reference blocks**
   - **Scope** : This document specifies the method for the calibration of reference blocks to be used for the indirect verification of Knoop hardness testing machines as specified in ISO 4545-2. The method is applicable only for indentations with long diagonals ≥0,020 mm
4. **Part 4 Tables of Hardness Values**
   - ***Scope :*** This document gives a table for the calculation of Knoop hardness values for use in tests carried out in accordance with ISO 4545-1.

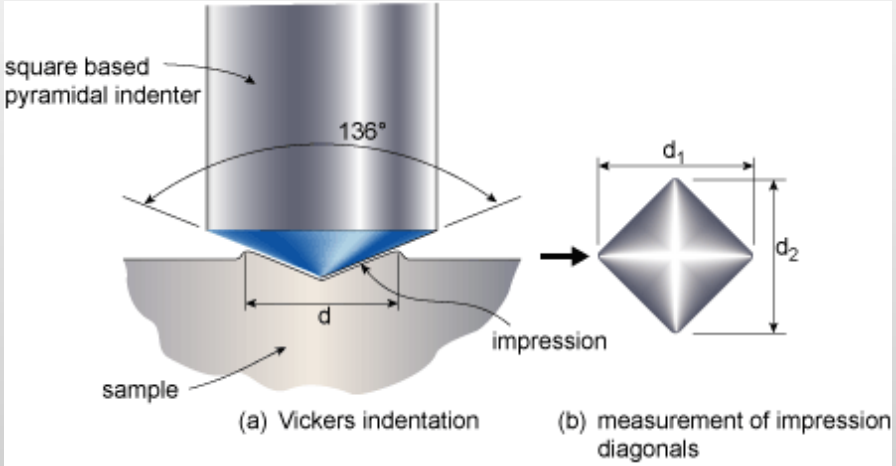
# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

# PRINCIPLE

• A diamond indenter, in the form of a right pyramid with a square base and with a specified angle between opposite faces at the vertex, is forced into the surface of a test piece followed by measurement of the diagonal length of the indentation left in the surface after removal of the test force, F

• The Vickers hardness is proportional to the quotient obtained by dividing the test force by the area of the sloped surface of indentation, which is assumed to be a right pyramid with a square base and having at the vertex the same angle as the indenter.

• Geometry of indenter, The measured angles between the opposite faces at the vertex of the diamond pyramid shall be within the range 136° ± 0.5° (a = 136° ± 0.5°)



# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

**Can anyone interpret following designations -**

- 640 HV 30/20

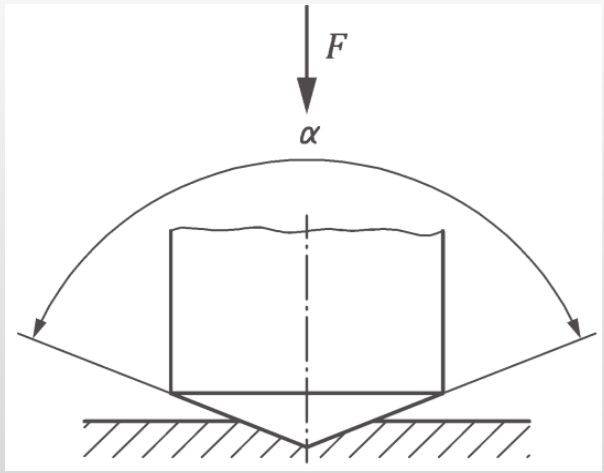
# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

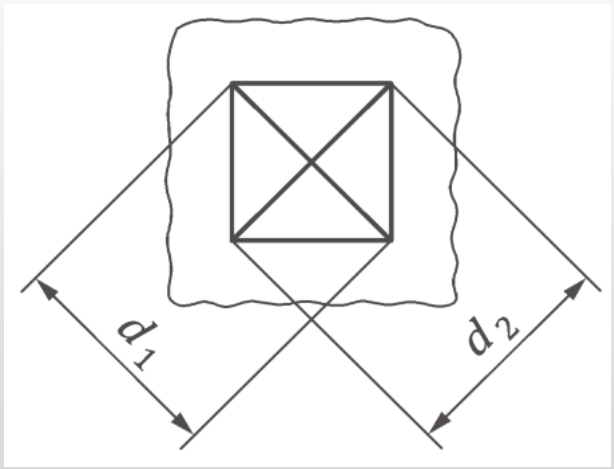
| | |
|---|---|
| 640 | Vickers hardness value |
| HV | Hardness Symbol |
| 30 | Approximate kgf equivalent value of applied test force where |
| 20 | Duration of test force (20 s) if not within the specified range (10 s to 15 s) |

# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

## TEST PIECE

- The thickness of the test piece or of the layer under test shall be at least 1,5 times the diagonal length of the indentation as defined in Annex A of the standard.
- No deformation shall be visible at the back of the test piece after the test. The thickness of a hard metal test piece shall be at least 1 mm



# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

# PROCEDURE

• If the test is carried out at a temperature outside 10°C 35°C range, it shall be noted in the test report. Test carried out under controlled condition shall be made at a temperature of (23 ± 5) °C.

• Periodic verification shall be done for each test force used.

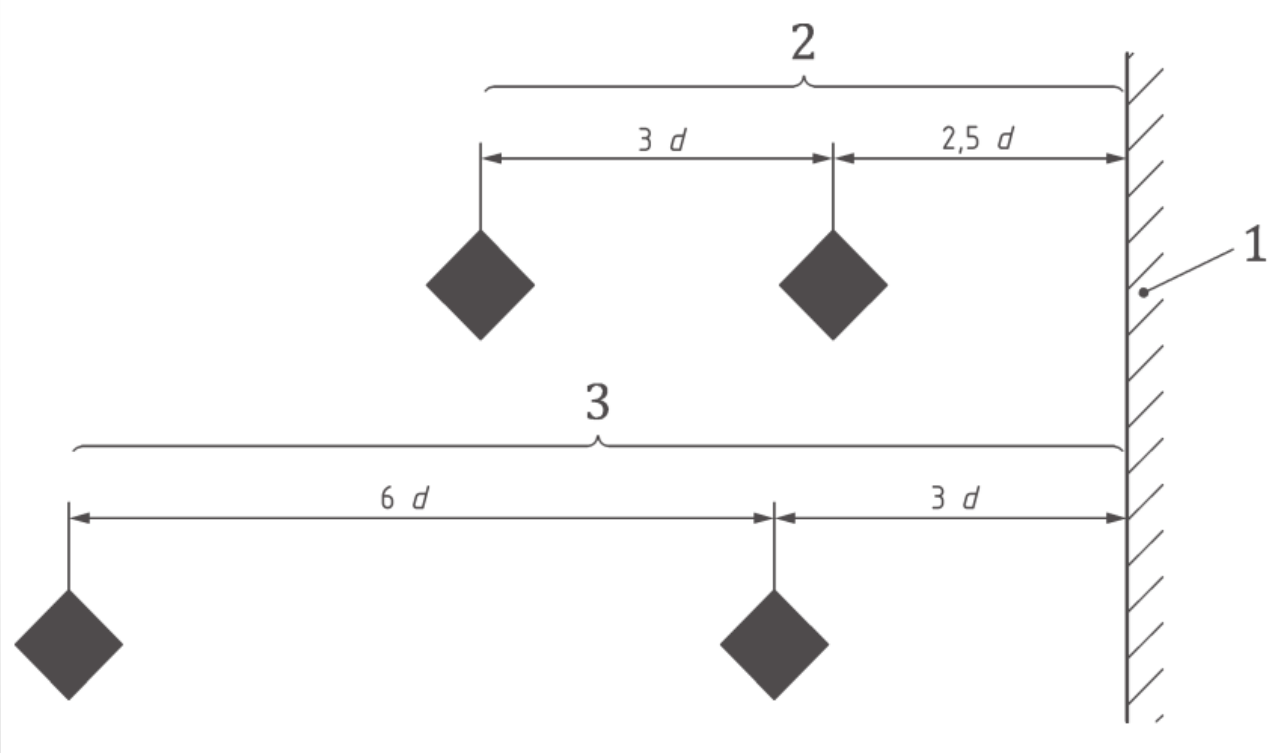
• The indenter shall be brought into contact with the test surface and the test force shall be applied in a direction perpendicular to the surface. Without shock. Vibration ot overload. Until the applied force attains the specified balue. The time from the intial application of the force until the full test force is reached shall be 7 $^{+1}_{-5}$

• For the Vicker hardness range and low-force Vickers hardness range and low-force Vickers hardness range tests, the indenter shall contact the test piece at a velocity of ≤0.2 mm/s. For micro-hardness tests, the indenter shall contact the test piece at a velocity of ≤0.070 mm/s.

• The duration of the test force shall be 14± $\frac{1}{4}$ s, except for test on materials whose time-dependent properties would make this an unsuitable range.

# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

Minimum distance for Vickers indentations




| Key |
| --- |
| 1 edge of test piece |
| 2 steel, copper and copper alloys |
| 3 light metals, lead and tin and their alloys |

# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

# PROCEDURE

**Measurement of the diagonal length**

• The lengths of the two diagonals shall be measured.The arithmetical mean of the two readings shall be taken for the calculation of the Vickers hardness. For all tests, the perimeter of the indentation shall be clearly defined in the field of view of the microscope.

$$d = \frac{d_1 + \ d_2}{2}$$

• Magnifications should be selected so that the diagonal can be enlarged to greater than 25%, but less than 75% of the maximum possible optical field of view

# IS1501 / ISO6507-METALLIC MATERIALS — VICKERS HARDNESS TEST

# TEST REPORT

The test report shall include the following information unless otherwise agreed by the parties concerned:

a) a reference to this document, i.e., ISO 6507-1;

b) all information necessary for identification of the test piece;

c) the date of the test;

d) the hardness result obtained in HV, reported in the format defined in 5.2;

e) all operations not specified in this document or regarded as optional;

f) details of any circumstances that affected the results;

g) the temperature of the test, if it is outside the ambient range specified in 8.1;

h) where conversion to another hardness scale is also performed, the basis and method of this conversion .

# IS1757 / ISO148-METALLIC MATERIALS — CHARPY PENDULUM IMPACT TEST

# PARTS & SCOPE

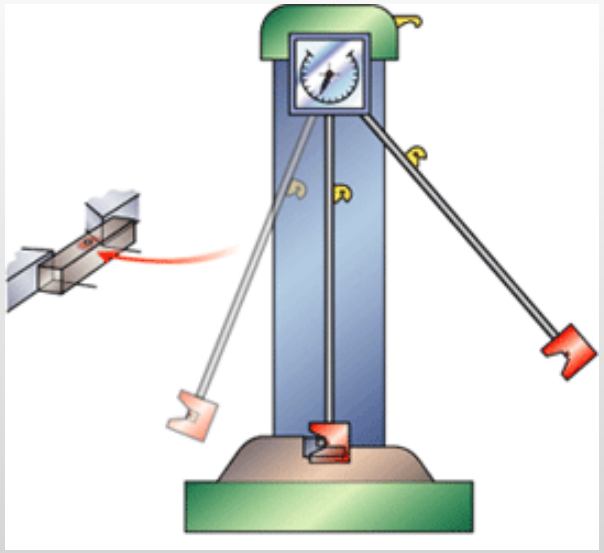
***This standard has three parts:***

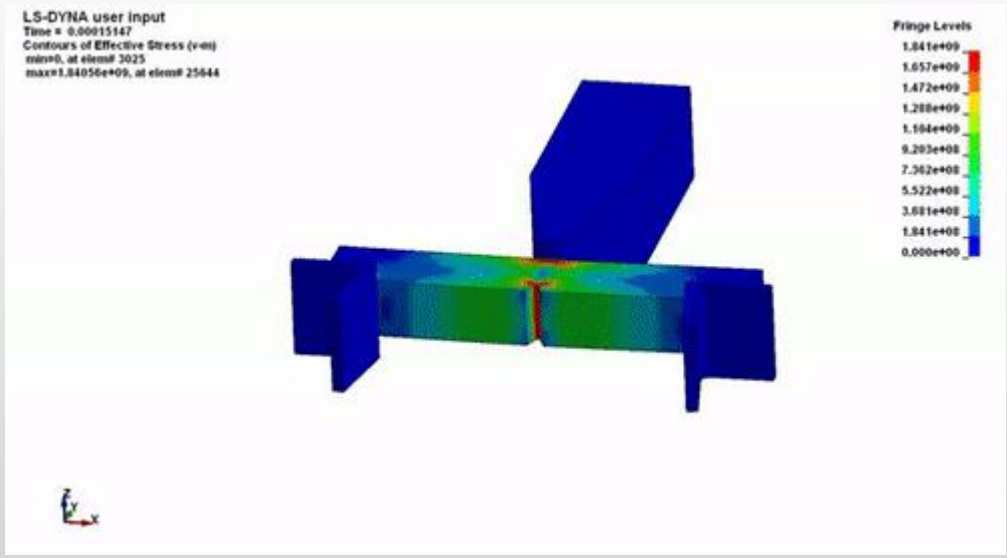
1. **Part 1 Test method**
   - **Scope :** This part of ISO 148 specifies the Charpy (V-notch and U-notch) pendulum impact test method for determining the energy absorbed in an impact test of metallic materials.
2. **Part 2 Verification of Testing Machines**
   - **Scope** : This part of ISO 148 covers the verification of pendulum-type impact testing machines, in terms of their constructional elements, their overall performance and the accuracy of the results they produce. It is applicable to machines with 2 mm or 8 mm strikers used for pendulum impact tests carried out, for instance, in accordance with ISO 148-1.
3. **Part 3 Preparation and characterization of charpy V-notch test pieces for indirect verification of pendulum impact machines**
   - **Scope :** This part of ISO 148 specifies the requirements, preparation and methods for qualifying test pieces used for the indirect verification of pendulum impact testing machines in accordance with ISO 148-2.
   - It specifies notched test pieces with nominal dimensions identical to those specified in ISO 148-1; however, the tolerances are more stringent.

# IS1757 / ISO148-METALLIC MATERIALS — CHARPY PENDULUM IMPACT TEST

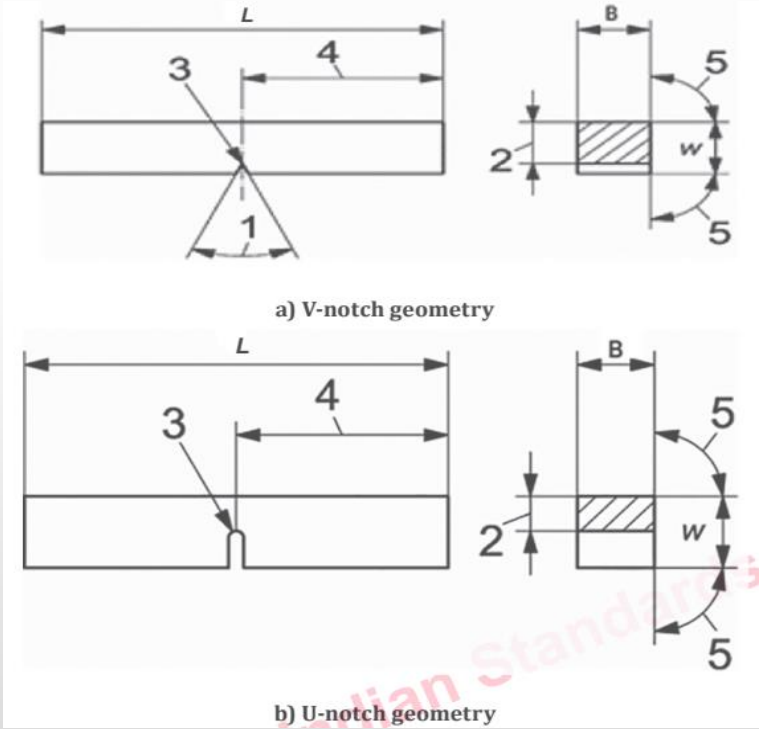
# PRINCIPLE OF TEST

- This test consists of breaking a notched test piece with a single blow from a swinging pendulum, under the conditions defined in Clauses 6, 7 and 8 of the standard.
- The notch in the test piece has a specified geometry and is located in the middle between two supports, opposite to the location which is impacted in the test. The energy absorbed in the impact test, the lateral expansion and the shear fracture appearance are normally determined.





# IS1757 / ISO148-METALLIC MATERIALS — CHARPY PENDULUM IMPACT TEST




# TEST PIECE

| Designation | Symbol and no. | V-notch test piece | U-notch test piece |
|---|---|---|---|
| Length | L | 55 mm ±0.60 mm | 55 mm ±0.60 mm |
| Width | W | 10 mm ± 0.075 mm | 10 mm ±0.11 mm |
| Thickness[c] | B | 10 mm ±0.11 mm | 10 mm ±0.11 mm |
| Angle of notch | 1 | 45° ±2° | |
| Ligament | 2 | 8 mm ±0.075 mm | 5 mm ±0.09mm |
| Notch radius | 3 | 0.25 mm ±0.025 mm | 1 mm ±0.07 mm |
| Notch position (centering) | 4 | 27.5 mm ±0.42 mm [d] | 27.5 mm ±0.42 mm [d] |
| Angle between adjacent longitudinal faces of test piece | 5 | 90° ±2° | 90° ±2° |

# IS1757 / ISO148-METALLIC MATERIALS — CHARPY PENDULUM IMPACT TEST

# TEST REPORT

Mandatory information

The test report shall contain the following information or, when agreed by the customer, it shall be possible to retrieve this information based on a traceable coding of the test report by the test laboratory:

a) Reference to this part of ISO 148, i.e. ISO 148-1;

b) Identification of the test piece (e.g. type of steel and cast number);

c) Size of the test piece, if other than the standard test piece;

d) Temperature of the test or the conditioning temperature of the test specimens;

e) Absorbed energy, KV2, KV8, KU2, or KU8, as appropriate;

f) Whether the specimen, or the majority of specimens in a group of specimens were broken (not required for material acceptance tests);

g) Any abnormalities that could have affected the test.

# IS1757 / ISO148-METALLIC MATERIALS — CHARPY PENDULUM IMPACT TEST

# TEST REPORT

Optional information
The test report may optionally include, in addition to the information :

a) Test piece orientation (see ISO 3785);

b) Initial potential energy of the testing machine, in joules;

c) Lateral expansion (see Annex B);

d) Shear fracture appearance (see Annex C);

e) Absorbed energy/temperature curve (see D.1);

f) Shear fracture appearance/temperature curve;

g) Transition temperature(s) and the criteria used for its (their) determination (see D.2);

h) Number of test pieces which were not completely broken in the test;

i) Date (month and year) of the most recent full direct and indirect verifications;

j) Measurement uncertainty of the absorbed energy (see Annex E).

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

# PARTS & SCOPE

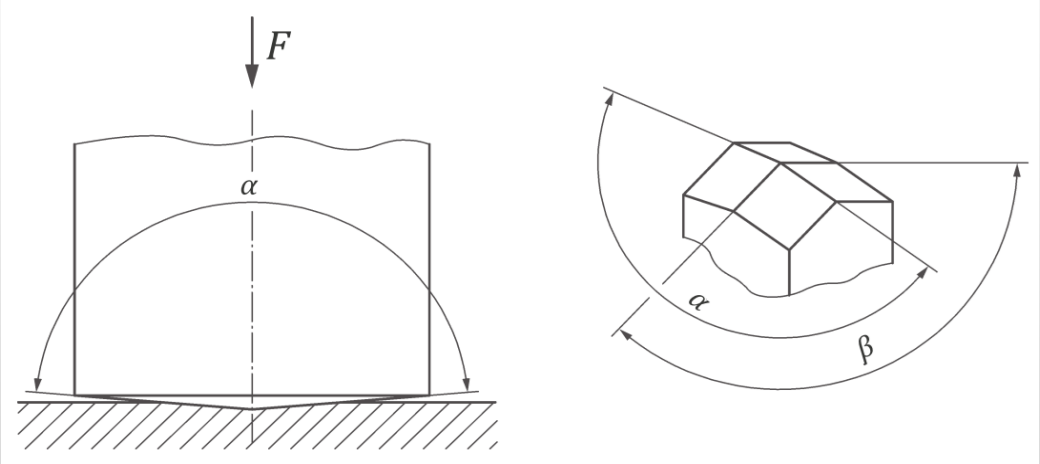
***This standard has four parts:***

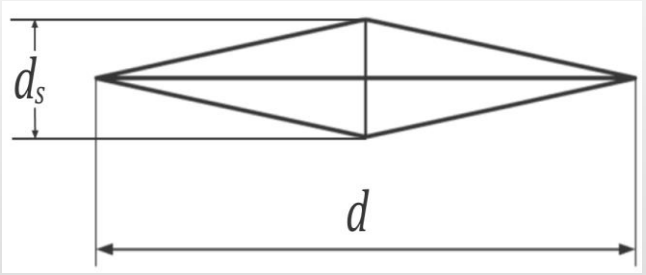
1. **Part 1 Test method**
   - **Scope :** This document specifies the Knoop hardness test method for metallic materials for test forces from 0,009 807 N to 19,613 N. The Knoop hardness test is specified in this document for lengths of indentation diagonals ≥0,020 mm. Using this method to determine Knoop hardness from smaller indentations is outside the scope of this document as results would suffer from large uncertainties due to the limitations of optical measurement and imperfections in tip geometry. ISO 14577-1 allows the determination of hardness from smaller indentations.
2. **Part 2 Verification and Calibration of Testing Machines**
   - **Scope** : This document specifies the method of verification and calibration of testing machines for determining Knoop hardness for metallic materials in accordance with ISO 4545-1. A direct method of verification and calibration is specified for the testing machine, indenter, and the diagonal length measuring system. An indirect verification method using reference blocks is specified for the overall checking of the machine.
3. **Part 3 Calibration of reference blocks**
   - **Scope** : This document specifies the method for the calibration of reference blocks to be used for the indirect verification of Knoop hardness testing machines as specified in ISO 4545-2. The method is applicable only for indentations with long diagonals ≥0,020 mm
4. **Part 4 Tables of Hardness Values**
   - ***Scope :*** This document gives a table for the calculation of Knoop hardness values for use in tests carried out in accordance with ISO 4545-1.

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

## PRINCIPLE

- A diamond indenter, in the form of a rhombic-based pyramid with angles, α and β, between opposite edges respectively equal to 172,5° and 130° at the vertex, is forced into the surface of a test piece followed by measurement of the long diagonal, d, of the indentation remaining in the surface after removal of the test force, F



# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

| Symbol | Designation |
|---|---|
| F | Test force, in newtons (N) |
| d | Length of the long diagonal, in millimetres |
| $d_s$ | Length of the short diagonal, in millimetres |
| α | Angle between the opposite edges of the long diagonal at the vertex of the diamond pyramid indenter (nominally 172,5°) |
| β | Angle between the opposite edges of the short diagonal at the vertex of the diamond pyramid (nominally 130°) |
| V | Magnification of the measuring system |
| c | Indenter constant, relating projected area of the indentation to the square of the length of the long diagonal<br>Indenter constant, c = $\frac{tan\frac{\beta}{2}}{2tan\frac{\alpha}{2}}$ , for nominal angles α and β, c is approximately 0.07028 |
| HK | Knoop hardness = $\frac{\text{Test force (kgf)}}{\text{Projected area of indentation (mm}^2\text{)}} = \frac{1}{g_n} \times \frac{\text{Test force (kgf)}}{\text{Projected area of indentation (mm}^2\text{)}} = \frac{1}{g_n} \times \frac{F}{cd^2}$<br>For the nominal indenter constant c ≈ 0.070 28,<br>Knoop hardness = $1.451 \times \frac{F}{d^2}$ |

*Note :* Standard acceleration due to gravity, $g_n$ =9.80665 m/s2, which is the conversion factor from kgf to N.
To reduce uncertainty, the Knoop hardness can be calculated using the actual indenter angles α and β.

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

**Can anyone interpret following designations -**

- 640 HK 0.1/20

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

| | |
|---|---|
| 640 | Knoop hardness value |
| HK | Hardness Symbol |
| 0.1 | Approximate kgf equivalent value of applied test force where (0.1 kgf = 0,980 7 N) |
| 20 | Duration of test force (20 s) if not within the speciied range (10 s to 15 s) |

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

## TEST PIECE

- The test shall be carried out on a polished surface, which is smooth and even, free from oxide scale and foreign matter and, in particular, free from lubricants, unless otherwise specified in product standards. The finish of the surface shall permit accurate determination of the diagonal length.
- The thickness of the test piece, or of the layer under test, shall be at least 1/3 times the length of the diagonal length of the indentation. No deformation shall be visible at the back of the test piece after the test.th of the indentation.

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

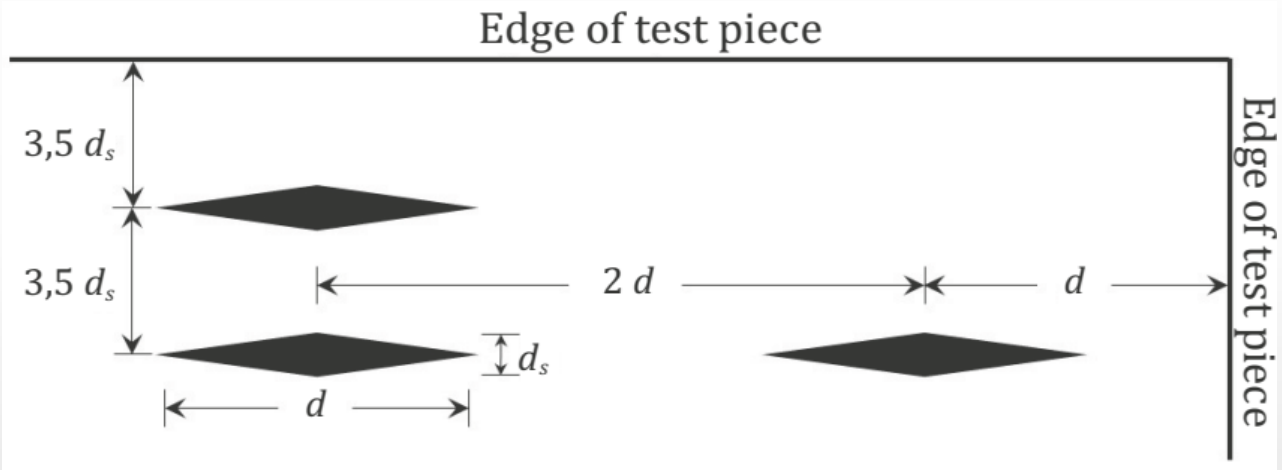
# PROCEDURE

• If the test is carried out at a temperature outside 10 °C to 35 °C range, it shall be noted in the test report. Test carried out under controlled conditions shall be made at a temperature of (23 ± 5) °C.
• Periodic verification shall be done for each test force used.
• The indenter shall be brought into contact with the test surface and the test force shall be applied in a direction perpendicular to the surface, without shock, vibration or overload, until the applied force attains the specified value. The time from the initial application of the force until the full test force is reached shall be $7^{+1}_{-5}$ S
• The indenter shall contact the test piece at a velocity of ≤ 0.070 mm/s
• The duration of the test force shall be $14^{+1}_{-4}\ s$, except for tests on materials whose time-dependent properties would make this an unsuitable range.
• The length of the long diagonal shall be measured and used for the calculation of the knop hardness. For all tests, the perimeter of the indentation shall be clearly defined in the field of view of the microscope. Magnifications should be selected so that the diagonal can be enlarged to greater than 25 %, but less than 75 % of the maximum possible optical field of view.

# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

# PROCEDURE

- Minimum distance for knoop indentations



# IS6885/ ISO4545 - METALLIC MATERIALS — KNOOP HARDNESS TEST

# TEST REPORT

- The test report shall include the following information, unless otherwise agreed by the parties concerned:

a) a reference to this document, i.e. ISO 4545-1;

b) all information necessary for identification of the test piece;

c) the date of the test;

d) the hardness result obtained in HK, reported in the format defined in 5.2;

e) all operations not specified in this document, or regarded as optional;

f) the details of

g) the temperature of the test, if it is outside the ambient range specified in 8.1;

h) where conversion to another hardness scale is also performed, the basis and method of this conversion any circumstances that affected the results;

# IS 1598 METHOD FOR IZOD IMPACT TEST OF METALS

***Scope :***

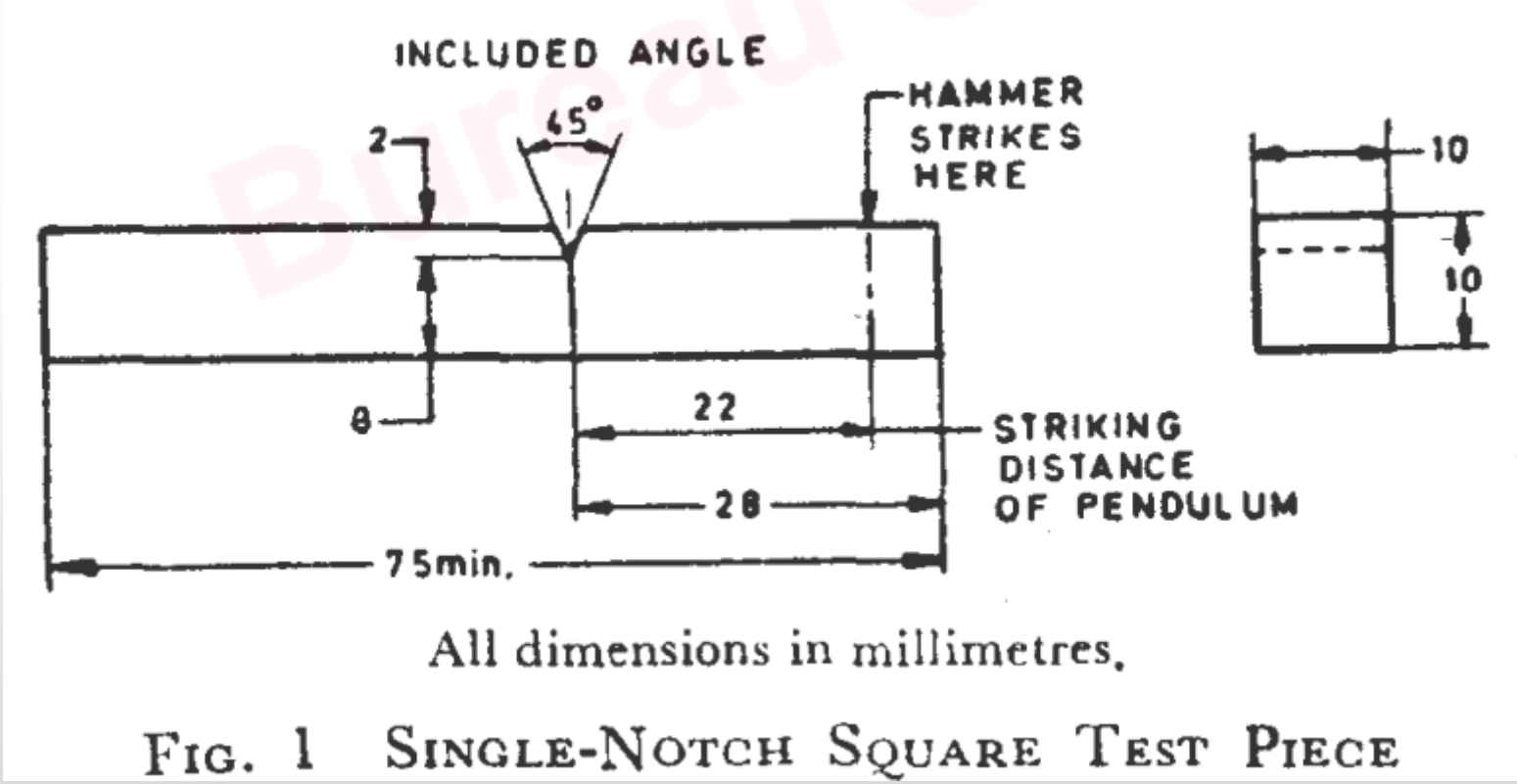
This standard prescribes the method of conducting Izod impact test on metals

***Principle :***

The test consists of breaking by one blow from a swinging hammer, under specified conditions, a notched test piece, gripped vertically with the bottom of the notch in the same plane as the upper face of the grips. the blow is struck at a fixed position on the face having the notch. The energy absorbed is determined.

# IS 1598 METHOD FOR IZOD IMPACT TEST OF METALS

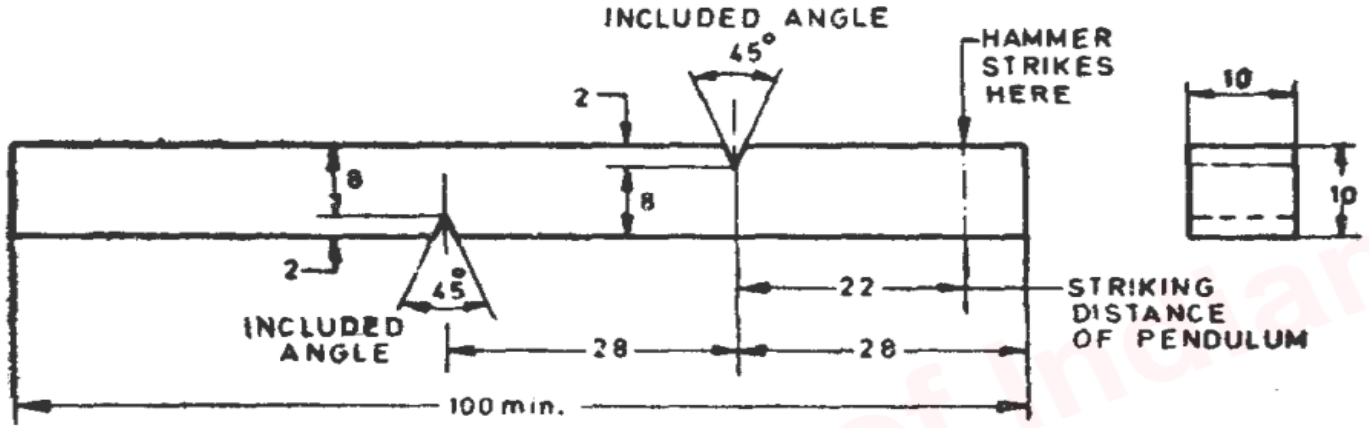
## TEST PIECE




All dimensions in millimetres.

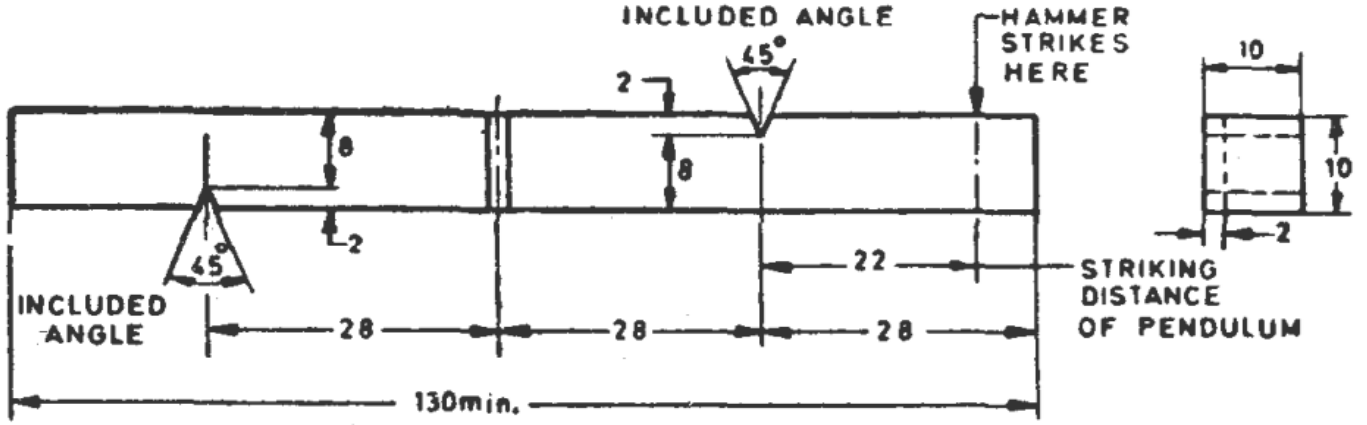
FIG. 1 SINGLE-NOTCH SQUARE TEST PIECE

# IS 1598 METHOD FOR IZOD IMPACT TEST OF METALS




All dimensions in millimetres.

FIG. 3 TWO-NOTCH SQUARE TEST PIECE




All dimensions in millimetres.

FIG. 2 THREE-NOTCH SQUARE TEST PIECE

# IS 1598 METHOD FOR IZOD IMPACT TEST OF METALS

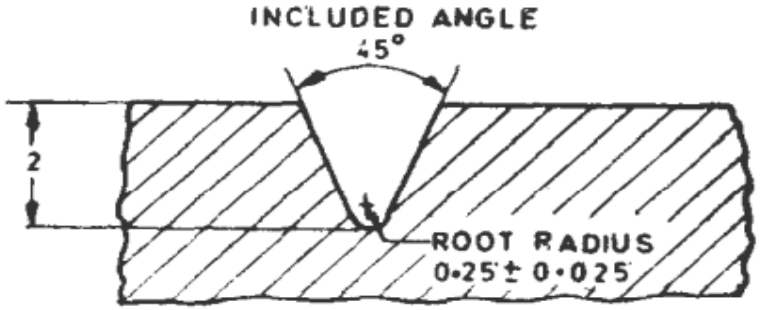
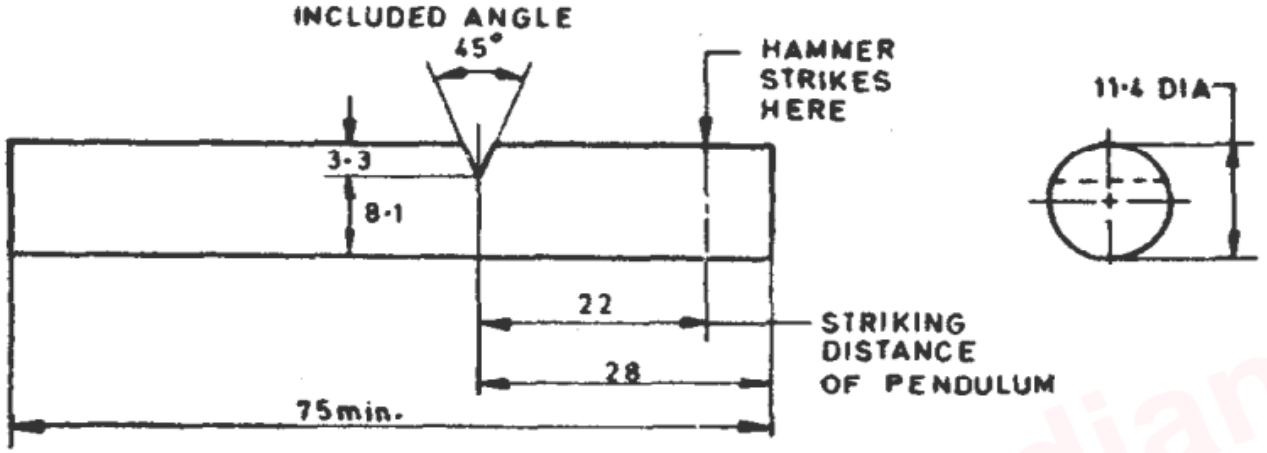


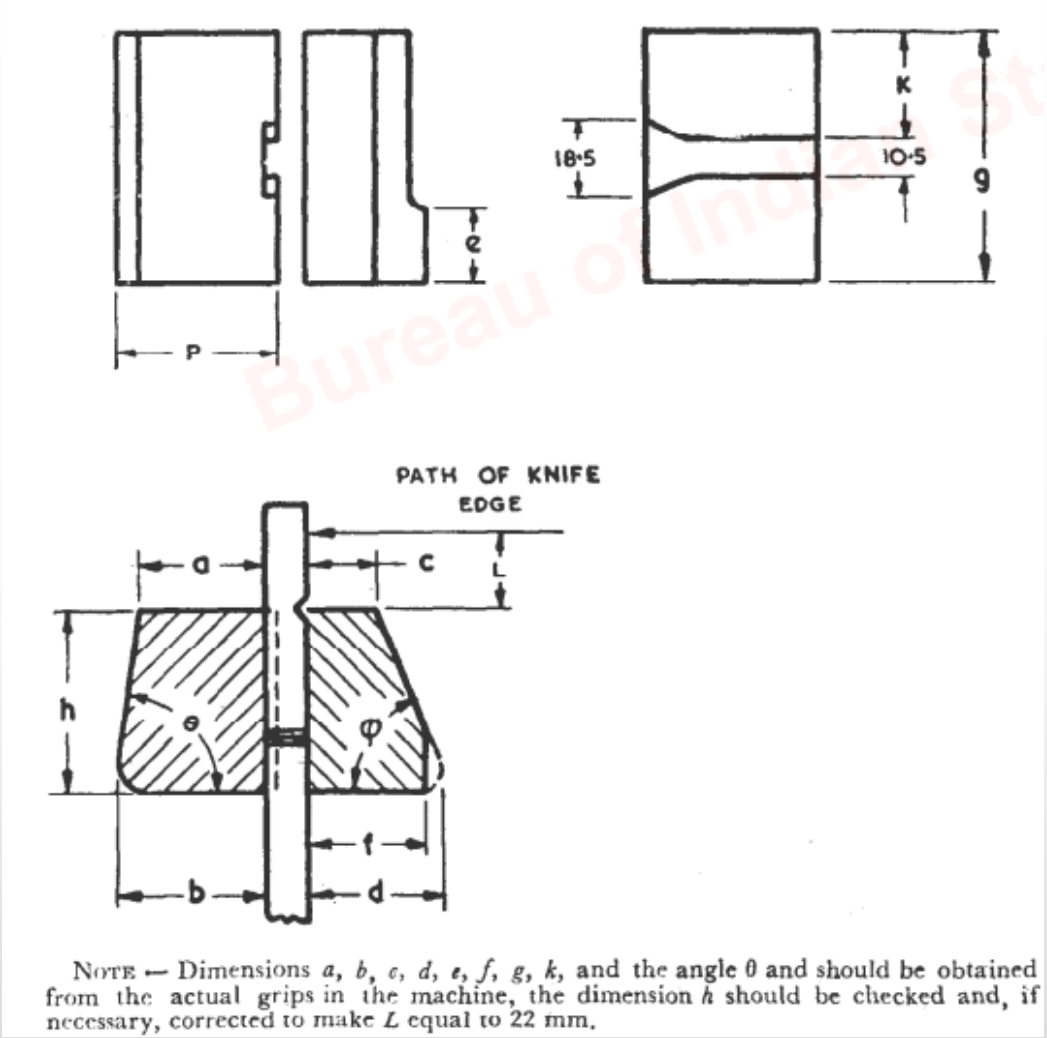

Fig. Enlarged view of notch for square test piece




All dimensions in millimetres.

FIG. 5 SINGLE-NOTCH ROUND TEST PIECE

# IS 1598 METHOD FOR IZOD IMPACT TEST OF METALS




NOTE — Dimensions *a*, *b*, *c*, *d*, *e*, *f*, *g*, *k*, and the angle θ and should be obtained from the actual grips in the machine, the dimension *h* should be checked and, if necessary, corrected to make *L* equal to 22 mm.

# IS1599 / ISO7438 - METALLIC MATERIALS - BEND TEST

## SCOPE

- This Indian Standard specifies a method for determining the ability of metallic materials to undergo plastic deformation in bending.
- This International Standard applies to test pieces taken from metallic products, as specified in the relevant product standard. It is not applicable to certain materials or products, for example tubes in full section or welded joints, for which other standards exist.

# IS1599 / ISO7438 - METALLIC MATERIALS - BEND TEST

## PRINCIPLE

- The bend test consists of submitting a test piece of round, square, rectangular or polygonal crossection to plastic deformation by bending, without changing the direction of loading, until a specified angle of bend is reached.

- Test Equipment:
  - Bending device with two supports and a former( Figure 1);
  - Bending device with a V-block and a former ( Figure 2);
  - Bending device with a clamp ( Figure 3);

# IS1599 / ISO7438 - METALLIC MATERIALS - BEND TEST

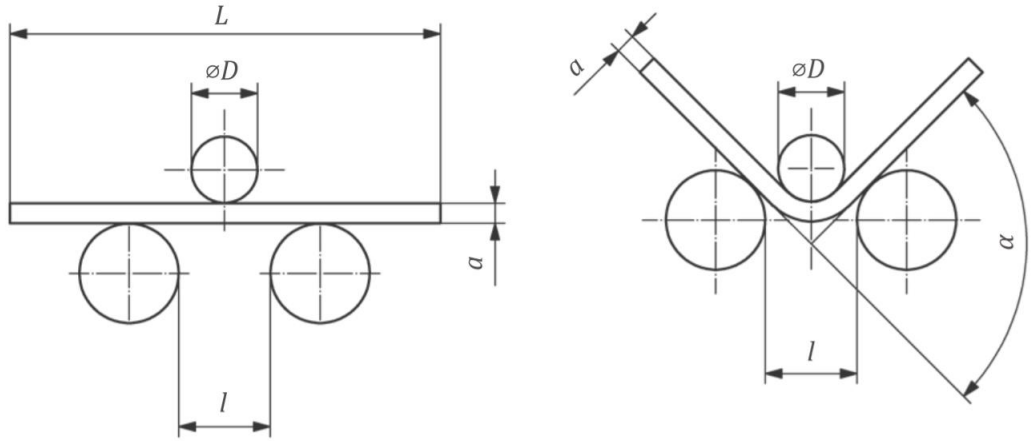



Figure 1 — Bending device with two supports and a former

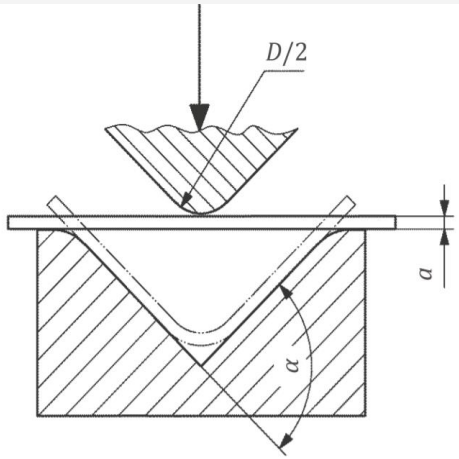
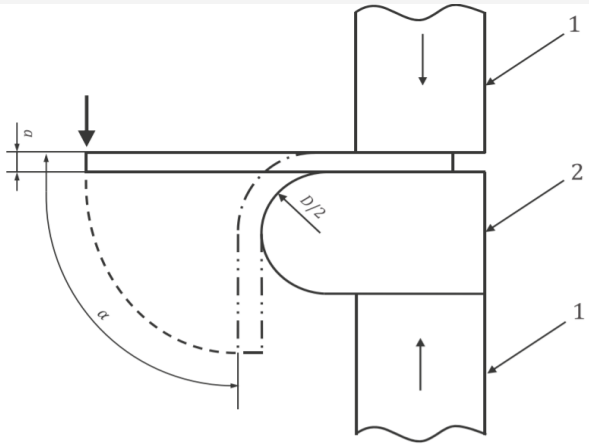



Figure 2 — Bending device with a V-block and a former




Key
1 clamp
2 former

Figure 3 — Bending device with a clamp

# IS1599 / ISO7438 - METALLIC MATERIALS - BEND TEST

## TEST PIECE

1. General : Round, square, rectangular, or polygonal cross-section test pieces shall be used in the test. Any areas of the material affected by shearing or flame cutting and similar operations during sampling of test pieces shall be removed.
2. Edges of rectangular test pieces
3. Width of the test piece:
   a) the same as the product width, if the latter is equal to or less than 20 mm;
   b) when the width of a product is more than 20 mm:
      i. 20 ± 5) mm for products of thickness less than 3 mm,
      ii. between 20 mm and 50 mm for products of thickness equal to or greater than 3 mm
4. Thickness of the test piece
5. Length of the test piece

# IS1599 / ISO7438 - METALLIC MATERIALS - BEND TEST

## TEST REPORT

The test report shall include the following information:

- a reference to this International Standard, i.e. ISO 7438;
- identification of the test piece (type of material, cast number, direction of the test piece axis relative to a product, etc.);
- shape and dimensions of the test piece;
- test method;
- any deviation from this International Standard;
- test result.

# THANK YOU

**Regards,**

**METALLURGICAL ENGINEERING DEPARTMENT**

धातुकर्म यांत्रिकी विभाग

**BUREAU OF INDIAN STANDARDS**

भारतीय मानक ब्यूरो