

# Concrete Quality Assessment by Using Non-Destructive Test

Nikhil Mulik <sup>1</sup>, Sujata Deo <sup>2</sup>, Kartik Dhumal <sup>3</sup>, Vaibhav Ghaywat <sup>4</sup>

<sup>1,2</sup>Assistant Professor, Dept. of Civil Engineering, Indira College of Engineering and Management, Pune, Maharashtra, India

<sup>3,4</sup>Undergraduate Student, Dept. of Civil Engineering, Indira College of Engineering and Management, Pune, Maharashtra, India

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**Abstract** - Structures are members that are capable of safely transferring superimposed load directly to foundation. Their main and most looked after property is the strength of the material that they are made of. Concrete is the integral material which is used for construction purposes. The concept of non-destructive testing (NDT) is to obtain material properties of in place specimens without destruction neither the specimen nor the structure from which it is taken. As compared to other methods this method produces results that lie close to the true values. Rebound hammer and strength of concrete are then correlated, which can be used as well for strength estimation of concrete structures. Test of existing structures by taking direct measurements on concrete elements can be done by extending the method. The need of evaluation the in-situ mechanical properties of the concrete together with the seismic vulnerability assessment were the reasons of carrying out such amount of test. For purpose of quality control and in-situ concrete strength estimation method like non-destructive, surface hardness method and ultrasonic method are used. For purpose of extraction of cylindrical specimen from some structural element the destructive method to determine strength is employed. Experimental data relationship can be obtained from a given concrete. And also this relation is dependent on factors that affect the concrete surface such as degree of saturation, carbonation, temperature, surface preparation and location, and type of surface finish.

is kept, and also durability and performance of the infrastructure in each country, early and regular quality assurance can be established during and after the construction of new structures and after reconstruction processes and the characterization of material properties and damage as a function of time and environmental influences is more and more becoming a serious concern. NDT methods in general are widely used in several industry branches. Aircrafts, nuclear facilities, chemical plants, electronic devices and other safety critical installations are tested regularly with fast and reliable testing technologies. Therefore, the objective of this project is to study the applicability, performance, availability, complexity and restrictions of NDT.

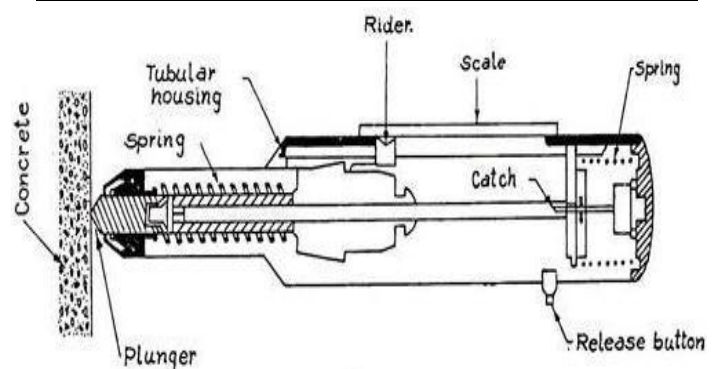
**Table 1:** Rebound Hammer types, impact energy and grade of concrete

Hammers type	Grade / Type of concrete	Impact energy (N-m)
N	M-15 to M-45	2.2
L	Light weight concrete	0.75
M	Mass concrete	30
P	Below M-15	<2.2

**Key Words:** Non-destructive Testing, Rebound Hammer Test, Rebound Number, Impact Energy, Compressive Strength.

## 1. INTRODUCTION

To keep a high level of structural safety, durability and performance of the infrastructure in each country, an efficient system for early and regular structural assessment is urgently required. The quality assurance during and after the construction of new structures and after reconstruction processes and the characterization of material properties and damage as a function of time and environmental influences is more and more becoming a serious concern. It is also helpful in Detecting cracks, voids, fractures, honeycombs, weak location and actual condition of reinforcement. High level of structural safety



**Fig -1:** Schmidt Rebound Hammer

## 2. TEST METHODOLOGY

The Rebound hammer test The Schmidt rebound hammer is basically a surface hardness test with little apparent theoretical relationship between the strength of

concrete and the rebound number of the hammer. Rebound hammers test the surface hardness of concrete, which cannot be converted directly to compressive strength. The method basically measures the modulus of elasticity of the near surface concrete. The distance travelled by the mass, expressed as a percentage of the initial extension of the spring, is called the Rebound number. Simple and handy tool, which can be used to provide a convenient and rapid indication of the compressive strength of concrete. It consists of a spring controlled mass that slides on a plunger within a tubular housing.

### 2.1 Principle

This test is based on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges. In rebound hammer test, a spring loaded mass has a fixed amount of energy imparted to it by extending the spring to a fixed position. This is achieved by pressing the plunger against the surface of concrete under test. Upon release, the mass rebounds from the plunger, still in contact with concrete surface and the distance traveled by the mass expressed as the percentage of the initial extension of spring is called the rebound number.

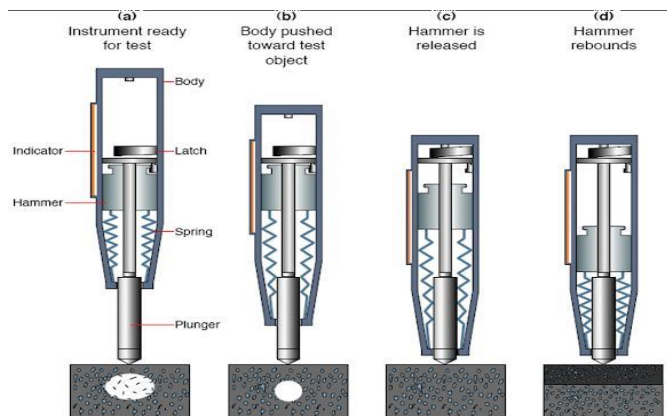


Fig -2: Working Diagram of Rebound Hammer

Table 2: Impact Energy of Rebound Hammers (As per IS 13311 Part 2)

S. No.	Applications	Approximate impact energy required for rebound hammers (N·m)
1.	For testing normal weight concrete	2.25
2.	For light weight concrete or small and impact sensitive part of concrete	0.75
3.	For testing mass concrete i.e. in roads, airfield pavements and hydraulic structures	30.00

### 2.2 Procedure for Testing

- [1] The plunger is pressed against the concrete surface to be tested and the pressure is applied on it. The spring loaded mass called the hammer is loaded with a fixed amount of energy and upon release the hammer strikes against the plunger and rebounds. The rider is clamped and the rebound is measured on the graduated scale by the rider. The reading on the scale is termed as rebound number. The higher the rebound, stronger the concrete.
- [2] The rebound number is an arbitrary quantity and correlation between this and concrete strength depends on the mechanical characteristics of the instrument.
- [3] The test must be performed on a smooth spot, free from honeycomb and if necessary, the spot is smoothed by rubbing with silicon carbide stone.

### 3. READING THE RESULTS

After taking 10 - 12 readings from a concrete surface, discard the highest and lowest rebound numbers. Average the remaining numbers. Use this average rebound number to estimate the strength of the concrete. Compare your average rebound number to the chart shown on your rebound hammer.

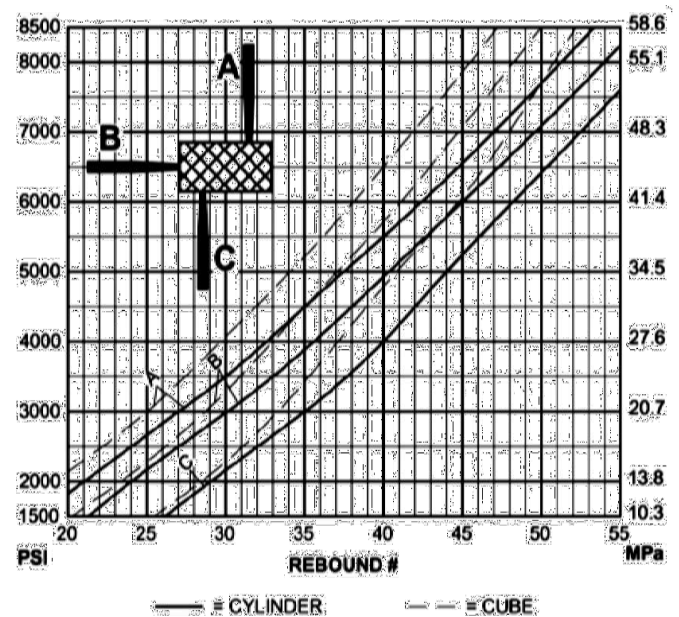


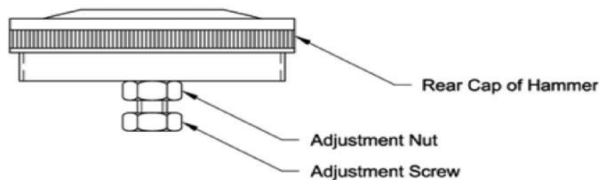
Fig -3: Concrete Rebound Hammer correlation curves

- A - Refers to using the Rebound Hammer against a concrete floor (downward).
- B - Refers to using it against a concrete wall (forward).
- C - Refers to using it against a concrete ceiling (upward).

#### 4. CALIBRATION OF REBOUND HAMMER

When tested against the Anvil, the impact energy level of the Rebound Hammer must be 1.64 foot-pounds or 0.227 kilograms-meter and the rebound number must be a value of  $80 \pm 2$ . As the Rebound Hammer approaches 2,000 uses, it may start to read outside of the range of  $80 \pm 2$  on the test Anvil. At this point you should calibrate it.

- [1] With the piston fully extended, twist the cap on the top of the Rebound Hammer to open it. Keep your hand positioned on the top of the cap, as you will feel some slight spring compression pushing against the cap. Set the Rebound Hammer aside and examine the cap. The cap has an adjustment screw and nut, which are used to calibrate the Rebound Hammer.
- [2] Using a 10 mm wrench, loosen the adjustment nut away from the cap. If the Rebound Hammer is reading low, tighten the adjustment screw (clockwise) into the cap. If the Rebound Hammer is reading high, loosen the adjustment screw (counter clockwise) away from the cap. When you are finished, tighten the adjustment nut to lock the screw in this new position.
- [3] Put the Rebound Hammer back together, and test it on the Anvil again to get a calibrated reading. If it reads  $80 \pm 2$ , the Rebound Hammer is calibrated. If the readings fall outside of this range, take the Rebound Hammer apart and try to adjust it again. Keep adjusting and testing the Rebound Hammer until it reads  $80 \pm 2$ .



**Fig -4:** Nut adjustment in Rear Cap of Hammer

#### 5. LIMITATIONS

- [1] Smooth Surface is preferred for testing. Textured concrete cannot be investigated.
- [2] Jerking acts as a major issue for small concrete structures, it should be supported in an unyielding manner.
- [3] Reading will be reduced if it is taken at a distance less than 2inch from the edge of the concrete member.
- [4] The plunger should be always perpendicular to the desired concrete surface on which the test is performed. But the vertical position of the hammer will affect the rebound number. This is because of the gravitational force on the plunger.
- [5] Test gives versatile reading on the same concrete also, this is because of the immediate presence of a large piece of aggregate under the plunger, this may increase

the rebound number and if a void is present under the plunger, it may result in low rebound number.

#### 6. CONCLUSIONS

- [1] Considerable engineering judgment is needed to properly evaluate a measurement. Misinterpretation is possible when poor contact is made. For example, in some cases it may not be possible to identify corroded reinforcing bar in poor quality concrete. However, it is possible to identify poor quality concrete which could be the cause of reinforcing bar problems. The poor quality concrete allows the ingress of moisture and oxygen to the reinforcing bars, and hence corrosion occurs.
- [2] The final results were compared with previous ones from literature and also with actual results obtained from samples collected from existing structures.
- [3] The use of the combined methods increases the accuracy of the estimation of the in situ compressive strength.
- [4] The mechanical properties of steel structural members are assumed to be SS400 grade steel by hardness or chemical compositions in the non-destructive test and meet the design specification.
- [5] Based on the performance evaluation procedure of steel structural members, the performances of structural members of the building steel structure for reuse are verified.

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