NON-DESTRUCTIVE TESTING BY REBOUND HAMMER METHOD

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Abstract: **Non destructive testing is a form of testing to be carried out on various construction members and materials without causing any permanent damage to' them. As NDT is used in concrete, it can also be used very effectively for other building members and materials. This paper covers case study of NDT on concrete as well as other elements of building. Concrete has been used in construction industry for its compressive strength and for protection of reinforcement of steel.**

Keywords: **NDT INTRODUCTION, METHODS OR TECHNIQUES, COMPRESSIVE STRENGHT, REBOUND HAMMER**

1. Introduction

Non-destructive testing (NDT) methods are techniques used to obtain information about the properties or internal condition of an object without damaging the object. Non-destructive testing is a descriptive term used for the examination of materials and components in such way that allows materials to be examined without changing or destroying their usefulness. NDT is a quality assurance management tool which can give impressive results when used correctly. It requires an understanding of the various methods available, their capabilities and limitations, knowledge of the relevant standards and specifications for performing the tests. NDT techniques can be used to monitor the integrity of the item or structure throughout its design life.

2. NDT METHODS / TECHNIQUES

The various Non destructive / partial destructive tests are as below

Group - A: Non Destructive Tests for Concrete

- Surface Hardness Tests – Rebound Hammer Test
- Ultrasonic Pulse Velocity Test

Group - B: Partially Destructive Tests for Concrete

- Penetration Resistance Test (Windsor Probe)
- Pull-out Test
- Pull-off Test
- Break-off Test
- Core Cutting

3. SCHMIDT'S REBOUND HAMMER TEST OBJECTS

The rebound hammer method could be used for:

- Assessing the compressive strength of concrete with the help of suitable co-relations between rebound index and compressive strength
- Assessing the uniformity of the concrete
- Assessing the quality of concrete in relation to the standard requirements
- Assessing the quality of one element of concrete in relation to another.(1)

Principle of test: The test is based on the principle that the rebound of an elastic mass depends on the hardness of the surface upon which it impinges. When the plunger of the rebound hammer pressed against the surface of the concrete, the spring controlled mass rebounds and the extent of such rebound depend upon the surface hardness of concrete. The surface hardness and therefore the rebound is taken to be relation to the compressive strength of concrete. The rebound is read off along a graduated scale and is designated as the rebound number or rebound index.

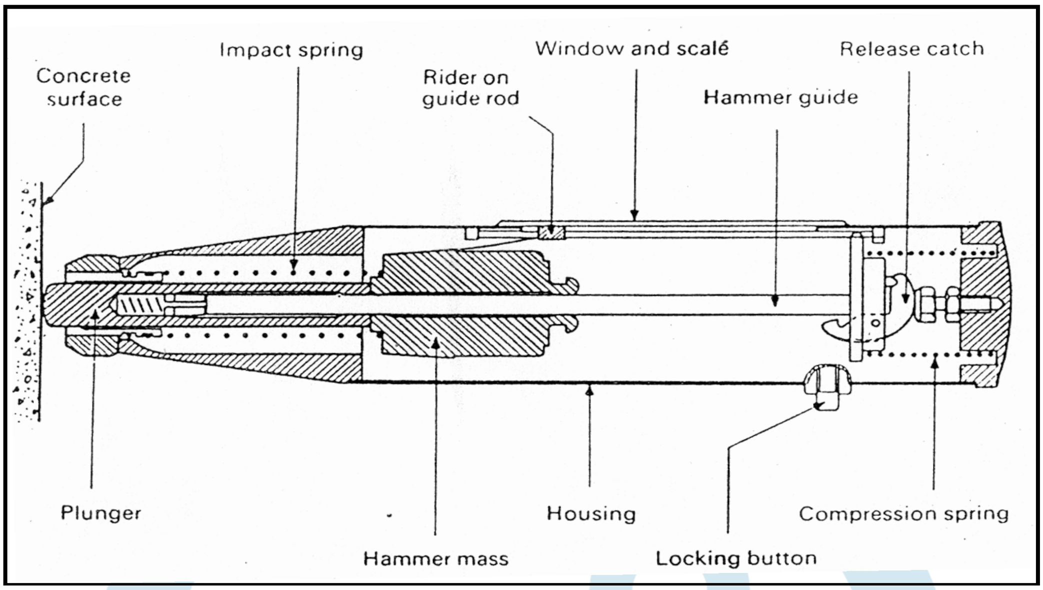

Fig.1: Basic Features of Rebound Hammer

Working of rebound hammer: A schematic cut way view of schmidt rebound hammer is shown in fig. 1. The hammer weight about 1.8 kg., is suitable for use both in a laboratory and in the field. When the plunger of rebound hammer is pressed against the surface of concrete, a spring controlled mass rebounds and the extent of such rebound depends upon the surface hardness of concrete.

The rebound distance is measured on a graduated scale and is designated as rebound number. Basically, the rebound distance depends on the value of kinetic energy in the hammer, prior to impact with the shoulder of the plunger and how much of that energy is absorbed during impact. The energy absorbed by the concrete depends on the stress-strain relationship of concrete. Thus, a low strength low stiffness concrete will absorb more energy than high strength concrete and will give a lower rebound number.

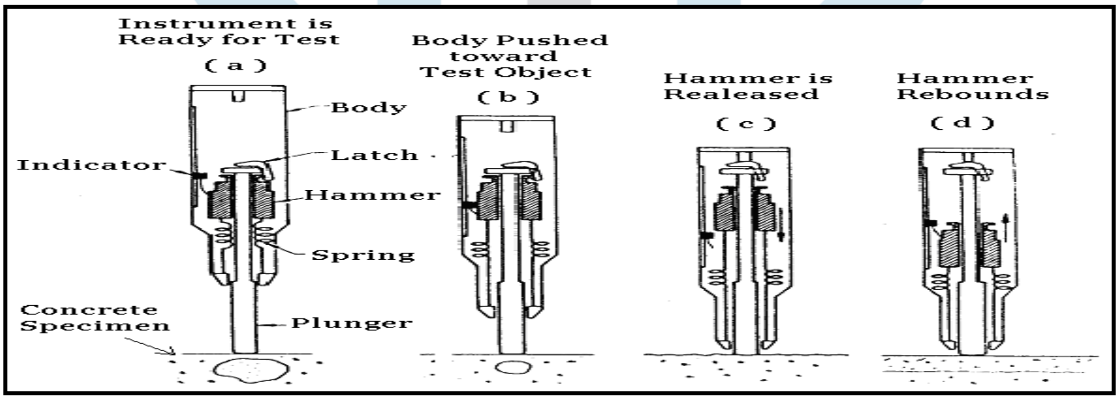

Fig.2: Schematic Cross Section of Rebound Hammer & Principle of Operation

Method of testing (operation)

1. To prepare the instrument for a test, release the plunger from its locked position by pushing the plunger against the concrete and slowly moving the body away from the concrete. This causes the plunger to extend from the body and the latch engages the hammer mass to the plunger rod.
2. Hold the plunger perpendicular to the concrete surface and slowly push the body towards the test object. (The surface must be smooth, clean and dry and should preferably be formed, but if trowelled surfaced are unavoidable, they should be rubbed smooth with the carborundum stone usually provided with the equipment. Loose material can be ground off, but areas which are rough from poor compaction, grout loss, spalling or tooling must be avoided, since the results will be unreliable).

3. As the body is pushed, the main spring connecting the hammer mass to the body is stretched. When the body is pushed to the limit, the latch is automatically released and the energy stored in the spring propels the hammer mass towards the plunger tip. The mass impacts the shoulder of the plunger rod and rebounds.

4. During rebound, the slide indicator travels with the hammer mass and records the rebound distance. A button on the side of the body is pushed to lock the plunger in the retracted position and the rebound number is read from the scale.

   The test can be conducted horizontally, vertically upward or downward or at any intermediate angle. Due to different effects of gravity on the rebound as the test angle is changed, the rebound number will be different for the same concrete. This will require separate calibration or correction charts, given by the manufacturer of the hammer.

Correlation procedure: Each hammer is provided with correlation curves developed by the manufacturer using standard cube specimens. However, the use of these curves is not recommended because material and testing conditions may not be similar to those in effect when the calibration of the instrument was performed. A typical correlation procedure is given as below:

1. Prepare a number of 150 mm cube specimens covering the strength range to be encountered on the job site. Use the same cement and aggregates as are to be used on the job. Cure the cubes under standard moist curing room conditions.
2. After capping, place the cubes in a compression testing machine under an initial load of approximately 15% of the ultimate load to restrain the specimen. Ensure that cubes are in saturated surface dry conditions.
3. Make 5 hammer rebound readings on each of four moulded faces without testing the same spot twice and minimum 20 mm gap from edges.
4. Average the readings and call this the rebound number for the cube under test.
5. Repeat this procedure for all the cubes.
6. Test the cubes to failure in compression and plot the rebound numbers against the compressive strength on a graph.
7. Fit a curve or a line by the method of least squares.

   It is important to note that some of the curves deviate considerably from the curves supplied with the hammer.

Limitations: Although the rebound hammer provides a quick inexpensive means of checking the uniformity of concrete, it has serious limitations and these must be understood clearly for interpretation of test results.

Factors affecting rebound number

The results of Schmidt rebound hammer are significantly influenced by the following factors

(a) Smoothness of Test Surface
(b) Size, Shape and Rigidity of the Specimen
(c) Age of Test Specimen
(d) Moisture Condition
(e) Type of Coarse Aggregate
(f) Type of Cement
(g) Type of Mould
(h) Surface Carbonation

Influence of these factors has different magnitudes. Hammer orientation will also influence the measured values, although correction factors can be used to allow for this effect.

Precautions to be taken while using rebound hammer: The following precautionary measures are taken while using the rebound hammer which may give rise to minimize error

- The surface on which the hammer strikes should be smooth and uniform. Moulded faces in such cases may be preferred over the Trowelled faces.
- The test hammer should not be used within about 20 mm from the edge of the specimen.
- Rebound hammer should not be used over the same points more than once.
- The rebound test must be conducted closely placed to test points; on at least 10 to 12 locations while taking the average extremely high and low values of the index number should be neglected.

4. CONCLUSION

In the era of 20th century rapid technology development is an essential part of our work for quality assurance. While taking concrete in mind, it is a versatile construction material and one of the most commonly used composite material in today's construction industry. A proper technology for making concrete starts with good knowledge of concrete materials; it's judicious selection, proportioning, mixing, placing, compaction and curing. This has to be supported with advanced testing technologiesso as to assure the safety and durability of structure with ease and perfection.

REFFENCES:

[1] Akashi,T., & Amasaki, S. (1984).Study of the Stress Waves in the Plunger of a Rebound Hammer at the Time of Impact. Detroit:American Concrete Institute.
[2] Concrete Institute of Australia. (2008). *Nondestructive Testing of Concrete.*
[3] Concrete Institute of Australia. (2008). Nondestructive Testing of Concrete. Sydney: Concrete Institute of Australia.
[4] Kolek, J. (1969). Non-destructive testing of concrete by hardness methods. London: Institute of Civil Engineers.
[5] Malhotra, V. (2004). Surface Hardness Methods.In V. Malhotra, & N. Carino, Handbook onNondestructive Testing of Concrete (pp. 1-9).New York: CRC Press.
[6] Naik, T., Malhotra, V., & Popovics, J. (2004). The Ultrasonic Pulse Velocity Method. In V. Malhotra, & N. Carino, Handbook on Nondestructive Testing of Concrete (pp. 84-97). New York: CRC Press.
[7] Shetty.MS (2010).Concrete Technology.S.Chand& Company, New Delhi.
[8] Stanley, J. (1995). Nondestructive Testing Handbook 9: Special Nondestructive Testing Methods. Columbus: American Society of Nondestructive Testing.
[9] Sydney:Concrete Institute of Australia. Schmidt E. (1950) „Rebound hammer for concrete testing (Der Beton-Prufhammer)", Schweizerische Bauzeitung, 15. Juli 1950, 68. Jahrgang, Nr. 28, pp. 378-379. (in German)
[10] Workman, G., & O. Moore, P. (2012). Nondestructive Testing Handbook 10: Overview. Columbus: American Society of Nondestructive Testing.