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METHOD FOR BRINELL HARDNESS TEST FOR METALLIC MATERIALS

(Second Revision)

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(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 27 June 1983, after the draft finalized by the Methods of Physical Tests Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1959, and then revised in 1968. Subsequently, it was decided to revise the standard once more so as to have a single reference Indian Standard on method for Brinell hardness test for metallic materials, amalgamating three other Indian Standards on the subject.

0.2.1 This standard thus supersedes the following Indian Standards:

IS : 1789-1961 Method for Brinell hardness test for grey cast iron

IS : 1790-1961 Method for Brinell hardness test for light metals and their alloys

IS : 3054-1965 Method for Brinell hardness test for copper and copper alloys

0.3 Tables 1 to 5 for Brinell hardness values for different ball diameters and test loads as were given in the previous version of this standard (IS : 1500-1968) have now been deleted from this standard as the same values have been covered in IS : 10588-1983*. However, the load to be applied to different types of metals have been incorporated in this revised standard, along with the adoption of SI Units.

0.4 This standard is based on ISO 6506-1981 'Metallic materials — Hardness test — Brinell test', prepared by International Organization for Standardization.

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*Tables of Brinell hardness values for use in tests made of flat surfaces.

0.5 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard specifies the method for the Brinell hardness test for metallic materials.

2. PRINCIPLE OF TEST

2.1 The Brinell hardness is proportional to the quotient obtained by dividing the test force by the curved surface area of the indentation which is assumed to be spherical and of diameter equal to that of the ball.

2.2 In actual practice an indenter (hardened steel ball or hard metal ball with diameter D) is forced into the surface of a test piece and the diameter of the indentation d left in the surface after removal of the test force F is measured.

3. GENERAL

3.1 The steel ball indenter is used for materials with a Brinell hardness not exceeding 450.

3.2 The hard metal ball indenter is used for materials with a Brinell hardness not exceeding 650.

NOTE — The values obtained using a steel ball or a hard metal ball are significantly different for hardnesses above 350.

4. SYMBOLS AND DESIGNATIONS

4.1 The following symbols have been used in this standard:

Symbols (*see* Fig. 1 and 2)	*Designation*
D	Diameter, in millimetres, of the ball
F	Test force, in newtons
d	Mean diameter, in millimetres, of the indentation
h	Depth in millimetres, of the indentation $= \frac{D - \sqrt{D^2 - d^2}}{2}$

*Rules for rounding off numerical values (*revised*).

HBS
or
HBW — Brinell hardness

$$= \text{Constant} \times \frac{\text{Test force}}{\text{Surface area of indentation}}$$

$$= 0{\cdot}102 \times \frac{2F}{\pi D \left(D - \sqrt{D^2 - d^2} \right)}$$

NOTE — Constant $= \frac{1}{g} = \frac{1}{9{\cdot}806\ 65} = 0{\cdot}102$

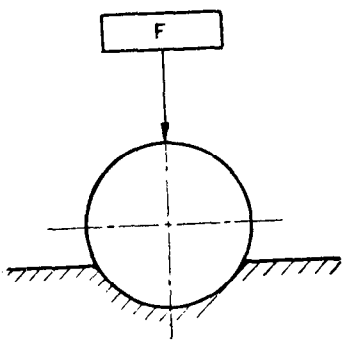

FIG. 1 PRINCIPLE OF TEST

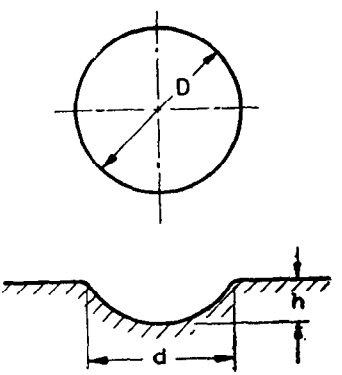

FIG. 2 MEASUREMENT OF INDENTATION

4.2 The Brinell hardness is denoted by the following symbols;

a) HBS in cases where a steel ball is used; and

b) HBW in cases where a hardmetal ball is used.

NOTE — In previous standards, in case when a steel ball was used, the Brinell hardness was denoted by HB.

4.3 The symbol HBS or HBW is preceded by the hardness value and supplemented by an index indicating the test conditions, in the following order:

a) Diameter of the ball, in millimetres;

b) A figure representing the test force (*see* Table 1); and

c) Duration of loading, in seconds, if different from the specified time (*see* **7.6**).

Examples:

350 HBS 5/750 = Brinell hardness of 350 determined with a steel ball of 5 mm diameter and with a test force of 7·355 kN applied for 10 to 15 seconds.

600 HBW 1/30/20 = Brinell hardness of 600 determined with a hard metal ball of 1 mm diameter and with a test force of 294·2 N applied for 20 seconds.

5. APPARATUS

5.1 Testing machine, capable of applying the predetermined test force or forces within the range of 9·807 N to 29·42 KN, in accordance with IS : 2281-1968*.

5.2 Indenter — Indenter is a hardened and polished steel ball or hard metal ball, as specified in IS : 2281-1968*.

5.3 Measuring Device — Measuring device as specified in IS : 2281-1968*.

6. TEST PIECE

6.1 The test shall be carried out on a surface which is smooth and even, free from oxide scale, foreign matter and, in particular, completely free from lubricants.

6.2 Preparation shall be carried out in such a way that any alteration of the surface for example due to heat or cold working, is minimized.

*Method for verification of Brinell hardness testing machines (*first revision*).

TABLE 1 TEST FORCES FOR DETERMINATION OF BRINELL HARDNESS VALUES

(*Clauses* 4.3 *and* 7.2)

Hardness Symbol	Ball Diameter D mm	$\frac{0{\cdot}102\ F}{D^2}$	Test Force F Nominal Value
HBS (HBW) 10/3 000	10	30	29·42 kN
HBS (HBW) 10/1 500	10	15	14·71 kN
HBS (HBW) 10/1 000	10	10	9·807 kN
HBS (HBW) 10/500	10	5	4·903 kN
HBS (HBW) 10/250	10	2·5	2·452 kN
HBS (HBW) 10/125	10	1·25	1·226 kN
HBS (HBW) 10/100	10	1	980·7 N
HBS (HBW) 5/750	5	30	7·355 kN
HBS (HBW) 5/250	5	10	2·452 kN
HBS (HBW) 5/125	5	5	1·226 kN
HBS (HBW) 5/62·5	5	2·5	612·9 N
HBS (HBW) 5/31·25	5	1·25	306·5 N
HBS (HBW) 5/25	5	1	245·2 N
HBS (HBW) 2·5/187·5	2·5	30	1·839 kN
HBS (HBW) 2·5/62·5	2·5	10	612·9 N
HBS (HBW) 2·5/31·25	2·5	5	306·5 N
HBS (HBW) 2·5/15·625	2·5	2·5	153·2 N
HBS (HBW) 2·5/7·812 5	2·5	1·25	76·61 N
HBS (HBW) 2·5/6·25	2·5	1	61·29 N
HBS (HBW) 2/120	2	30	1·177 kN
HBS (HBW) 2/40	2	10	392·3 N
HBS (HBW) 2/20	2	5	196·1 N
HBS (HBW) 2/10	2	2·5	98·07 N
HBS (HBW) 2/5	2	1·25	49·03 N
HBS (HBW) 2/4	2	1	39·23 N
HBS (HBW) 1/30	1	30	294·2 N
HBS (HBW) 1/10	1	10	98·07 N
HBS (HBW) 1/5	1	5	49·03 N
HBS (HBW) 1/2·5	1	2·5	24·52 N
HBS (HBW) 1/1·25	1	1·25	12·26 N
HBS (HBW) 1/1	1	1	9·807 N

6.3 The thickness of the test piece shall be at least eight times the depth of indentation h (*see* Table 2).

6.4 No deformation shall be visible at the back of the test piece after the test.

7. PROCEDURE

7.1 In general, the test is carried out at ambient temperature within the limits of 10°C and 35°C. Tests carried out under controlled conditions shall be made at a temperature of 23 ± 5°C.

7.2 The test forces shall be used in accordance with Table 1.

7.3 The test force shall be chosen so that the diameter of the indentation d lies between the values 0·24 D and 0·6 D.

7.4 The ratio 0·102 F/D^2 shall be chosen according to the material and the hardness under test as indicated below:

Material	*Brinell Hardness*	0·102 F/D^2
Steel	—	30
Cast iron*	< 140	10
	> 140	30
Copper and copper alloys	< 35	5
	35 to 200	10
	> 200	30
Light metals and their alloys	< 35	1·25
		2·5
		5
	35 to 80	10
		15
	> 80	10
		15
Lead and tin	—	1
	—	1·25

*For the testing of cast iron the nominal diameter of the ball shall be 2·5, 5 or 10 mm.

TABLE 2 MINIMUM THICKNESS OF THE TEST PIECE

(*Clause* 6.3)

All dimensions in millimetres.

MEAN DIAMETER OF THE INDENTATION	MINIMUM THICKNESS OF THE TEST PIECE				
d	$D = 1$	$D = 2$	$D = 2{\cdot}5$	$D = 5$	$D = 10$
0·2	0·08	—	—	—	—
0·3	0·18	—	—	—	—
0·4	0·33	—	—	—	—
0·5	0·54	0·25	—	—	—
0·6	0·80	0·37	0,29	—	—
0·7	—	0·51	0·40	—	—
0·8	—	0·67	0·53	—	—
0·9	—	0·86	0·58	—	—
1·0	—	1·07	0·83	—	—
1·1	—	1·32	1·02	—	—
1·2	—	1·60	1·23	0·58	—
1·3	—	—	1·46	0·69	—
1·4	—	—	1·72	0·80	—
1·5	—	—	2·00	0·92	—
1·6	—	—	—	1·05	—
1·7	—	—	—	1·19	—
1·8	—	—	—	1·34	—
1·9	—	—	—	1·50	—
2·0	—	—	—	1·67	—
2·2	—	—	—	2·04	—
2·4	—	—	—	2·46	1·17
2·6	—	—	—	2·92	1·38
2·8	—	—	—	3·43	1·60
3·0	—	—	—	4·00	1·84
3·2	—	—	—	—	2·10
3·4	—	—	—	—	2·38
3·6	—	—	—	—	2·68
3·8	—	—	—	—	3·00
4·0	—	—	—	—	3·34
4·2	—	—	—	—	3·70
4·4	—	—	—	—	4·08
4·6	—	—	—	—	4·48
4·8	—	—	—	—	4·91
5·0	—	—	—	—	5·36
5·2	—	—	—	—	5·83
5·4	—	—	—	—	6·33
5·6	—	—	—	—	6·86
5.8	—	—	—	—	7·42
6·0	—	—	—	—	8·00

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

7.6 Bring the indenter into contact with the test surface and apply the test force in a direction perpendicular to the surface. Without shock or vibration, until the applied force attains the specified value. The time from the initial application of force until the full test force is reached shall not be less than 2 seconds nor greater than 8 seconds. Maintain the test force for 10 to 15 seconds.

7.6.1 For certain materials it may be necessary to maintain the test force for a longer duration than specified in **7.6**. The *Min* duration should be specified in the relevant material specification, when required.

7.7 Throughout the test, the apparatus shall be protected from shock or vibration.

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 diameter of the indentation in the case of steel, cast iron, copper and copper alloys and at least three times the mean diameter of the indentation in the case of light metals, lead and tin and their alloys.

7.8.1 The distance between the centres of two adjacent indentations shall be at least four times the mean diameter of the indentation in the case of steel, cast iron, copper and copper alloys and at least six times the mean diameter of the indentation in the case of light metals, lead and tin and their alloys.

7.9 Measure the diameter of each indentation in the plane of surface in two directions at right angles. The arithmetic mean of the two readings shall be taken for the calculation of the Brinell hardness.

8. TEST REPORT

8.1 The test report shall include the following information:

a) Reference to this standard;

b) All details necessary for identification of the test sample;

c) The result obtained;

d) All operations not specified by this standard, or regarded as optional;

e) Details of any occurrence which may have affected the result.

NOTE 1 — There is no general process of accurately converting Brinell hardness into other scales of hardness or into tensile strength. These conversions therefore should be avoided, unless a reliable basis for the conversion can be obtained by comparison tests.

NOTE 2 — It should be noted that for anisotropic materials, for example, those which have been heavily cold-worked, there will be a difference between the lengths of the two diameters of the indentation. The specification for the product may indicate limits for such differences.

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