Non-Destructive tests (In site tests)

1-Rebound Hammer (Schmidt hammer)

Rebound Hammer is also called as **Schmidt hammer** or **Concrete hammer test**. This NDT method is used to detect the strength of concrete or rock, by identifying the hardness or elastic property.

Principle of Rebound Hammer Test.

Schmidt's hammer test is based on the principle of "rebound of a spring loaded mass depends on the hardness of the concrete mass on which the hammer strikes". This rebound distance of the rebounded Plunger mass is noted down in the graduated scale. The graph in the hammer body is used to determine the corresponding compressive strength. The concrete with low energy and low stiffness absorbs more energy from plunger and produces a low rebound value on the scale.

Objective of Hammer rebound test :

- To estimate the compressive strength of concrete.
- To compare the quality of two different concrete pours.
- To assess the quality of concrete against the requirements of construction standards.
- To detect the locations of voids or weakness.

How to do Concrete Hammer Test:

Step 1 : Calibration

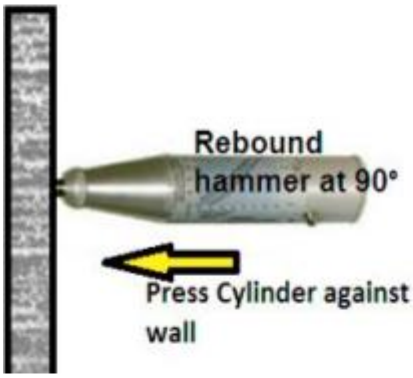
Carry out rebound test on a calibrated sample, supplied by the manufacturers. The sample would be made of steel with a hardness value of approximately 5000N/mm^2. The rebound hammer should give reliable results. If the results are positive, proceed with the inspection procedures. If not, then send the instrument for re-calibration to the manufacturer.

Step 2 : Surface Preparation

The tested surface should be smooth clean and dry. The loosely adhering husk should be grinded off using grinding wheel or stone. Rough surfaces resulting from incomplete compaction or mortar shortage. Spalled or notched surfaces do not give reliable results and should be avoided. The point of impacting the rebound hammer should be at least 20mm away from edges or corners of concrete.

Step 3 : Testing

Hold the Rebound Hammer at a correct angle to the test surface, with the plunger facing towards the test location. Press the plunger against the concrete, and push the body of the hammer towards the concrete. The pressure causes the lock to release and make an impact on the concrete. The rebound is measured by the pressure mass acting on the spring.



The measured value is Rebound Index which is checked in the graph for its corresponding Compression Strength in N/mm^2 .

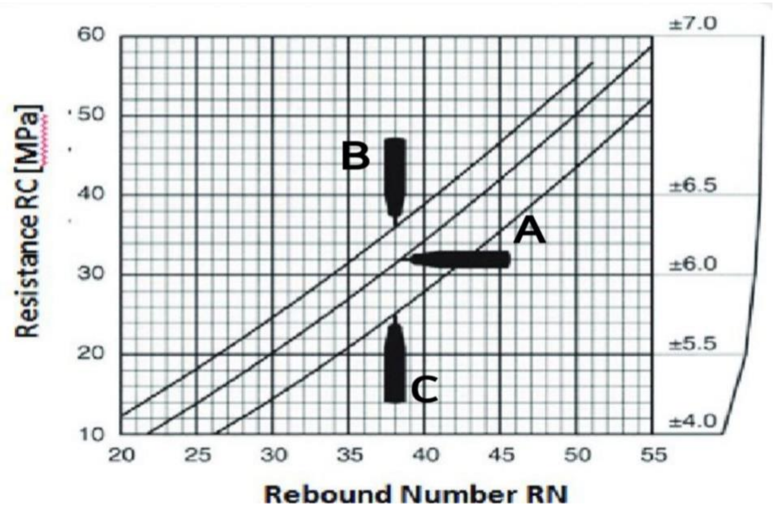
Rebound hammer graph

The Graph Contains Three different curves for three Different positions of Testing.

Pos. A – Horizontal Position (forward)

Pos. B- Vertical downward,

Pos. C – Vertical Upward,



This diagram shows the relationship between the compressive strength for concrete, measured directly in a laboratory using concrete cylinders or concrete cubes, and the rebound numbers you receive using your Rebound Hammer.

A refers to using it against a concrete wall (forward).

B refers to using the Rebound Hammer against a concrete floor (downward).

C refers to using it against a concrete ceiling (upward).

The strength values shown in this diagram are directly based on compressive strength testing in a laboratory, using concrete 14 to 56 days old. The tests use concrete cylinders, 6 inches wide and 12 inches high

(15cm x 20cm), or concrete cubes six inches high. According to ASTM C-805-08. Any readings that differ from the average rebound value by more than six units should be discarded. Then, calculate the average of the remaining values. If more than two readings deviate from the average rebound value by more than six units, disregard all your readings and do the test again. Take ten new readings using your rebound hammer in a different section of the concrete but in the same testing area.

Step 4: Interpretation of Results

The result from the test tells us the quality of Concrete or rocks.

Average rebound	Quality of concrete
>40	Very good
30-40	Good
20-30	Fair
<20	Poor
0	Very poor

2- Ultrasonic Pulse Velocity (UPV)

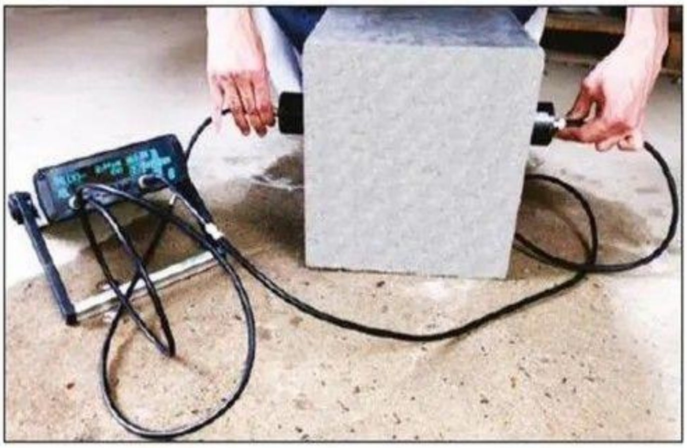
An ultrasonic pulse velocity (UPV) test is an in-situ, nondestructive test to check the quality of concrete and natural rocks. In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic pulse passing through a concrete structure or natural rock formation. The test is conducted according to IS 13311-1992 by passing a pulse of ultrasonic through concrete to be tested and measuring the time taken by pulse to get through the structure. Higher velocities indicate good quality and continuity of the material, while slower velocities may indicate concrete with many cracks or voids.

Ultrasonic testing equipment includes a pulse generation circuit, comprising electronic components for generating pulses, and a transducer for converting the electronic pulse into a mechanical pulse with a oscillation frequency in the range of 40 kHz to 50 kHz. It also includes a pulse receiving circuit that receives the signal.

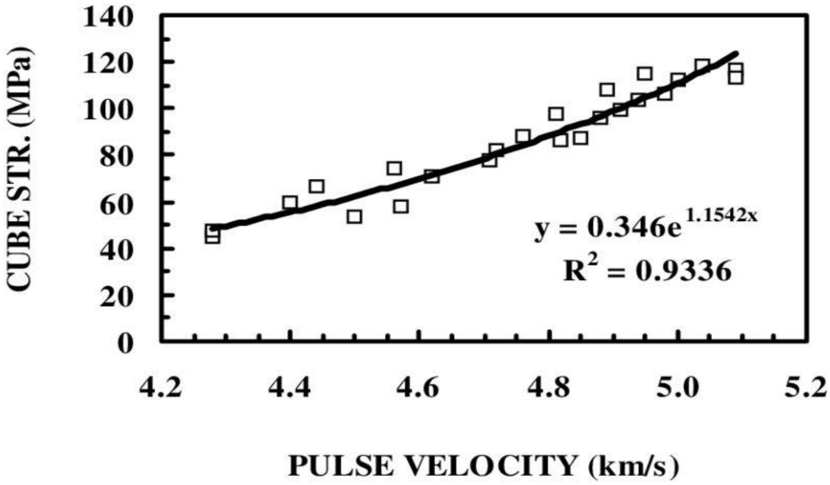
The transducer, clock, oscillation circuit, and power source are assembled for use. After calibration to a standard sample of material with known properties, the transducers are placed on opposite sides of the material. Pulse velocity is measured by a simple formula:

$$\text{pulse velocity} = \frac{\text{width of structure}}{\text{time taken by pulse to go through}}$$

Pulse velocity (km/sec.)	Concrete quality
Above 4.5	**Excellent**
3.5 to 4.5	**Good**
3.0 to 3.5	**Medium**
Below 3.0	**Doubtful**



After knowing the speed of the pulses, the compressive strength of the concrete can be known through the relationship between the speed impulse and compressive strength from the figure below:



Applications

Ultrasonic Pulse Velocity can be used to:

- Evaluate the quality and homogeneity of concrete materials
- Predict the strength of concrete
- Evaluate dynamic modulus of elasticity of concrete,
- Estimate the depth of cracks in concrete.
- Detect internal flaws, cracks and honeycombing.