Rebound Hammer Test for Assessment of Weatheribility and Corresponding Rebound Hardness of Deccan Trap Basalt, near Indore

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ABSTRACT

To achieve the main objectives of the present investigation, a carefully planned study have been carried out in field and laboratory. Field study involves general observations on the weathering pattern and other weakening features in the basalt rock have been studied at open cast basalt querry mines around Indore. Basalt rock samples have been collected from vertical walls of these mines at different depths, convert these samples into cylindrical shaped and Schmidt Hammer Rebound Hardness Test were conducted on these specimens. The results were analyzed, compared, and classified according to several internationally known classification systems.

Key Words: Rebound hammer, non-destructive tests, basalt core samples.

1. INTRODUCTION

The rebound hammer test is one of the non-destructive tests used to check the compressive strength of rocks. An empirical relationship has been determined between the absorbed by the rock when given a high impact and its compressive strength. The rebound hammer is designed to carry out instant non-destructive test on rock structure without damage and gives an immediate indication of the compressive strength of the rock using the calibration curve applied each instrument. The hammer is simply pressed firmly against the concrete whereupon a powerful internal spring is first compressed and thin tripped to deliver a hammer blow through the hardened concrete trip to the surface being test. A numerical value of hardness is as much a function of the kind of test used as it is a material property.

In general, hardness implies the resistance to deformation. Richards (1961) defines technological hardness as "the resistance of a material to permanent deformation of its surface." When metals are deformed or indented the deformation is predominantly outside the elastic range and often involves considerable plastic or permanent deformation. However, in dynamic hardness measurements, the elastic properties may be as important as the plastic properties. In all types of hardness, the properties of toughness, resilience, strength, and elasticity are involved to some degree.

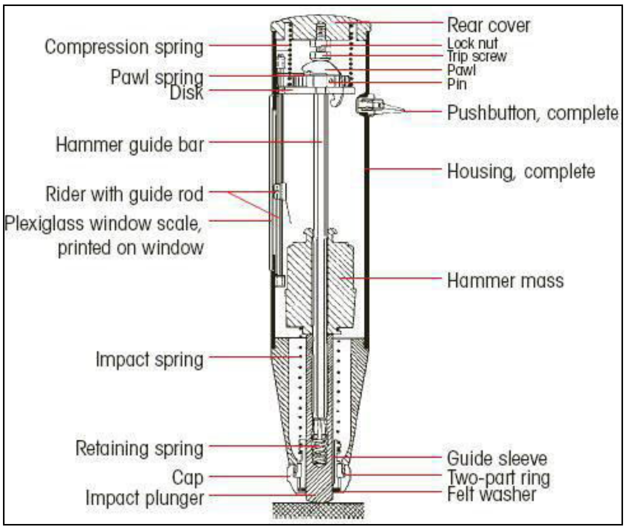

Figure 1: Working principle of a Schmidt Hammer.

With its portable, simple and affordable attributes, the Schmidt hammer (SH) is an ideal index apparatus, which underlies its increasing popularity and expanding range of applications. The SH rebound hardness value (R) is perhaps themost frequently used index in rockmechanics practice for estimating the uniaxial compressive strength (UCS) and the modulus of elasticity (E) of intact rock both in laboratory conditions and in situ. The SH is also widely used for estimating the UCS of discontinuity walls and assessing the workability, excavatability and boreability of rocks by mechanical means (cutting, polishing, milling, crushing and fragmentation processes in quarrying, drilling and tunneling).

Rock hardness is considered to consist of the resistance of rock to the displacement of surface particles by a tangential abrasive force, as well as its resistance to a normal, penetrating force, whether static or dynamic. Rock hardness depends on substantially the same factors as toughness. Toughness is governed by the efficiency of the matrix in binding together the grains or minerals comprising the bulk of the rock. . In addition, rock toughness is a function of the grain strength or mineral toughness. The toughest rocks comprise those having strong minerals embeded in a strong matrix(Shcpherd, 195l). Both hardness and toughness depend on the type of binding forces between atoms, ions, or molecules and increase, like strength, with the magnitude of those forces. Both properties are also closely related to the yield strength of the material.

2. FIELD STUDY- DATA COLLECTION

Aimed at a considerate of design of weathering, comprehensive field studies were showed concluded some vertical soil-rock profiles at different locality have been studied and total numbers of 45 samples have been collected. Sample of Deccan trap basalt which cover entire study area have been collected at various depths from the surface in road aggregate queries. In general, the upper zone of weathering profiles are characterized by core stones with exfoliation features. They are quite widespread even in residual soil zones. Excessive amount of ferromagnesian minerals results intense leaching and staining to the complete weathering profile. Residual soil reflects reddish brown colour with varying orange to yellow shades. Mature soils are also present as black cotton soils nearly at all locations. The overall distribution of weathering in a typical profile of basalt can be attributed to heterogeneous pattern, with some exceptions.

3. SAMPLE PREPARATION

To measure or evaluate any property of basalt, suitable specimens needed to be prepared. The suggested test procedure by many authorities worldwide, such as the American Society for Testing & Materials (ASTM) or International Society of Rock Mechanics (ISRM), cylindrical specimens extracted either in-situ or in the laboratory. For this study, rock specimens were prepared by means of laboratory equipment, such as the laboratory rock coring drill, the commercial diamond impregnated rock saw, a universal specimen grinding machine, and other necessary accessories.

The pattern of weathering was studied and the information on weathering profiles was gathered as per existing procedures and guidelines suggested by the concerned professional societies like International Society for Rock Mechanics (ISRM, 1981a), International Association of Engineering Geology (IAEG 1981), Geological Society of London (Anon, 1977,1995) & some researchers (Hencher & Martin, 1986, de Freitas & Lee, 1989). Depending upon the suitability, these guidelines were used directly and in some case after few alterations. Detailed examination of the exposed bedrock at several weathering profiles was carried out at material and mass scale.

In order to obtain valid test results from the various performed tests on collected materials, cautious & specific example preparation is necessary. Rock samples have been collected from the vertical profiles of road aggregate queries. Naming of all collected samples have been done in filed itseff and a log chart also prepared for future use. Large size samples are cut by hand core drill machine for preparing core samples but weak samples are further broken in to pieces, such weak samples cut by hand rock cutter machine for preparing cubical sample. After cutting of sample (either core or cubical), weste materials further crushed to convert aggregate and passed from 4.75 sieve. Retained materials on 4.75 sieve collected and store for specific gravity, abrasion value, impact value test ect. In some locations upto some depth, only soil found and such soil collected for grain size analysis curve. Laboratory coring has been done by thin walled rotary diamond drill bits, diameter of core can vary since 35 mm towards 150 mm.

4. MATERIAL IDENTIFICATION

Generally, the climatic phase is continuous and gradational, with each phase of the climate continuously following the next stages of the weather. The study area located in the south of the city of Indore has almost one-dimensional geology and has consistently reported three stratigraphic units of the Deccan trap. Basalt, which is part of the Lower Trap (Cretaceous to Lower Eocene), encompasses the entire region, and often includes quaternary alluvial and black cotton soil. Lematas (Upper Cretaceous) & Gondwana rocks are found in some places, but are not revealed near the studied site.

5. LABORATORY ANALYSIS

The SH consists of a spring-loaded piston which is released when the plunger is pressed against a surface (Figure 2). The impact of the piston onto the plunger transfers the energy to the material. The extent to which this energy is recovered depends on the hardness (or impact penetration/damage resistance) of the material, which is expressed as a percentage of the maximum stretched length of the key spring before the release of the piston to its length after the rebound.

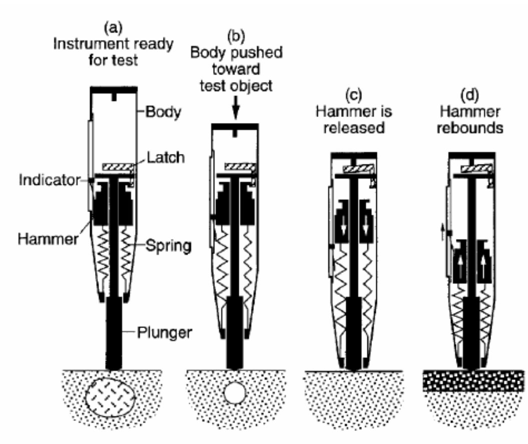

Figure 2 : Operation of the Rebound hammer

Figure 3: Performing Rebound Hammer Test on core samples.

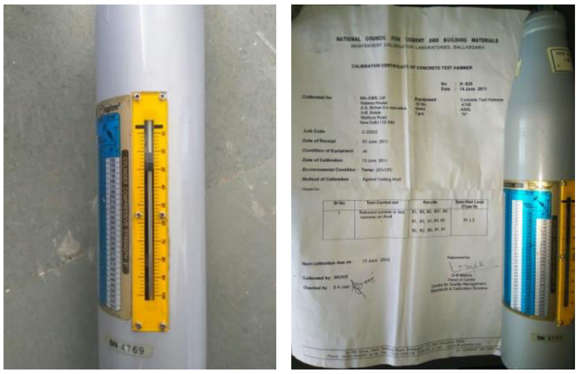

Figure 4: Rebound hammer test apparatus and its calibration chart

6. CALCULATION

Rebound hammer test is carried out on numbers of basalt cores as per the specification of test hammer and rebound values of each test have been noted then average of all values have been taken for measurement. Calibration chart (figure 6) has been used to calculate Rebound Index. Details of number of tests and average values has been shown in table 1

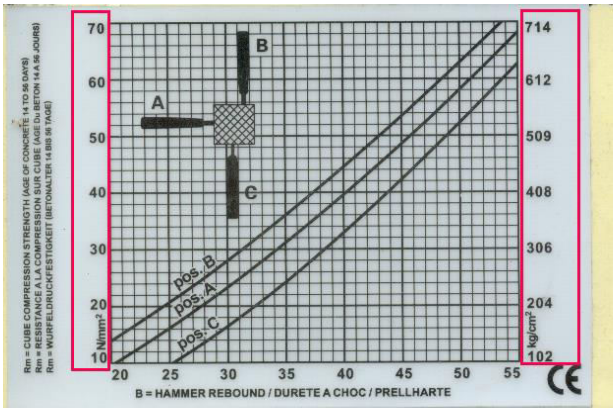

Figure 6: Calibration chart (Position B is used)

An N-type Schmidt hammer (Amil Model No H:535, Sl.No 4769) was utilized for the test over saw cut surfaces of chunk sized Deccan basalt rock samples which was collected from various locations. Minimum two surfaces were selected for the rebound test from each sample and at least 8-10 readings were taken. Horizontal position of the flat surface was ensured in each test to neglete the angle of correction. The test procedure given by ISRM (1978c) and few important ideas given by Poole and Farmer (1981) and McCaroll (1992), reading its repetition and applications for the weathered rocks, were followed in obtaining the R- value.

7. TEST RESULTS

Average rebound number is calculated and revised (if required) rejecting the values with a difference of 5 units or more from the average. Details of test data and calculation of average rebound number for both hammer position can be found. Rock core samples are tested at various depths as shown in table 1 against various proposed grades of weathering. At every depth at least 8-9 samples are tested and average values of RH is noted, against RH values , compressive strength is obtained from calibration chart as shown in figure 6.

Table 1: Average Rebound Hardness (kg/ cm^2) at various Weathering Grades

S. No.	Proposed Weathering Grade	Nos of Sample Tested	Average Rebound Value (R)	Average Rebound Hardness (kg/ cm^2)
01	V	10	21.15	161.22
02	IV	08	25.23	215.06
03	III	08	27.76	252.93
04	II	09	31.31	307.14
05	I	10	36.05	384.94
Total	--	45		--

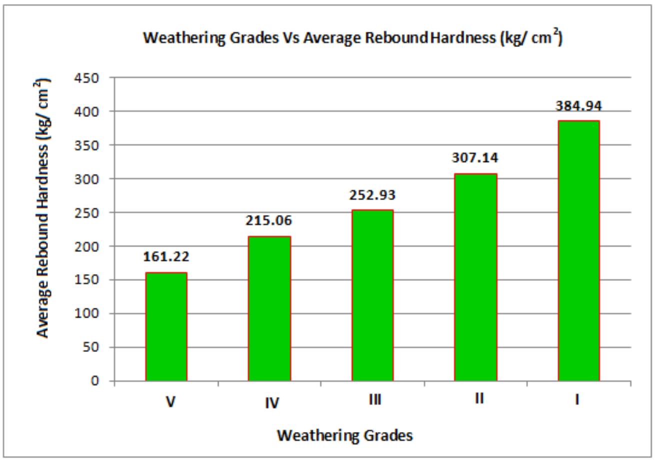

Figure 7: Graphical representation of test result

8. ADVANTAGES AND DISADVANTAGES OF REBOUND HAMMER TEST

The advantages of Rebound hammer tests are:

- Apparatus is easy to use.
- Determines uniformity properties of the surface.
- The equipment used is inexpensive.
- Used for the rehabilitation of old monuments.

The disadvantages of Rebound Hammer Test

- The results obtained is based on a local point.
- The test results are not directly related to the strength and the deformation property of the surface.
- The probe and spring arrangement will require regular cleaning and maintenance.
- Flaws cannot be detected with accuracy

9. CONCLUSION

Rebound hammer is a handy and portable device and its operation is simple. Rebound hammer method, therefore, can be a suitable and convenient way for field identification of bricks and estimating their compressive strength. But this method does not give true value of strength and hence its application should be limited for inspection purpose only.

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