



Standard Practice for Indentation Hardness of Metallic Materials by Comparison Hardness Testers¹

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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 standardized test blocks in accordance with Test Method E 10 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 indenting force used during comparison hardness testing is normally an impact load applied by striking a hammer at the appropriate areas as outlined in the manufacturer's instructions. Final indentation diameter in both the comparative test bar and material tested shall be within the range of the comparator used for the instrument.

1.5 *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:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products²

E 10 Test Method for Brinell Hardness of Metallic Materials³

3. Apparatus

3.1 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.

3.1.1 Required equipment includes an apparatus that contains the Brinell ball and a slot or spacing to insert the calibration bar, the bar 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. Calibration tables (slide rule) are used to compare impression diameters and the hardness of the calibration bar to determine the hardness of the piece.

3.1.2 This apparatus is designed with a surface directly above the Brinell ball where impact is to occur. The apparatus may also be designed to include an extension for stabilization.

3.2 *Measuring Microscope*—The divisions of the micrometer scale on the microscope, or other measuring devices used for the measurement of the diameter of the impression, shall permit the direct measuring of the diameter to 0.1 mm and the estimation of the diameter to 0.02 mm. This requirement applies to the construction of the microscope only and is not a requirement for measurement of the impression.

4. Test Parts

4.1 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.

4.1.1 *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.

4.1.2 *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.

¹ This practice 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 *Annual Book of ASTM Standards*, Vol 01.03.

³ *Annual Book of ASTM Standards*, Vol 03.01.



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

5. Verification of Apparatus and Calibration of Comparative Bars

5.1 *Verification*—The hardness-testing apparatus and test bars shall be calibrated in accordance with Test Method E 10 prior to use when new, upon replacement of the ball indenter, and periodically during usage as deemed necessary.

5.2 *Comparative Bars*—Hardness of comparative bars (rods) shall be determined by the manufacturer on at least one face at approximately the mid-length of the bar. The ends of the bar shall be permanently marked with the hardness number by the manufacturer prior to shipment. The user shall check the hardness on each additional face to be used prior to testing in accordance with Test Method E 10. If the hardness of a face is not within ±2 % of the marked hardness number, the face shall not be used for part testing.

6. Procedure

6.1 Assemble the comparative 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. 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.

6.2 *Impression Diameter*—The diameter of the impression produced on the comparative 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.

6.3 *Measurements*—Measurement of the impression diameters shall be in accordance with Test Methods and Definitions A 370.

6.4 *Determination of Part Hardness*—Employing the calibration device supplied by the manufacturer for the apparatus, determine the hardness of the part by comparing both impression diameters and the hardness of the comparative bar. Accuracy can be improved by using a comparative bar with a hardness number within thirty Brinell (HB) numbers of the part tested.

6.4.1 *Analytical Hardness Determination*—Analytically, the hardness of the part being tested may be determined from the following equation:

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

- B_1 = indentation 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.

7. Report

7.1 The report shall include the following information:

- 7.1.1 Indentation hardness number of the component and the Brinell hardness number of the comparative bar,
- 7.1.2 Identification of the manufacturer’s equipment, and
- 7.1.3 Diameters of the indentations in the component and comparative bar.

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