



Standard Test Method for Determination of Rock Hardness by Rebound Hammer Method¹

This standard is issued under the fixed designation D5873; 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 test method covers the testing apparatus, sampling, test specimen preparation, and testing procedures for determining the rebound hardness number of rock material using a spring-driven steel hammer, referred to variously as a rebound hammer, impact test hammer, or concrete test hammer.

1.2 This test method is best suited for rock material with uniaxial compressive strengths ranging between approximately 1 and 100 MPa. Test Method **D7012** provides more information on compressive strength of rock.

1.3 The portable testing apparatus may be used in the laboratory or field to provide a means of rapid assessment of rock hardness or to serve as an indicator of rock hardness.

1.4 Rebound hammers are available from their original manufacturers in several different energy ranges. For a given plunger tip diameter and radius of curvature, the impact energy of the rebound hammer determines its range of applicability. Accordingly, this limitation should be kept in mind when selecting a hammer type. Earlier recommendations for rock mechanics applications were only for hammers with an impact energy of 0.735 N·m, especially on smaller core samples and weaker rocks (see also Brown 1981²). This test method applies only to hammers with an impact energy not to exceed 0.735 N·m. Hammers with energies above 0.735 N·m tend to break the rock and are not recommended.

1.5 Rocks exhibiting vesicular texture may be beyond the scope of this test. Care should be taken when testing such rocks and conglomerates as the rebound values will vary between testing a large piece of aggregate versus softer matrix of the conglomerate.

1.6 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice **D6026**.

¹ This test method is under the jurisdiction of ASTM Committee **D18** on Soil and Rock and is the direct responsibility of Subcommittee **D18.12** on Rock Mechanics. Current edition approved Feb. 1, 2014. Published February 2014. Originally approved in 1995. Last previous edition approved in 2013 as D5873 – 13. DOI: 10.1520/D5873-14.

² Brown, E. T., ed., *Suggested Methods: Rock Characterization, Testing, and Monitoring*, International Society of Rock Mechanics (ISRM): Pergamon Press, London, 1981.

1.6.1 The procedures used to specify how data are collected/recorded or calculated, in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analytical methods for engineering design.

1.7 For determining the rebound number of concrete, see Test Method **C805/C805M**.

1.8 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.9 *This standard does not purport to address all of the safety concerns, 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:³

C805/C805M Test Method for Rebound Number of Hardened Concrete

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4543 Practices for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerances

³ 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.

D4879 Guide for Geotechnical Mapping of Large Underground Openings in Rock

D6026 Practice for Using Significant Digits in Geotechnical Data

D7012 Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

3. Terminology

3.1 *Definitions*—For definitions of common technical terms in this standard, refer to Terminology **D653**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *rebound hammer*—a portable, spring loaded, steel hammer used to classify the hardness of rock in the field or laboratory.

3.2.2 *rebound hardness number, H_R* —a dimensionless number representing empirically determined, relative hardness of rock material or other hard substance by use of a rebound hammer.

3.2.3 *rebound number*—a dimensionless reading or value based on the absorption of part of the stored elastic energy of the spring through plastic deformation of the rock surface and mechanical waves propagating through the stone while the remaining elastic energy causes the actual rebound of the hammer.

3.2.3.1 *Discussion*—The rebound distance traveled by the spring loaded steel mass, expressed as a percentage of the initial extension of the spring, is called the *rebound number*.
Kolaiti and Papadopoulos (1993)⁴

4. Significance and Use

4.1 The rebound hardness method provides a means for rapid classification of the hardness of rock during site characterization for engineering, design, and construction purposes, geotechnical mapping of large underground openings in rock, see Guide **D4879**, or reporting the physical description of rock core, see Practice **D4543**.

4.2 The rebound hardness number, H_R , can serve in a variety of engineering applications that require characterization of rock material. These applications include, for examples, the prediction of penetration rates for tunnel boring machines, determination of rock quality for construction purposes, grouping of test specimens, and prediction of hydraulic erodibility of rock.

4.3 This test method is of limited use on very soft rock or very hard rock, which is defined as having uniaxial compressive strengths less than approximately 1 MPa or greater than 100 MPa.

4.4 The results of this test method are not intended for conversion to strength data suitable for design.

NOTE 1—Several types of rebound hammers are commercially available to accommodate testing of various sizes and types of rock. For the same

rock or material, rebound numbers obtained from different hammers are not comparable.

NOTE 2—The quality of the result produced by this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing and sampling. Users of this test method are cautioned that compliance with Practice **D3740** does not in itself assure reliable results. Reliable results depend on many factors; Practice **D3740** provides a means of evaluating some of those factors.

5. Interferences

5.1 Rock at 0° C or less may exhibit very high rebound values.

5.2 Temperature of the rebound hammer itself may affect the rebound number. The hammer and materials to be tested should be at the same temperature.

5.3 For readings to be compared, the direction of impact must be the same.

5.4 Different instruments of the same nominal design may give rebound numbers differing from one to three units and therefore, tests should be made with the same instrument in order to compare results. If more than one instrument is to be used, a sufficient number of tests must be made on typical rock surfaces to determine the magnitude of the differences to be expected in the readings of different instruments.

5.5 Rocks exhibiting vesicular texture may be beyond the scope of this test. The open texture may continue throughout the entire specimen and no practical amount of abrasive stone application will produce a consistent test surface. The honey-combed nature of the material may readily fail giving a falsely low hardness value.

6. Apparatus

6.1 *Rebound Hammer*—A device consisting of a spring-loaded steel hammer with a predetermined amount of energy that, when released, strikes a metal plunger in contact with the rock core or natural surface. Fig. 1 is an example of a typical rebound hammer. Fig. 2 is an example of the rebound hammer against a rock core specimen that is held in a metal anvil in contact with, and supported by, a solid surface. The hammer must travel with a fixed and reproducible speed. The rebound distance of the hammer from the top of the steel plunger is measured through the use of a mechanical slider or electronic display and is taken as an empirical measure of rock hardness.

6.2 *Core Holder*—A steel V-block or steel cradle with a semi-circular machined slot with a minimum mass of 20 kg to which specimens are securely held with some type of clamping device. See Note 4 for more information on test holders. Rock core specimens must be firmly seated in the base for the test. The slot in the test cradle shall be the same radius as the core to be tested. A guide may be attached to the core holder to keep the rebound hammer perpendicular to the surface of the test specimen. Fig. 2 shows this positioning.

NOTE 3—Instruments are available that will store the rebound numbers, which can then be transferred to a computer for analysis.

NOTE 4—An evaluation is made of three different holders for hammer tests on rock core in the laboratory, including steel angle, V-block, and semi-circular groove holders. The differences are shown in Fig. 3.

⁴ Kolaiti E., and Papadopoulos Z., *Evaluation of Schmidt Rebound Hammer Testing: A Critical Approach*, Bulletin of the International Association of Engineering Geology, 1993.