INTERNATIONAL STANDARD

ISO 6506-1

Second edition
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Metallic materials — Brinell hardness test —

Part 1: Test method

Matériaux métalliques — Essai de dureté Brinell —
Partie 1: Méthode d'essai

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6506-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This second edition, together with ISO 6506-4, cancels and replaces the first edition (ISO 6506-1:1999), which has been technically revised.

ISO 6506 consists of the following parts, under the general title *Metallic materials — Brinell hardness test*:

— *Part 1: Test method*

— *Part 2: Verification and calibration of testing machines*

— *Part 3: Calibration of reference blocks*

— *Part 4: Table of hardness values*

Introduction

Attention is drawn to the fact that in this part of ISO 6506, only the use of the hardmetal ball indenter is specified.

The designation of the Brinell hardness is HBW and should not be confused with the former designation HB, or HBS when a steel ball indenter was used.

Periodic checking of the testing machine described in the informative Annex A is good metrological practice. It is intended to make this annex normative in the next revision of this part of ISO 6506.

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Metallic materials — Brinell hardness test —

Part 1: Test method

1 Scope

This part of ISO 6506 specifies the method for the Brinell hardness test for metallic materials and is applicable up to the limit of 650 HBW.

For specific materials and/or products, particular International Standards exist (i.e. ISO 4498-1).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 6506-2:2005, *Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines*

ISO 6506-4, *Metallic materials — Brinell hardness test — Part 4: Table of hardness values*

3 Principle

An indenter (hardmetal ball with diameter D) is forced into the surface of a test piece and, after removal of the force F, the diameter of the indentation d left in the surface is measured.

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 retain the shape of the ball, and its surface area is calculated from the mean indentation diameter and the ball diameter.

4 Symbols and abbreviated terms

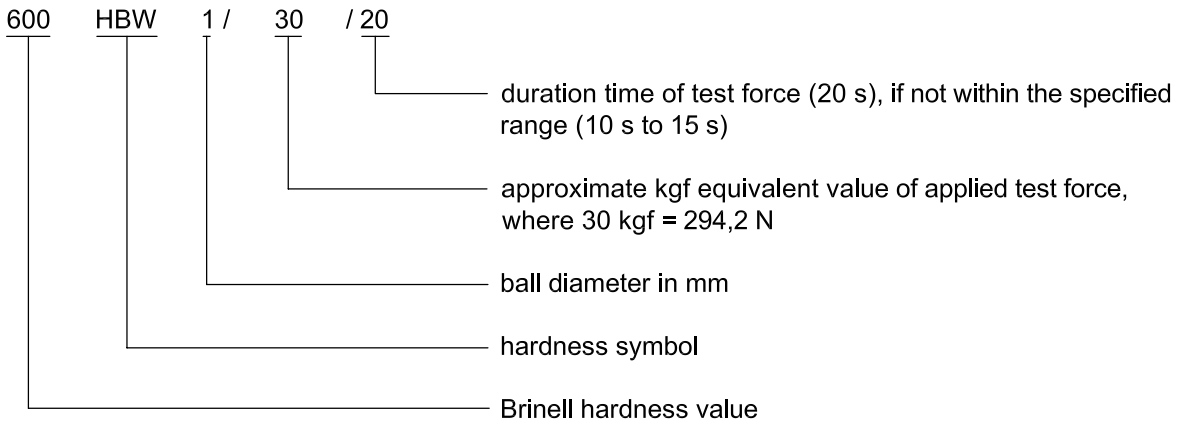
4.1 See Figure 1 and Table 1.

Table 1 — Symbols and abbreviated terms

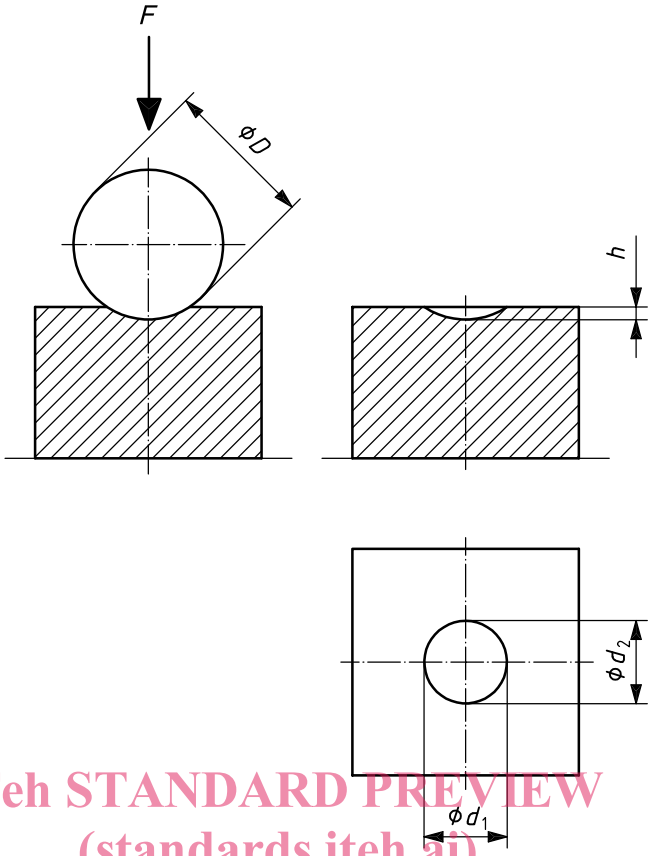
Symbol / Abbreviated term	Designation	Unit
D	Diameter of the ball	mm
F	Test force	N
d	Mean diameter of the indentation $d = \frac{d_1 + d_2}{2}$	mm
d_1, d_2	Indentation diameters measured at 90°	mm
h	Depth of indentation $h = \frac{D}{2}(1 - \sqrt{1 - d^2/D^2})$	mm
HBW	Brinell hardness $= \text{Constant} \times \frac{\text{Test force}}{\text{Surface area of indentation}}$ $\text{HBW} = 0{,}102 \times \frac{2F}{\pi D^2 (1 - \sqrt{1 - d^2/D^2})}$	
$0{,}102 \times F/D^2$	force-diameter ratio	N/mm^2
NOTE Constant $= 0{,}102 \approx \frac{1}{9{,}806\ 65}$, where 9,806 65 is the conversion factor from kgf to N.		

4.2 The following is an example of the designation of Brinell hardness, HBW.

EXAMPLE



NOTE In former standards, in cases when a steel ball had been used, the Brinell hardness was denoted by HB or HBS.



For symbols, see Table 1.

Figure 1 — Principle of test

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 6506-2.

5.2 **Indenter**, a polished hardmetal ball, as specified in ISO 6506-2.

5.3 **Measuring device**, as specified in ISO 6506-2.

NOTE A suggested procedure for periodic checks by the user is given in Annex A.

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, free from lubricants. The test piece shall have a surface finish that will allow an accurate measurement of the diameter of the indentation.

6.2 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.

6.3 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 given in Annex B.

Visible deformation at the back of the test piece can indicate that the test piece is too thin.

7 Procedure

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

7.2 The test forces given in Table 2 shall be used.

NOTE Other test forces and force-diameter ratios may be used by special agreement.

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.

Table 3 indicates recommended force-diameter ratios ($0{,}102 \times F/D^2$) that are appropriate for use when testing certain materials and hardness levels.

In order to test the largest representative area of the test piece, the diameter of the testing ball shall be chosen to be as large as possible.

When the thickness of the test piece permits, a 10 mm diameter ball is preferred.

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, vibration or overrun, until the applied force attains the specified value. The time from the initial application of force to the time the full test force is reached shall not be less than 2 s nor greater than 8 s. Maintain the test force for 10 s to 15 s. For certain materials, where a longer duration of the test force is required; this time shall be applied with a tolerance of ± 2 s.

7.6 Throughout the test, the testing machine shall be protected from significant shock or vibration, which can influence the test result.

7.7 The distance of the edge of the test piece to the centre of each indentation shall be a minimum of two and a half times the mean indentation diameter.

The distance between the centres of two adjacent indentations shall be at least three times the mean indentation diameter.

7.8 Measure the diameter of each indentation in two directions perpendicular to each other. The arithmetic mean of the two readings shall be taken for the calculation of the Brinell hardness.

NOTE For automatic measuring systems, the following may be used:

— the average of a greater number of equally spaced measurements;

— an assessment of the projected indentation area into the material surface.

7.9 ISO 6506-4 contains a calculation table, which shall be used to determine the Brinell hardness for tests on flat surfaces.

Table 2 — Test forces for the different testing conditions

Hardness symbol	Ball diameter D mm	Force-diameter ratio $0{,}102 \times F/D^2$ N/mm^2	Nominal value of test force F	
HBW 10/3 000	10	30	29,42	kN
HBW 10/1 500	10	15	14,71	kN
HBW 10/1 000	10	10	9,807	kN
HBW 10/500	10	5	4,903	kN
HBW 10/250	10	2,5	2,452	kN
HBW 10/100	10	1	980,7	N
HBW 5/750	5	30	7,355	kN
HBW 5/250	5	10	2,452	kN
HBW 5/125	5	5	1,226	kN
HBW 5/62,5	5	2,5	612,9	N
HBW 5/25	5	1	245,2	N
HBW 2,5/187,5	2,5	30	1,839	kN
HBW 2,5/62,5	2,5	10	612,9	N
HBW 2,5/31,25	2,5	5	306,5	N
HBW 2,5/15,625	2,5	2,5	153,2	N
HBW 2,5/6,25	2,5	1	61,29	N
HBW 1/30	1	30	294,2	N
HBW 1/10	1	10	98,07	N
HBW 1/5	1	5	49,03	N
HBW 1/2,5	1	2,5	24,52	N
HBW 1/1	1	1	9,807	N

Table 3 — Ratio $0{,}102 \times F/D^2$ for different metallic materials

Material	Brinell hardness HBW	Force-diameter ratio $0{,}102 \times F/D^2$ N/mm^2
Steel, nickel alloys, titanium alloys		30
Cast iron [a]	< 140 ⩾ 140	10 30
Copper and copper alloys	< 35	5
	35 to 200	10
	> 200	30
Light metals and their alloys	< 35	2,5
	35 to 80	5 10 15
	> 80	10 15
Lead, tin		1
Sintered metal	According to ISO 4498-1	

[a] For the testing of cast iron, the nominal diameter of the ball shall be 2,5 mm, 5 mm or 10 mm.