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IS 2281 (2005): Method for Verification of Brinell Hardness Testing Machines [MTD 3: Mechanical Testing of Metals]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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भारतीय मानक

ब्रिनेल कठोरता परीक्षण मशीनों के सत्यापन की पद्धति
(तीसरा पुनरीक्षण)

Indian Standard

**METHOD FOR VERIFICATION OF BRINELL
HARDNESS TESTING MACHINES**

(Third Revision)

ICS 77.040.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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NATIONAL FOREWORD

This Indian Standard (Third Revision) which is identical with ISO 6506-2 : 1999 'Metallic materials — Brinell hardness test — Part 2 : Verification and calibration of testing machines' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of the Mechanical Testing of Metals Sectional Committee and approval of the Metallurgical Engineering Division Council.

This standard was originally published in 1959 and subsequently revised in 1968 and 1983. This revision of the standard has been taken up to align it with ISO 6506-2 : 1999 by adoption under dual numbering system.

In this revision, the use of steel balls have been discontinued in favour of carbide balls, to bring it in line with the International practice.

In the adopted standard, some terminology and conventions are, however, not identical to those used in Indian Standard. Attention is especially drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their places are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 376 Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines	IS 4169 : 1988 Method for calibration of force-proving instruments used for the verification of uniaxial testing machines (<i>first revision</i>)	Technically equivalent
ISO 3878 Hardmetals — Vickers hardness test	IS 12783 : 1989 Hardmetals — Vickers hardness test	do
ISO 6506-1 : 1999 Metallic materials — Brinell hardness test — Part 1 : Test method	IS 1500 : 2005 Method for Brinell hardness test for metallic materials (<i>third revision</i>)	Identical
ISO 6506-3 : 1999 Metallic materials — Brinell hardness test — Part 3 : Calibration of reference blocks	IS 4132 : 2005 Method for calibration of standardization blocks to be used for Brinell hardness testing machines (<i>second revision</i>)	do

In reporting the results 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 'Rules for rounding off numerical values (*revised*)'.

Indian Standard
**METHOD FOR VERIFICATION OF BRINELL
HARDNESS TESTING MACHINES**
(Third Revision)

1 Scope

This part of ISO 6506 specifies a method of verification and calibration of testing machines used for determining Brinell hardness in accordance with ISO 6506-1.

It specifies a direct method for checking the main functions of machine operation and an indirect method suitable for checking the overall machine operation. The indirect method may be used independently for periodic routine checking of machine operation while in service.

If a testing machine is also to be used for other methods of hardness testing, it shall be verified independently for each method.

This part of ISO 6506 is applicable to portable hardness testing machines with the exception of the requirement in 6.1 a) in which the word "relocation" does not apply.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6506. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6506 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 376, *Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines.*

ISO 3878, *Hardmetals — Vickers hardness test.*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method.*

ISO 6506-3:1999, *Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks.*

3 General conditions

Before a Brinell hardness testing machine is verified, the machine shall be checked to ensure the following:

- a) the machine is properly set up;
- b) the plunger holding the ball slides correctly in its guide;
- c) the ball-holder with a ball (from a lot verified in accordance with 4.3) is firmly mounted in the plunger;
- d) the test force is applied and removed without shock, vibration or overrun and in such a manner that the readings are not influenced;

- e) for measuring devices integrated into the machine:
- the readings are not influenced between the removal of the test force to the measurement of indentation;
 - the readings are not affected by illumination;
 - the centre of the indentation is in the centre of the field of view, if necessary.

4 Direct verification

4.1 General

4.1.1 Direct verification should be carried out at a temperature of (23 ± 5) °C. If the verification is made outside this temperature range, this shall be reported in the verification report.

4.1.2 The instruments used for verification and calibration shall be traceable to national standards.

4.1.3 Direct verification involves:

- a) the calibration of the test force;
- b) the verification of the indenter;
- c) the calibration of the measuring device;
- d) the verification of the testing cycle.

4.2 Calibration of the test force

4.2.1 Each test force shall be measured and, whenever applicable, this shall be done at no less than three positions of the plunger spaced throughout its range of movement during testing.

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

- with a force-proving instrument conforming to class 1 of ISO 376, or
- balancing against a force, accurate to $\pm 0,2$ %, applied using calibrated masses by mechanical means.

4.2.3 Three measurements shall be made for each force at each position of the plunger. Immediately before each measurement is taken, the plunger shall be moved in the same direction as during testing.

4.2.4 Each measurement of a force shall be within $\pm 1,0$ % of the nominal test force, as defined in ISO 6506-1.

4.3 Verification of the indenters

4.3.1 The indenter consists of a ball and an indenter holder.

4.3.2 For the purpose of verifying the size and the hardness of the balls, a sample selected at random from a batch shall be tested. The ball(s) verified for hardness shall be discarded.

4.3.3 The balls shall be polished and free from surface defects.

4.3.4 The user shall either measure the balls to ensure that they meet the following requirements, or shall obtain balls from a supplier certifying that the following conditions are met.

4.3.4.1 The diameter shall be determined by taking the mean value of no less than three single values of diameter measured at different positions on the ball. No single value shall differ from the nominal diameter by more than the tolerance given in Table 1.

Table 1 — Tolerances for the different ball indenter diameter

Dimensions in millimetres	
Ball indenter diameter	Tolerance
10	± 0,005
5	± 0,004
2,5	± 0,003
1	± 0,003

4.3.4.2 The characteristics of the hardmetal balls shall be as follows:

- hardness: the hardness shall be no less than 1 500 HV 10, when determined in accordance with ISO 3878;
- density: $\rho = (14,8 \pm 0,2) \text{ g/cm}^3$.

NOTE The following chemical composition is recommended:

tungsten carbide (WC)	balance
total other carbides	2,0 %
cobalt (Co)	5,0 % to 7,0 %

4.4 Calibration of the measuring device

4.4.1 The scale of the measuring device shall be graduated to permit estimation of the diameter of the indentation to within $\pm 0,5 \%$.

4.4.2 The measuring device shall be verified by measurements made on a stage micrometer at a minimum of five intervals over each working range. The maximum error shall not exceed 0,5 %.

4.4.3 When measuring a projected area, the maximum error shall not exceed 1 %.

4.4.4 In addition to this direct verification, an indirect verification of the measuring device may be carried out in accordance with the procedure defined in annex A.

4.5 Verification of the testing cycle

The testing cycle shall conform with the testing cycle specified in ISO 6506-1 and shall be timed with an uncertainty less than $\pm 0,5 \text{ s}$.

5 Indirect verification

5.1 Indirect verification shall be carried out at a temperature of $(23 \pm 5) \text{ }^\circ\text{C}$ by means of reference blocks calibrated in accordance with ISO 6506-3. If the verification is made outside this temperature range, this shall be reported in the verification report.

The test and bottom surfaces of the reference blocks and the surfaces of indenters shall not contain any additives of corrosion product.

5.2 The testing machine shall be verified for each test force and for each size of ball used. For each test force, at least two reference blocks shall be selected from the following hardness ranges:

- $\leq 200 \text{ HBW}$
- $300 \leq \text{HBW} \leq 400$
- $\geq 500 \text{ HBW}$

The two reference blocks shall be taken from different hardness ranges, if possible.

NOTE When the hardness test in question makes it impossible to reach the higher hardness range defined in the above mentioned ranges (for $0,102 \times F/D^2 = 5$ or 10), the verification may be carried out with only one reference block from the lower hardness range.

5.3 On each reference block, five indentations shall be uniformly distributed over the test surface and measured. The test shall be made in accordance with ISO 6506-1.

5.4 For each reference block, let d_1, d_2, d_3, d_4, d_5 be the mean values of the measured diameters of the indentations arranged in increasing order of magnitude.

5.5 The repeatability of the testing machine under the particular verification conditions is determined by the following quantity:

$$d_5 - d_1$$

The overall mean value diameter \bar{d} is defined as follows:

$$\bar{d} = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5}$$

where d_1, d_2, d_3, d_4, d_5 have been defined in 5.4.

The repeatability of the testing machine to be verified shall be as specified in Table 2.

Table 2 — Repeatability and error of the testing machine

Hardness of the reference block HBW	Permissible repeatability of the testing machine mm	Permissible error of the testing machine % of H
≤ 125	$0,030 \bar{d}$	3
$125 < \text{HBW} \leq 225$	$0,025 \bar{d}$	2,5
> 225	$0,020 \bar{d}$	2

5.6 The error of the testing machine under the particular verification conditions is characterized by the following quantity:

$$\bar{H} - H$$

where

\bar{H} is the mean hardness value of the five indentations as follows:

$$\bar{H} = \frac{H_1 + H_2 + H_3 + H_4 + H_5}{5}$$

where

H_1, H_2, H_3, H_4, H_5 are the hardness values corresponding to d_1, d_2, d_3, d_4, d_5 ;

H is the specified hardness of the reference block.

The error of the testing machine, expressed as a percentage of the specified hardness of the reference block, shall not exceed the values given in Table 2.

6 Intervals between verifications

6.1 Direct verification

The direct verification shall be carried out:

- a) when the machine is installed or after having been dismantled and reassembled or after relocation;
- b) when the result of the indirect verification is not satisfactory;
- c) when indirect verification has not been made for a period greater than 12 months.

Each direct verification shall be followed by an indirect verification.

6.2 Indirect verification

The period between two indirect verifications depends on the maintenance standard and number of times the machine is used. In any case, this period shall not exceed 12 months.

7 Verification report/calibration certificate

The verification report/calibration certificate shall include the following information:

- a) a reference to this International Standard, i.e. ISO 6506-2;
- b) the method of verification (direct and/or indirect);
- c) the identification data for the hardness testing machine;
- d) the means of verification (reference blocks, elastic proving devices, etc.);
- e) the diameter of the ball indenter and test force;
- f) the verification temperature;
- g) the result obtained;
- h) the date of verification and reference to the verification institution.

Annex A

(informative)

Example of a method for an indirect verification of the measuring device

Indirect verification of the measuring device may be carried out by measurements of the reference indentation on each reference block to be used for the indirect verification of the testing machine in accordance with clause 5 (see note to 8.3 in ISO 6506-3:1999).

The error of the measuring device, expressed as a percentage of the assigned diameter of each reference indentation, shall be no more than 1 %.

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This Indian Standard has been developed from Doc : No. MTD 3 (4394).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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