Designation: D 5873 – 00

Standard Test Method for
Determination of Rock Hardness by Rebound Hammer Method[1]

This standard is issued under the fixed designation D 5873; 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 (see Test Method D 2938) ranging between approximately 1 and 100 MPa.

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 The values stated in SI units are to be regarded as the standard.

1.5 *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:*
C 805 Test Method for Rebound Number of Hardened Concrete[2]
D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes[3]
D 653 Terminology Relating to Rock, Soil, and Contained Fluids[3]
D 2938 Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens[3]
D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[3]
D 4543 Practice for Preparing Rock Core Specimens and Determining Dimensional and Shape Tolerances[3]
D 4879 Guide for Geotechnical Mapping of Large Underground Openings in Rock[3]
2.2 *ISRM Standards:*

Suggested Method for Determination of Schmidt Rebound Hardness[4]
Suggested Method for Quantitative Description of Discontinuities in Rock Masses[4]

3. Terminology

3.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *rebound hammer*—a portable, spring loaded, piston-type, 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.

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 (see Guide D 420), geotechnical mapping of large underground openings in rock (see Guide D 4879), or reporting the physical description of rock core (see Practice D 4543). 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, and prediction of hydraulic erodibility of rock.

4.2 This test method is of limited use on very soft rock or very hard rock (unconfined compressive strengths less than approximately 1 MPa or greater than 100 MPa).

4.3 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 concrete construction (See Test Method C 805) and rock material.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the

---

---

*A Summary of Changes section appears at the end of this standard.

suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing and sampling. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

5. Apparatus

5.1 *Rebound Hammer*, consisting of a spring-loaded piston, or hammer, which is projected against a metal anvil in contact with the rock surface. The hammer must travel with a fixed and reproducible velocity. The rebound distance of the piston from the steel plunger is measured in a linear scale attached to the frame of the instrument and is taken as an empirical measure of rock hardness.

5.2 *Steel Base*—A steel base of minimum mass of 20 kg to which specimens are securely fastened. Rock core specimens may be tested in a steel cradle with a semicylindrical machined slot of the same radius as the core, or firmly seated in a steel V-block.

5.3 *Calibration Anvil*—The standard calibration block used to calibrate the rebound hammer.

5.4 *Abrasive Stone*—A medium-grained texture silicon carbide or equivalent material.

6. Sampling

6.1 Drill core specimens shall be NX or larger core art at least 15 cm in length. Block specimens shall have edge lengths of at least 15 cm. Rock surfaces tested in place, including natural outcrops or prepared surfaces such as tunnel walls or floors, shall have a smooth, flat test area at least 15 cm in diameter.

6.2 Samples shall be representative of the rock to be studied. Obtain samples by direct sampling of subsurface rock units with core borings or by sampling blocks of rock material from outcrops that correlate with the subsurface rock unit of interest. At surface outcrops, avoid sampling and testing rock material weakened by weathering or alteration or is otherwise unrepresentative of the rock material of interest.

6.3 The rebound hammer is generally unsuitable for very soft or very hard rock. Conduct simple field tests to quickly assess a rock material's suitability for the rebound hammer test method. Scratch very soft rock with a fingernail and peel with a pocket knife. An intact specimen of very hard rock breaks only by repeated, heavy blows with a geological hammer and cannot be scratched with a common 20d steel nail.

7. Specimen Preparation

7.1 For a block or core specimen, determine its length by taking the average of four lengths measured at four equally spaced points on the circumference and record to the nearest 5 mm.

7.2 For a block or core specimen, determine its diameter by taking the average of two diameters measured at right angles to each other approximately midway along the length of the specimen and record to the nearest 5 mm.

7.3 Report the moisture condition of the block or specimen.

7.4 The test surface of all specimens, either in the laboratory or in the field, shall be smooth to the touch and free of joints, fractures, or other obvious localized discontinuities to a depth

of at least 6 cm. In situ rock shall be flat and free of surface grit over the area covered by the plunger. If the surface of the test area is heavily textured, grind it smooth with the abrasive stone described in 5.4.

8. Calibration

8.1 Prior to each testing sequence, calibrate the hammer using a calibration test anvil supplied by the manufacturer for that purpose.

8.1.1 Place the calibration anvil in the core holder and conduct ten readings on the anvil.

8.1.2 Calculate the correction factor by dividing the manufacturer's standard hardness value for the anvil by the average of the ten readings taken on the anvil.

NOTE 3—If the instrument reads lower than the manufacturer's standard hardness value, the correction factor will be greater than unity. If the readings are higher, the correction factor will be less than unity.

NOTE 4—Operation of the rebound hammer is satisfactory if the calibration readings fall within the range provided by the manufacturer. If the calibration readings fall outside this range, the instrument must be cleaned, adjusted, or returned to the manufacturer for correction.

NOTE 5—Rebound hammers require periodic servicing and verification to provide reliable results.

9. Procedure

9.1 Place the steel base on a flat, level surface that provides firm, rigid support, such as a concrete floor.

9.2 Securely clamp rock core specimens in a steel cradle with a semicylindrical machined slot of the same radius as the core, or firmly seat into a steel V-shaped block. Securely clamp block specimens to the rigid steel base in such a manner as to prevent vibration and movement of the specimen during the test.

9.3 For tests conducted on specimens in the laboratory, orient the instrument within 5° of vertical with the bottom of the piston at right angles to and in firm contact with the surface of the test specimen. A guide may be used to ensure the rebound hammer is positioned for optimum performance. Position the hammer not less than one diameter from the edge of the specimen.

9.4 For tests conducted in situ on a rock mass, the rebound hammer can be used at any desired orientation provided the plunger strikes perpendicular to the surface tested. The results are corrected to a horizontal or vertical position using the correction curves provided by the manufacturer.

9.5 Before conducting the tests, ensure the hammer is at the same temperature as the test specimens by exposing it to the ambient environmental conditions of the test area (indoors or outdoors) for at least 2 h.

9.6 Compress the hammer spring by gradually depressing the plunger until the hammer is triggered and impact occurs.

9.7 Read and record the height of the plunger rebound to the nearest whole number, as measured on an arbitrary scale of 10 to 100 divisions located on the side of the hammer, before restoring the piston to its original extension. Repeat this procedure at ten representative locations on the specimen. Test locations shall be separated by at least the diameter of the piston and only one test may be taken at any one point.

9.8 If a specimen breaks during rebound testing, energy is absorbed during breakage and, consequently, the rebound

reading will be lower than had it not broken. Any individual impact test that causes cracking or any other visible failure shall cause that test and the specimen to be rejected.

9.9 Some factors that may affect the results of the test include:

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

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

9.9.3 For readings to be compared, the direction of impact, horizontal, upward, downward, and so forth, must be the same.

9.9.4 Different hammers of the same nominal design may give rebound numbers differing from one to three units and therefore, tests should be made with the same hammer in order to compare results. If more than one hammer 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.

10. Calculation

10.1 Using the data from the ten readings obtained in 9.7, discard readings differing from the average of ten readings by more than seven units and determine the average of the remaining readings. To calculate the rebound hardness number (H_R) of the tested rock material, multiply this average by the correction factor determined in 8.1.2 and record the results to the nearest whole number.

11. Report

11.1 Report the following minimum information for each specimen or test area:

11.1.1 Source of samples, including geographic location; boring number, depth, orientation, and stationing; and rock type,

11.1.2 Weathering and alteration condition of samples, particularly when sampling a surface outcrop,

11.1.3 Type of specimen (core, block, or in situ); size and shape of specimen; and, if block type, whether cut or blasted,

11.1.4 Date of sampling and date of testing,

11.1.5 Storage conditions of samples (for example, exposure to temperature extremes, air drying, and moisture changes),

11.1.6 Type and model number of hammer,

11.1.7 Orientation of the plunger axis during the test,

11.1.8 Method of securing the sample (for example, V-block, or clamps),

11.1.9 Number of tests conducted,

11.1.10 Temperature of site at time of test, and

11.1.11 The individual and average values of hammer rebound, the value of the correction factor, and the rebound hardness number, H_R (obtained in 10.1).

12. Precision and Bias

12.1 *Precision*—No data exist to determine the precision of this test method in determining rock hardness.

12.2 *Bias*—There is no accepted standard value for H_R for any material, therefore bias cannot be determined.

13. Keywords

13.1 core; hardness; rock mass; rock; unconfined compressive strength

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1995) that may impact the use of the standard.

(1) Added in section 2.1, D 653 and D 3740 to list of ASTM referenced documents.

(2) Added section 3.1, reference to definitions of terms in Terminology D 653 and changed numbering in section 3 accordingly.

(3) Added the symbol H_R to the definition of rebound hardness number in 3.2.

(4) Added Note 2 caveat regarding use of D 3740 to section 4 on Significance and Use.

(5) Added "record the results to the nearest whole number" to sections 9.7 and 10.1.

(6) Changed wording of section 12.2, Bias, to read, "There is no accepted standard value for H_R for any material, therefore bias cannot be determined.

(7) Changed key words "cores" to "core", "rocks" to "rock", and "test" to "strength".