

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 191

LIGHT METALS AND THEIR ALLOYS
BRINELL HARDNESS TEST

2nd EDITION

October 1971

This second edition supersedes the first edition

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Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 191, *Brinell hardness test for light metals and their alloys*, was drawn up by Technical Committee ISO/TC 79, *Light metals and their alloys*, the Secretariat of which is held by the Association Française de Normalisation (AFNOR).

Work on this question led to the adoption of Draft ISO Recommendation No. 264, which was circulated, in December 1958, to all the ISO Member Bodies for enquiry. It was approved by 23 Member Bodies. Two Member Bodies opposed the approval of the Draft (Belgium and Romania).

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

BRIEF HISTORY RELATING TO THE 2nd EDITION

Work on the revision of ISO Recommendation R 191-1961 began in 1966 and led to the adoption of Draft ISO Recommendation No. 2089. In July 1970, this Draft ISO Recommendation was submitted to all ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Belgium	Iran	South Africa, Rep. of
Canada	Ireland	Spain
Czechoslovakia	Israel	Sweden
Denmark	Japan	Switzerland
Finland	Netherlands	Thailand
France	New Zealand	U.A.R.
Germany	Norway	United Kingdom
Greece	Poland	U.S.A.
Hungary	Portugal	U.S.S.R.
India	Romania	

No Member Body opposed the approval of the Draft.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as the second edition of ISO Recommendation R 191. The title of that Recommendation has been modified to read as follows : *Light metals and their alloys – Brinell hardness test*.

This edition (second edition) supersedes the first edition of ISO Recommendation R 191-1961.

LIGHT METALS AND THEIR ALLOYS

BRINELL HARDNESS TEST

1. SCOPE

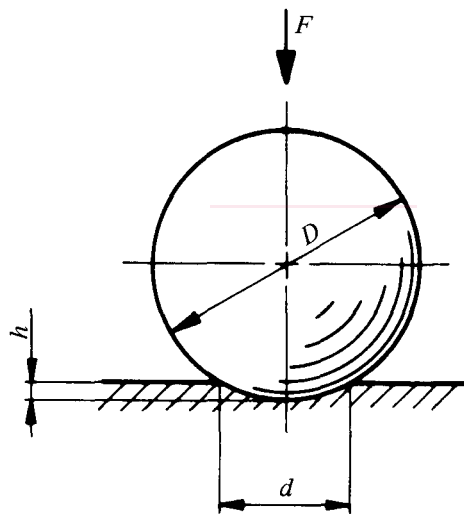
This ISO Recommendation describes the Brinell hardness testing of light metals and their alloys.

2. PRINCIPLE

The test consists in forcing an indenter, in the form of a steel ball of diameter D , under a load F , into the test piece, and measuring the diameter d of the indentation left in the surface after removal of the load.

The Brinell hardness, HB, is the quotient obtained by dividing the test load F (expressed in kilogrammes-force) by the curved surface area of the indentation (expressed in square millimetres), which is assumed to be spherical and of diameter D .

3. SYMBOLS AND DESIGNATIONS



FIGURE

TABLE 1

Symbol	Designation
D	Diameter of the ball, in millimetres
d	Mean diameter of the indentation, in millimetres
h	Depth of indentation, in millimetres
F	Test load, in kilogrammes-force
HB	Brinell hardness = $\frac{\text{Test load}}{\text{Surface area of indentation}} = \frac{2 F}{\pi D (D - \sqrt{D^2 - d^2})}$

NOTE. - The Brinell hardness is denoted by the symbol HB, supplemented by an index specifying the test conditions in the following order :

- (1) diameter of ball,
- (2) test load,
- (3) duration of loading.

Example : HB5/250/30 = Brinell hardness measured with a ball of 5 mm diameter and with a test load of 250 kgf applied for 30 seconds.

4. INDENTER

- 4.1 The nominal diameter of the ball should be not less than 1 mm, unless otherwise specified. Balls having diameters of 1, 2, 2.5, 5 and 10 mm are normally used for Brinell hardness tests (see also Note 5), and should comply with the tolerance on diameter given in Table 2.

TABLE 2
Dimensions in millimetres

Ball diameter	Tolerance on diameter	Maximum value of mean diagonal made with a Vickers indenter at 10 kgf
10	± 0.0045	0.146
5	± 0.004	0.145
2.5	± 0.0035	0.143
2	± 0.0035	0.142
1	± 0.0035	0.139

- 4.2 The ball should be of hardened steel with a hardness of at least 850 HV10 (taking into account the curvature of the ball) (see Table 2 and ISO Recommendation R 156, *Verification of Brinell hardness testing machines*). It should be polished and free from surface defects. Any ball showing, after the test, any deformation or any surface defect should be rejected and the corresponding test discarded.

5. TEST REQUIREMENTS

- 5.1 The test should be carried out at ambient temperature, unless otherwise specified. Throughout the test, the apparatus should be protected from shock and vibration.
- 5.2 The ball should be placed against the surface of the test piece and pressure gradually applied to the ball normal to the surface, without sudden shocks, until the test load is attained. The test load should be maintained for 10 to 15 seconds.
- 5.3 The test should be carried out on a surface which is sufficiently smooth and even to permit the accurate determination of the diameter of the indentation. This surface should be free from foreign matter. Care should be taken, in preparing the surface, to avoid any prejudicial change in condition, for example, due to heating or cold working.

It is recommended that the surface finish be such that the diameter of the indentation can be determined to ± 0.01 mm.

- 5.4 The test piece should be placed on a rigid support. The contact surfaces should be clean and free from foreign matter (oil, dirt, etc.). It is important that the test piece lies firmly on the support so that displacement cannot occur during the test.
- 5.5 The test loads that should be used are :

$$F = 2.5 D^2 \quad \text{for materials with a Brinell hardness below or equal to 35 HB;}$$

$$F = 5 D^2 \quad \text{for materials with a Brinell hardness between 35 and 80 HB;}$$

$$F = 10 D^2 \quad \text{for materials with a Brinell hardness above 80 HB.}$$

The tolerance on the load should be, in every case, ± 1 %.

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

- 5.6 The thickness of the test piece should be not less than 8 times the depth of indentation h . No deformation should be visible at the back of the test piece after test.

The depth of indentation, h , is given by the formula

$$\frac{F}{\pi D \times \text{HB}}$$

- 5.7 As a general rule, the distance from the centre of the indentation to the edge of the test piece should be at least 3 times the diameter of the indentation, and the distance between the centres of two adjacent indentations should be at least 6 times the diameter of the indentation. The test should be carried out in such a way that nothing occurs to falsify the test result (such as bulging at the edge or distortion of the test piece).
- 5.8 The diameter of each indentation should be measured in two directions at right angles, and the mean value of the two readings used for the purpose of determining the Brinell hardness. The measuring microscope or other measuring device should be capable of measuring the diameter of indentations to an accuracy of $\pm 0.25\%$ of the diameter of the ball.

NOTES

1. Attention is drawn to ISO Recommendation R 410, *Tables of Brinell hardness values (HB) for use in tests made on flat surfaces*, for use in conjunction with this ISO Recommendation.
2. There is no general process for converting accurately Brinell hardness into other scales of hardness or tensile strength. These conversions therefore should be avoided, except for special cases where a reliable basis for the conversion has been obtained by comparison tests. Even in such cases, the relation between Brinell hardness and tensile strength or other scales of hardness is only indicative.
3. Experimental evidence is available to show that the Brinell hardness of most light metals and alloys will vary with the diameter of the ball and the magnitude of the indenting load.
4. It is desirable that the diameter, d , of the indentation should range between $0.25 D$ and $0.5 D$ (D being the diameter of the ball).
5. A new ball for an indenter should be selected from a batch which has been verified (see ISO Recommendation R 156) to the tolerance given in clause 4.1. It is advisable to ensure that this ball is representative of the batch.
6. For the verification of Brinell hardness testing machines and the calibration of standardized blocks, see ISO Recommendations R 156, *Verification of Brinell hardness testing machines*, and R 726, *Calibration of standardized blocks to be used for Brinell hardness testing machines*.