International Standard 6506

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Metallic materials — Hardness test — Brinell test

Matériaux métalliques — Essai de dureté — Essai Brinell

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6506 was developed by Technical Committee ISO/TC 164, *Mechanical testing of metals*, and was circulated to the member bodies in June 1980.

It has been approved by the member bodies of the following countries :

Australia	Hungary	South Africa, Rep. of
Austria	India	Spain
Bulgaria	Japan	Sweden
Canada	Korea, Dem. P. Rep. of	Switzerland
China	Korea, Rep. of	United Kingdom
Czechoslovakia	Netherlands	USA
Egypt, Arab Rep. of	Norway	USSR
France	Poland	
Germany, F. R.	Romania	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Ireland
Italy

This International Standard cancels and replaces ISO Recommendations R 79-1968, R 191-1971 and R 403-1964, of which it constitutes a technical revision.

Printed in Switzerland

Metallic materials — Hardness test — Brinell test

1 Scope and field of application

This International Standard specifies the method for the Brinell hardness test for metallic materials.

Special International Standards exist for particular materials and/or products (see clause 2).

2 References

ISO 156, *Metallic materials — Hardness test — Verification of Brinell hardness testing machines.*[1]

ISO 410, *Metallic materials — Hardness test — Tables of Brinell hardness values for use in tests made on flat surfaces.*[2]

ISO 4498/1, *Sintered metal materials excluding hardmetals — Determination of apparent hardness — Part 1 : Materials of essentially uniform section hardness.*

3 Principle

Forcing an indenter (hardened steel ball or hardmetal ball with diameter D) into the surface of a test piece and measuring the diameter of the indentation d left in the surface after removal of the test force F.

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

The hardmetal ball is used for materials with a Brinell hardness not exceeding 650.

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

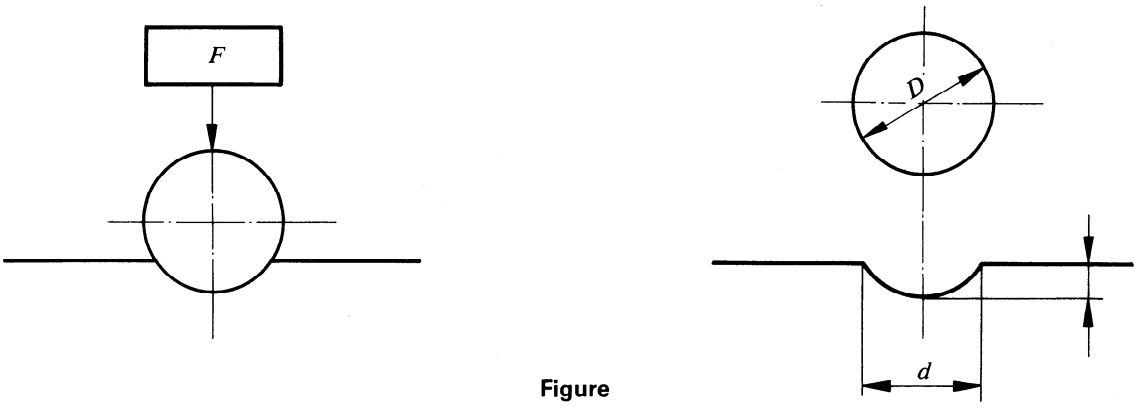
The Brinell hardness is proportional to the quotient obtained by dividing the test force by the curved surface area of the indentation which is assumed to be spherical and of diameter equal to that of the ball.

4 Symbols and designations

4.1 Table 1

Symbol	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 identation $= \frac{D - \sqrt{D^2 - d^2}}{2}$
HBS or HBW	Brinell hardness $= \text{Constant} \times \frac{\text{Test force}}{\text{Surface area of indentation}} = 0{,}102 \times \frac{2F}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$

NOTE — Constant $= \frac{1}{g_n} = \frac{1}{9{,}806\ 65} \simeq 0{,}102$



Figure

1) At present at the stage of draft. (Revision of ISO/R 156-1967.)

2) At present at the stage of draft. (Revision of ISO/R 410-1964.)

4.2 The Brinell hardness is denoted by the following symbols :

— HBS in cases where a steel ball is used;

— HBW in cases where a hardmetal ball is used.

NOTE — In former International Standards, in cases when a steel ball was used, the Brinell hardness was denoted by HB.

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

a) diameter of the ball, in millimetres;

b) a figure representing the test force (see table 2);

c) duration of loading, in seconds, if different from the specified time (see 7.5).

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 s.

600 HBW 1/30/20 = Brinell hardness of 600 determined with a hardmetal ball of 1 mm diameter and with a test force of 294,2 N applied for 20 s.

5 Apparatus

5.1 Testing machine, capable of applying a predetermined test force or forces within the range of 9,807 N to 29,42 kN, in accordance with ISO 156.

5.2 Indenter : a hardened and polished steel ball or hardmetal ball, as specified in ISO 156.

5.3 Measuring device, as specified in ISO 156.

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.

6.3 The thickness of the test piece shall be at least eight times the depth of indentation h. See the annex.

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 following test forces shall be used.

Table 2

Hardness symbol	Ball diameter D mm	$\frac{0,102\,F}{D^2}$	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

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.

The ratio $0,102\ F/D^2$ shall be chosen according to the material and the hardness under test as indicated in table 3.

Table 3

Material	Brinell hardness	$0,102\ F/D^2$
Steel		30
Cast iron[1]	< 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
	35 to 80	5
		10
		15
	> 80	10
		15
Lead, tin		1
		1,25
Sintered metal	See ISO 4498/1	

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

When the thickness of the test piece permits, a 10 mm diameter ball is preferred. (For sintered metal materials, special requirements will be given in an International Standard to be prepared).

7.4 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.

7.5 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 s nor greater than 8 s. Maintain the test force for 10 to 15 s. For certain materials, a longer time for maintaining the test force is provided; this time shall be applied with a tolerance of ± 2 s.

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

7.7 The distance between the centre of any identation 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.

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.

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

7.9 Attention is drawn to ISO 410 which contains calculation tables for use in tests made on flat surfaces.

8 Test report

The test report shall include the following information :

a) reference to this International Standard;

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

c) the result obtained;

d) all operations not specified by this International Standard, or regarded as optional;

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

NOTES

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.

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.

Annex

Dimensions in millimetres

Mean diameter of the indentation d	Minimum thickness of the test piece				
	$D = 1$	$D = 2$	$D = 2,5$	$D = 5$	$D = 10$
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	0,67		
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