IS 12608 (1989): rock joints-direct shear strength-laboratory method of determination [CED 48: Rock Mechanics]

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IS 12608 : 1989
( Reaffirmed 2005 )

*Indian Standard*

# METHOD FOR DETERMINATION OF HARDNESS OF ROCK

भारतीय मानक

शिला कठोरता ज्ञात करने की पद्धति

UDC 694·121 : 620·178·1



BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 2

## FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 16 January 1989, after the draft finalized by the Rock Mechanics Sectional Committee had been approved by the Civil Engineering Division Council.

The hardness of rock is dependent on the type and quantity of various mineral constituents of the rock and the bond strength that exists between the mineral grains. Tests have been developed to predict wall strength of discontinuity by correlating [ *see* IS 11315 ( Part 5 ) : 1987 'Method for the quantitative descriptions of discontinuities in rock masses : Part 5 Wall strength' ]. Considerable research has been conducted in the past and is now underway regarding this property of rock. Based on experience gained so far in conducting this test, this standard has been formulated.

Hardness is a concept of material behaviour rather than fundamental material property. Therefore, the quantitative measure of hardness depends on the type of test employed. Three types of tests, that is, indentation, dynamic and scratch are used by various laboratories. Experience shows that indentation tests are not applicable to rock due to its brittle nature. Similarly, scratch tests which are done based on Mohs scale have not been found to be accurate. This standard therefore, covers dynamic or rebound method of test.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( *revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# METHOD FOR DETERMINATION OF HARDNESS OF ROCK

## 1 SCOPE

This standard covers method for determination of hardness of rock.

## 2 REFERENCE

The Indian Standard IS 11315 (Part 5): 1987 'Method for the quantitative description of discontinuities in rock mass: Part 5 Wall strength' is a necessary adjunct to this standard.

## 3 GENERAL

### 3.1 Dynamic or Rebound Tests

Employ a moving indenter to strike the test specimen. Any plastic or yielding material behaviour produced by the impact will reduce the elastic energy available to rebound the indentor. The height of rebound is taken as a measure of the hardness of the material. Two methods are used as mentioned in **3.1.1** and **3.1.2**.

**3.1.1** The Schmidt impact hammer is used for hardness determination of rock. The device which has both field and laboratory uses, consists of a spring-loaded piston which is projected against a metal anvil which is in contact with the rock surface. The height of piston rebound is taken as an empirical measure of hardness. The method is of limited use on very soft or very hard rocks.

**3.1.2** The Shore scleroscope is a laboratory test device that measures hardness by dropping a small diamond tipped indenter on the specimen and measuring its rebound height. Because of the small size of the diamond indenter tip and the heterogeneous nature of most rocks, it is necessary to conduct a large number of rebound tests to obtain an average for a particular material.

## 4 SCHMIDT IMPACT HAMMER METHOD

### 4.1 Apparatus

The apparatus shall consist of the following:

a) The Schmidt hammer which determines the rebound hardness of a test material. The plunger of the hammer is placed against the specimen and is depressed into the hammer by pushing the hammer against the specimen. Energy is stored in a spring which automatically releases at a prescribed energy level and impacts a mass against the plunger. The height of rebound of the mass is measured on a scale and is taken as the measure of hardness. The device is portable and may be used both in the laboratory and field. The Type L hammer having an impact energy of 0·74 Nm shall be used.

b) A steel base of minimum weight 20 kg to which specimens should be securely clamped. Cored specimens should be tested in a steel 'cradle' with a semi-cylindrical machined slot of the same radius as the core, or in a steel V-block (*see* Fig. 1).

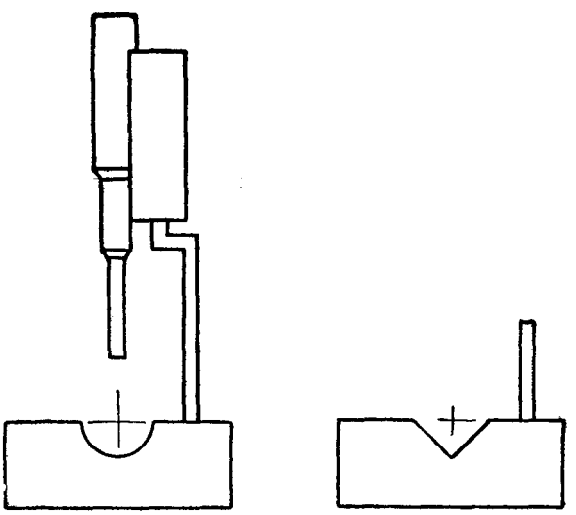

FIG. 1 CORE SPECIMEN HOLDERS

### 4.2 Procedure

**4.2.1** Prior to each testing sequence, the Schmidt hammer should be calibrated using a calibration test anvil. The average of 10 readings on the test anvil should be obtained.

**4.2.2** Specimens obtained for laboratory tests shall be representative of the rock to be studied. When possible, use larger pieces of rock and not less than 50 mm core or having on edge length of at least 60 mm.

**4.2.3** The test surface of all specimens, either in the laboratory or in the field, shall be smooth and flat over the area covered by the plunger. This area and the rock material beneath to a depth of 60 mm shall be free from cracks, or any localized discontinuity of the rock mass.

NOTE — Sometimes flat surfaces are not available in field. In such cases, tests should be conducted at the same spot in which case first three readings should be rejected

**4.2.4** Small individual pieces of rocks, whether tested in the laboratory or in the field, shall be securely clamped to a rigid base to adequately secure the specimen against vibration and movement during the test. The base shall be placed on a flat surface that provides firm support.

**4.2.5** The hardness value obtained will be effected by the orientation of the hammer. It is recommended that the hammer be used in one of the three positions, vertically upwards, horizontally, or vertically downwards with the axis of the hammer at $\pm$ 5° from the desired position. When use of one of the three orientations is not feasible ( as *in situ* testing in a circular tunnel ), the test should be conducted at the necessary angle and the results corrected to a horizontal or vertical position using the correction curves. The hammer orientation for the test and any corrections applied to non-vertical or non-horizontal orientations should be recorded and reported in the results. Corrections to reading shall be done according to IS 11315 ( Part 5 ) : 1987.

**4.2.6** At least 25 individual tests shall be conducted on any one rock sample. Test locations shall be separated by at least twice the diameter of the plunger. Any test that causes cracking or any other visible failure shall cause that test and the specimen to be rejected.

### 4.3 Calculations

**4.3.1** The correction factor is calculated as:

$$\text{Correction factor} = \frac{\text{Specified standard value of the anvil}}{\text{Average of 10 readings on calibration anvil}}$$

**4.3.2** The measured test values for the sample should be tabulated in descending order. The lower 50 percent of the values should be discarded and the average obtained of the upper 50 percent values. This average shall be multiplied by the correction factor to obtain the Schmidt rebound hardness.

### 4.4 Reporting of Results

The following information shall be reported:

a) Lithologic description of the rock; source of sample, including geographic location, depth and orientations.

b) Type of specimen ( core, blasted or broken sample, *in situ* ); size and shape of core or block specimen.

c) Date of sampling, date of testing and condition of storage ( that is, exposure to temperature extremes, air drying moisture, etc ).

d) Orientation of the hammer axis in the test.

e) Method of clamping sample ( V-block or clamps ).

f) The Schmidt hardness value obtained as in **4.3**.

## 5 THE SHORE SCLEROSCOPE METHOD

**5.1** This laboratory method is suggested for hardness determination of rock minerals using the Shore sclerescope and for the verification of other scleroscope hardness instruments. Rock hardness may be obtained as an average of readings taken at random on individual mineral grains.

### 5.2 Apparatus

**5.2.1** The instrument used for determining scleroscope hardness number is supplied in two models designated Model C and Model D. Model C-2 is recommended for use with rock.

a) The Scleroscope Model C consists of vertically disposed barrel containing a precision bore glass tube. A scale graduated from 0 to 140 mm is set behind the barrel and is visible through the glass tube. A pneumatic actuating head, affixed to top of the barrel, is manually operated by a rubber bulb and tube. A hammer drops from specified height and rebounds within the glass tube. The hammer for Model C shall have the following dimensions:

| | |
|---|---|
| Diameter | 5·94 mm |
| Mass | 2·300+0·500 g |
| Overall length | 20·7 to 21·3 m |
| Distance hammer falls | $251{\cdot}2^{+0{\cdot}13}_{-0{\cdot}38}$ mm |

b) The diamond shall be shaped to produce a correct reading on reference bars of known hardness. In profile, the diamond is convex, having a radius terminated by a flat striking surface, as shown in Fig. 2. The flat striking surface is approximately circular and from 0·01 to 0·4 mm in diameter, depending on the hardness and other physical characteristic of the diamond.

**5.2.2** The following procedure should be followed:

a) Before and after each day's use, make at least five hardness readings on the standard test block furnished by the manufacturer at the hardness level at which the machine is being used. If the values fall within the range of the standardized hardness test block, the instrument may be regarded as satisfactory; if not, the machine should

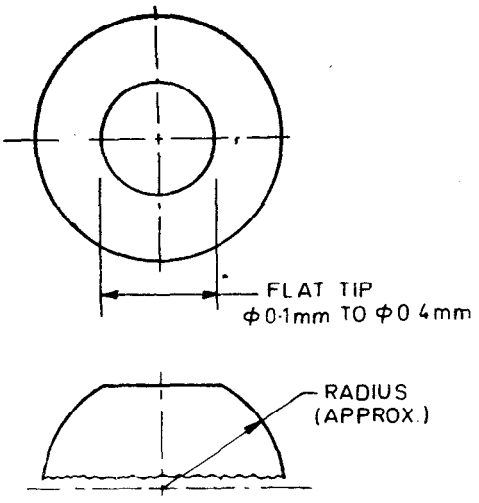


FIG. 2 PROFILE OF SCLEROSCOPE DIAMOND SHOWING RANGE OF DIAMETERS

be verified using procedure recommended by the manufacturer.

b) Tests shall be made on flat surface ground smooth using No. 1800 grade aluminium oxide abrasive powder. An excessively coarse surface will yield low and erratic readings.

c) Specimens should have a minimum test surface of 100 $mm^2$ and a minimum thickness of 10 mm. Small specimens should be clamped securely with the flat test surface perpendicular to the scleroscope axis.

d) To perform a test, hold or set the instrument in a vertical position with the bottom of the barrel in firm contact with test specimen and normal to the surface of the specimen. Bring the hammer to the elevated position by squeezing the rubber bulb and then allow it to fall and strike the test surface and measure the height of rebound. The height to which the hammer rebounds on the first bounce indicates the hardness of the material.

e) To prevent errors resulting from misalignment, the instrument must be set or held in a vertical position, using the plumb bob or spirit level on the instrument to determine verticality. The most accurate readings of the scleroscope are obtained with the instrument mounted in a clamping stand. Lateral vibration must be avoided since they tend to cause the free fall of the hammer to be impeded and hence cause the instrument to read low.

f) An error may result if the indentations are spaced too closely together.

Space indentations at least 5 mm apart and make only one test at the same spot. At least 25 hardness determinations should be taken.

**5.2.3** *Calculations*

The Shore scleroscope hardness shall be the average of not less than 25 measurements made on the same specimen using the above method.

**5.2.4** *Reporting of Results*

The report should include the following information on each specimen tested:

a) Lithologic description of the rock; source of the sample including geographic location, depth and orientations.

b) Approximate mineral composition and grain sizes of the rock specimen.

c) Date of sampling, date of testing, storage conditions and specimen preparations procedures.

d) Orientation of the test surface with respect to bedding or foliation planes when these are significant characteristics of the rock.

e) The number of tests conducted and the average shore hardness.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
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|---|---|
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| Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054 | 36 24 99 |
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