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भारतीय मानक
कठोर धातु — विकर्स कठोरता परीक्षण
(आई एस 12783 का पहला पुनरीक्षण)

Draft Indian Standard
HARDMETALS- VICKERS HARDNESS TEST
(*First Revision of IS 12783*)

ICS 77.160

Powder Metallurgical Materials and Products
Sectional Committee, MTD 25

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4 April 2024

FOREWORD

(Formal clause will be added later)

This standard was first published in 1989. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards.

In addition, the following changes have been made:

- Reference clause has to be added;
- Removal of IS 1754, IS 10927 (Part 1), and IS 10927 (Part 2) are removed as the standards are withdrawn;
- In **5.1**, Editorial change has been made;
- In **5.3**, substitute “ $d \geq 200 \mu\text{m} : \pm 3 \text{ percent}$ ” instead of “ $d \geq 200 \mu\text{m} : \pm 5 \text{ percent}$ ”;
- In **5.4**, Verification of test force clause has been added;
- In **6.6**, referred to the following mounting materials : Bakelite, epoxy resin, and thermosetting resin; and
- In **7.3**, substitute “9.807 N” instead of “9.0807 N”.

With the increasing use of hardmetals, a need has been felt to formulate standards on the method of tests for various properties of hardmetals. This standard is one of the series of standards on this subject. It is hoped that this standard would be of considerable use to the industry.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard
HARDMETALS- VICKERS HARDNESS TEST
(First Revision of IS 12783)

1 SCOPE

This standard specifies the method of conducting vickers hardness test for hardmetals

2 REFERENCES

The following standards contain provisions which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

<i>IS No.</i>	<i>Title</i>
IS 11520 : 2023	Metallographic Sample Preparation of Hardmetals - Method (<i>first revision</i>)

3 PRINCIPLE

3.1 A diamond indenter in the form of a right pyramid with a square base and a specified angle α between opposite faces at the vertex, is forced into the surface of the hardmetal test piece under the test force F (*see Fig. 1*). The diagonal d of the indentation left in the surface, after removal of the test force F , is measured (*see Fig. 2*).

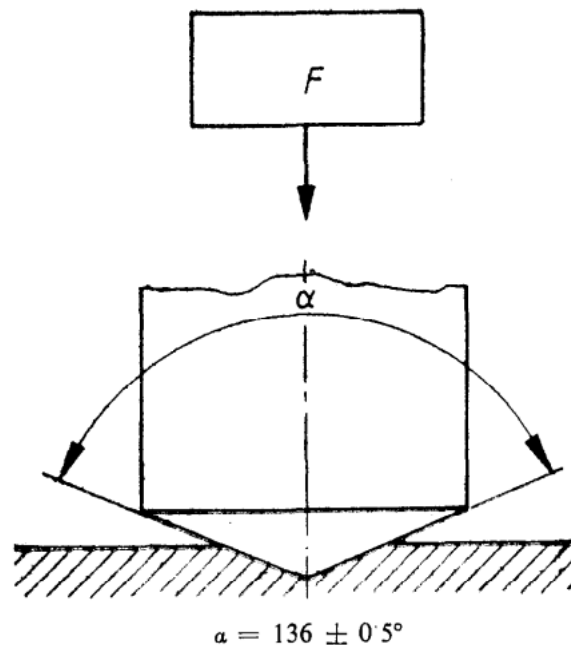


FIG. 1. INDENTER (DIAMOND PYRAMID)

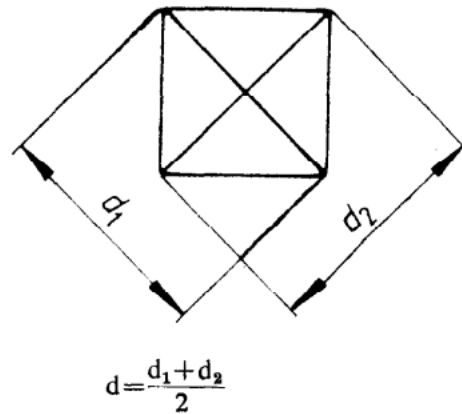


FIG. 2. VICKERS INDENTATION

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

4 SYMBOLS AND DESIGNATION

4.1 The symbols as given below have been used in this standard.

Sl No.	Symbol	Designation
(1)	(2)	(3)
i)	α	Angle between the opposite faces at the vertex of the pyramidal indenter ($136 \pm 0.5^\circ$)
ii)	F	Test Force in newtons
iii)	d	Arithmetic means of the two diagonals d_1 and d_2 in millimetres

HV Vickers hardness

$$\begin{aligned}
 &= \text{Constant} \times \frac{\text{Test Force}}{\text{Surface area of indentation}} \\
 &= 0.102 \times \frac{2 F \sin \frac{136^\circ}{2}}{d^2} \\
 &= 0.1891 \times \frac{F}{d^2}
 \end{aligned}$$

NOTE – Constant = $1/g = 1/9.80665 = 0.102$

4.2 The Vickers hardness is denoted by the symbol HV preceded by the hardness value and completed by:

- number representing the test force (see **7.3**) ; and
- the duration of loading, in seconds, if different from the time specified in **7.5**.

Example:

- 640 HV 30 = Vickers hardness of 640 determined with a test force of 294.2 N applied for 10 to 15 sec.

2. 640 HV 30/20 = Vickers hardness of 640 determined with a test force of 294.2 N applied for 20 sec.

5 TESTING EQUIPMENT

5.1 Testing Machine

Capable of applying a predetermined force (s) within the range of 9.807 N to 490.3 N (HV 1 to HV 50). Verification of test force shall be as given in 5.4.

5.2 Indenter

Consists of a diamond in the form of a right pyramid with square base. The angle at the vertex between opposite faces of the indenter is $136 \pm 0.5^\circ$ (see Fig. 1).

5.2.1 Four faces of the indenter are equally inclined to the axis of the indenter and meet in a point, that is any line of junction between opposite faces is less than 0.002 mm in length. A common form of point when examined under high magnification is shown as given in Fig. 3. The limiting length of 0.002 mm maximum is also shown in Fig. 3.

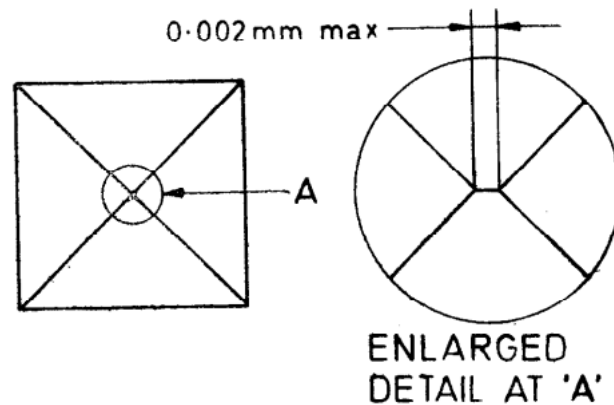


FIG. 3. INDENTER POINT (MAGNIFIED)

5.2.2 The indenter should be well polished and free from cracks and other surface defects.

5.3 Measuring Device

Capable of measuring indentation diagonals to the following accuracy:

$$\begin{aligned} d < 100 \mu\text{m} &: \pm 0.2 \mu\text{m} \\ 100 \mu\text{m} \leq d < 200 \mu\text{m} &: \pm 1.0 \mu\text{m} \\ d \geq 200 \mu\text{m} &: \pm 3 \text{ percent.} \end{aligned}$$

5.4 Verification of the Test Force

5.4.1 Each test force used (chosen from Table 1) within the working range of the testing machine, shall be measured and, whenever applicable, this shall be done at not less than three positions of the plunger uniformly spaced throughout its range of movement during testing

5.4.2 The test force shall be measured by one of the following two methods:

- Measuring by means of an elastic proving device previously calibrated to an accuracy of ± 0.2 percent;
- Balancing against a force, accurate to ± 0.2 percent applied by means of standardized masses with mechanical advantages.

5.4.3 Three readings shall be taken for each test force at each position of the plunger. Immediately before each reading is taken, the plunger shall have been moved in the same direction as during testing.

5.4.4 Each measurement of the force shall be within ± 1.0 percent of the nominal value of the test force as given in Table 1.

TABLE 1 TEST FORCE FOR DETERMINATION OF VICKERS HARDNESS
(Clause 5.4.1 and 5.4.4)

Sl. No.	Hardness Symbol	Nominal Test Force, F N
i)	HV 0.2	1.961
ii)	HV 0.3	2.942
iii)	HV 0.5	4.903
iv)	HV 1	9.807
v)	HV 2	19.61
vi)	HV 2.5	24.52
vii)	HV 3	29.42
viii)	HV 5	49.03
ix)	HV 10	98.07
x)	HV 20	196.1
xi)	HV 30	294.2
xii)	HV 50	490.3
xiii)	HV 100	980.7

6 TEST PIECES

6.1 The surface of the piece to be tested shall be even and have mirror finish to permit the accurate determination of the size of the indentation. The test surface shall be polished in accordance with IS 11520. It shall be free from foreign matter and in particular, completely free from lubricant.

6.2 Care should be taken in preparing the test piece to avoid any alternation of surface hardness, for example, due to heating or cold working.

6.3 At least 0.2 mm material should be removed from the thickness of the piece.

6.4 While determining the hardness of the test piece with a curved surface, a flat surface shall be prepared on the test piece on which the hardness test is carried out.

6.5 For prepared test, piece shall be at least 1 mm thick. The thickness of the test piece shall be sufficient to allow the test to be carried out without breaking or deforming the test piece under the chosen force.

6.6 For test piece of small cross section or of irregular shape, it may be necessary to provide some form of additional support, for example, mounting in resin (Bakelite, epoxy resin, and/or thermosetting resin).

7 PROCEDURE

7.1 The test is carried out at ambient temperature unless otherwise stated.

7.2 Throughout the test the testing equipment should be protected from shock or vibration.

7.3 The test force shall be within the range of 9.807 N (HV 1) to 490.3 N (HV 50), the preferred force being 294.2 N (HV 30).

7.4 The test piece shall be placed firmly on a rigid support. The contact surfaces shall be clean and free from foreign matter (scale, oil, dirt, etc). It shall be ensured that the test piece lies firmly on the support so that displacement cannot occur during the test.

7.5 Force the indenter without shock or vibration perpendicularly into the surface to be tested until the applied force attains the specified value. The time from the initial application of force until the full test force is reached shall neither be less than 2 seconds nor greater than 8 seconds. The duration of the test force shall be 10 to 15 seconds.

7.7 If possible, at least three hardness determinations shall be made on the test piece.

7.8 The distance between the centre of any indentation and the edge of the test piece shall be at least 2.5 times the mean diagonal of the indentation.

7.9 The distance between the centre of two adjacent indentations shall be at least three times the mean diagonal of the indentation. If two adjacent indentations differ in size, the spacing shall be based on the mean diagonal of the large indentation.

7.10 The satisfactory condition of the indenter shall be verified frequently. Any irregularities in the shape of the indentation may indicate poor condition of the indenter. If the examination of the indenter confirms this, then the test shall be rejected and the indenter shall be renewed.

7.11 Measure the lengths of the two diagonals. Wide variation in the length of diagonal readings shall be discarded. The arithmetical means of the two readings shall be taken for the calculation of the Vickers hardness.

7.12 Vickers hardness value may be determined readily from mean diagonal with the help of calculation given in 4.

8 TEST RESULTS

Report the arithmetical mean of the hardness values obtained rounded to the nearest 10 HV.

9 TEST REPORT

The report shall include the following information:

- a) Reference to this standard IS 12783.
- b) All details necessary for identification of the test sample.
- c) Result obtained.
- d) Temperature of the test, if other than the ambient temperature.
- e) Any additional information not covered by this standard.
- f) Details or any occurrence which may have affected the results.

NOTE — There is no general process for converting accurately Vickers hardness into other scales of hardness. Such conversions therefore should be avoided.