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Standard ~~Practice~~ Test Method for Indentation Hardness of Metallic Materials by Comparison Hardness Testers[1]

This standard is issued under the fixed designation A833; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

~~1. Scope~~

~~1.1 This practice covers the determination of indentation hardness of metallic materials using comparison hardness testers.~~

~~1.2 This practice applies only to those comparison hardness testers, normally portable, that use comparative test bars that have been standardized according to Test Method E10 as a basis for comparison.~~

~~1.3 Calibration of comparative test bars (rods), used for comparison to determine hardness numbers, is also covered by this practice.~~

~~1.4 The impression force used during comparison hardness testing is normally an impact load applied by striking a hammer on the appropriate areas as outlined in the manufacturer's instructions.~~

~~1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.~~

~~1.6 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*~~

~~2. Referenced Documents~~

~~2.1 *ASTM Standards:*[2]~~
~~A370 Test Methods and Definitions for Mechanical Testing of Steel Products~~
~~E10 Test Method for Brinell Hardness of Metallic Materials~~

~~3. Significance and Use~~

~~3.1 The comparative hardness test is an empirical dynamic indentation hardness test. Comparative hardness tests provide useful information about metallic materials. This information may correlate to tensile strength, wear resistance, ductility, heat treatment condition, or other physical characteristics of metallic materials, and may be useful in quality control and selection of materials.~~

~~3.2 Comparative hardness testing at a specific location on a part may not represent the physical characteristics of the whole part or end product.~~

~~4. Apparatus~~

~~4.1 Comparison hardness testers are used principally for testing articles that are too large or unwieldy to be tested in the usual types of testing machines, for testing parts of fixed structures, or for testing under any conditions that require that the indenting force be applied in a direction other than vertical.~~

~~4.1.1 Required equipment includes an apparatus that contains the impression ball and a slot or spacing to insert the comparative test bar (rod), the comparative test bar, a structure to apply the impact (anvil), and an impacting tool, normally a hammer. This apparatus is designed to allow a ball impression to be produced on the standard rod simultaneously with one produced on the piece to be tested. Comparison of the impression diameters together with the hardness of the comparative bar (rod) is used to determine hardness of the part.~~

[1] This ~~practice~~ test method is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4.1.2 The structure to convey the impact to the test bar, impression ball, and part being tested is designed with the striking surface for the impacting tool centered directly above the location of the impression ball.

4.1.3 The apparatus may also be designed to include an extension for stabilization.

4.1.4 The Brinell hardness of the comparison test bar (rod) used should be within ±15% of the anticipated Brinell hardness of the part being tested, and of the same general type of material.

4.1.5 *Impression Ball:*

4.1.5.1 The diameter of the impression ball shall be 10 ± 0.01 mm.

4.1.5.2 The ball shall be made from steel hardened within the range of 60 to 67 HRC and shall be capable of being used in a reasonable number of tests without incurring damage that could affect the results. Use of a tungsten carbide ball may result in fracture or spalling of the ball.

4.1.5.3 The ball shall be inspected regularly according to the equipment manufacturer's recommendations to ensure accuracy.

4.2 *Measuring Microscope*—The divisions of the micrometer scale of the microscope, or other measuring devices used for measuring the impression diameter, shall be such as to permit the direct measuring of the diameter to 0.1 mm and the estimation of the diameter to 0.05 mm.

5. Test Parts

5.1 Parts tested by this hardness testing practice vary greatly in form since it is frequently desirable to make the impression upon a part to be used in the finished product rather than upon a sample test specimen.

5.1.1 *Dimensions*—The thickness of the tested part shall be such that no bulge or other marking showing the effect of the load appears on the side of the piece opposite the impression. In any event, the thickness of the part shall be at least ten times the depth of the indentation. The minimum width shall be at least two and one half times the diameter of the indentation.

5.1.2 *Finish*—When necessary, the surface on which the impression is to be made shall be filed, ground, machined, or polished with abrasive material so that the edge of the impression shall be defined clearly enough to permit the measurement of the diameter to the specified accuracy. Take care to avoid overheating or cold working the surface. Sufficient metal shall be removed to eliminate decarburized metal.

5.2 *Support*—All parts to be tested shall be adequately supported to prevent any movement or deflection during application of the impact load.

6. Verification of Apparatus and Calibration of Test Bars

6.1 *Verification of Apparatus*—The hardness-testing apparatus (including test bars) shall be verified by performing tests on Brinell blocks that have been standardized according to the requirements of Test Method E10.

6.1.1 Full verification of the apparatus shall be performed prior to use when new, and upon replacement of the impression ball. The full verification shall include testing at least one Brinell test block 3 times. The average of the three measurements shall be within ±5 % of the Brinell value of the test block.

6.1.2 Periodic verifications are recommended at the beginning of each day the comparative tester is used, or during usage as deemed necessary. Periodic verifications should be performed using Brinell test blocks within ±15 % of the expected Brinell hardness of the parts being tested. One measurement is satisfactory for periodic testing. The result of the periodic test measurement should be within ±5 % of the Brinell value of the test block to be considered to be in compliance with this practice.

6.2 *Calibration of Comparative Bars*—The Brinell hardness of the comparative test bars shall be determined by the test bar manufacturer using a 10 mm diameter ball and a 3000 kg load according to Test Method E10 on each of the four faces of the test bar at approximately the mid-length of the bar. If the test bar is too soft to permit the use of a 3000 kg load, then a 1500 kg load shall be used. The hardness values obtained shall not vary from each other by more than ±2 %. The ends of the bar shall be permanently marked with the average hardness value, as well as the applied load if the 1500 kg load was used by the manufacturer prior to shipment.

7. Procedure

7.1 Assemble the comparative test bar into the apparatus making sure a minimum distance of no less than 5 mm will exist between diameter of the impression to be made and any other indentations on the face. Minimum distance of the indentation diameter from the edge of the part tested shall be 12.5 mm. If the apparatus is equipped with a presetting bar stop, ensure the fixture is properly in place. Place the apparatus on the surface of the component to be tested and apply the impact load using a 1 to 2¼ kg hammer. It is essential to apply a well guided, short blow in order to avoid a rebound and thus a double blow that may produce an erroneous result by damaging the sharp edge of the ball impression.

NOTE 1—A hammer weight of 2 to 5 lb may be used instead of the kilogram rating.

7.2 *Impression Diameter*—The diameter of the impression produced on the comparative test bar should not exceed 4.2 mm. If a larger impression is produced, the comparative bar may give way laterally and the test result may be in error. In this case the use of the 1500-kg load should be considered (see 6.2).

7.3 *Measurements*—Two diameters of each impression at right angles to each other shall be measured to within 0.05 mm and their mean value used as the basis for subsequent calculations.

7.3.1 If the two diameter measurements differ by more than 0.1 mm, the readings shall be discarded in accordance with Test Methods and Definitions A370, and the test repeated.

7.4 *Determination of Part Hardness*—Employing the calibration device or mathematical equation supplied by the manufacturer for the apparatus, determine the hardness of the part by using both (test bar and part) impression diameters and the hardness of the comparative bar in accordance with the equipment manufacturer's instructions. Annex A1 gives details of typical formulae used in calculating the comparison hardness.

8. Report

8.1 The report shall include the following information:

8.1.1 Indentation hardness number of the part or component as calculated in 7.4 with the designation HBC and the Brinell hardness number of the comparative test bar,

8.1.1.1 The result shall be written as shown in the following example:

232HBC/240 where 232 is the hardness determined as defined in 7.4 and 240 is the Brinell hardness of the comparative test bar.

8.1.2 Identification of the manufacturer's equipment, and

8.1.3 Diameters of the impressions in the part or component and comparative test bar.

~~9. Keywords~~

~~9.1 Brinell hardness; comparative hardness; comparative hardness testers; metallic~~

~~ANNEX~~

~~A1. ANALYTICAL HARDNESS DETERMINATION~~

~~A1.1 As an example, the hardness of the part being tested may be determined from the following equation, based on the use of a 10 mm diameter ball. However the manufacturer of the actual apparatus used may use another formula for obtaining the comparison hardness value as stated in 7.4.~~

$$B_1 = B_2\left(10 - \sqrt{100 - D_1^2}\right)/\left(10 - \sqrt{100 - D_2^2}\right)$$

~~where:~~

~~B_1 = comparison hardness of the part being tested,~~
~~B_2 = Brinell hardness of the comparative bar,~~
~~D_1^2 = diameter of impression in the comparative bar,~~
~~D_2^2 = diameter of impression in the part being tested.~~

1. Scope*

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1.2 This test method applies only to those portable comparison hardness testers that use test bars that have been standardized according to Test Method E10 as a basis for comparison.

1.3 Calibration of test bars, used for comparison to determine hardness numbers, is also covered by this test method.

1.4 The impression force used during comparison hardness testing is normally an impact load applied by striking a hammer on the appropriate areas as outlined in the manufacturer's instructions.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products
E10 Test Method for Brinell Hardness of Metallic Materials
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions:*