Non-destructive Testing of Concrete
- Methods of Test

Lecture No. 26
The rebound hammer method could be used for:

i) Assessing the likely compressive strength of concrete with the help of suitable corelations between rebound index and compressive strength,

ii) Assessing the uniformity of concrete,

iii) Assessing the quality of the concrete in relation to standard requirements, and

iv) Assessing the quality of one element of concrete in relation to another
Rebound Hammer (IS 13311( Part 2 ) : 1992)

**Principle of Test:**

- When the plunger of rebound hammer is pressed against the surface of the concrete, the spring-controlled mass rebounds and the extent of such rebound depends upon the surface hardness of concrete. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete. The rebound is read off along a graduated scale and is designated as the rebound number or rebound index.
Rebound Hammer (IS 13311( Part 2 ) : 1992)

The Rebound Hammer:

- It consists of a spring controlled mass that slides on a plunger within a tubular housing. The impact energy required for rebound hammers for different applications is given in Table 1.

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Application</th>
<th>Approximate Impact Energy Required for the Rebound Hammers (Nm)</th>
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<tbody>
<tr>
<td>i)</td>
<td>For testing normal weight concrete</td>
<td>2.25</td>
</tr>
<tr>
<td>ii)</td>
<td>For light-weight concrete or small and impact sensitive parts of concrete</td>
<td>0.75</td>
</tr>
<tr>
<td>iii)</td>
<td>For testing mass concrete, for example in roads, airfields pavements and hydraulic structures</td>
<td>30.00</td>
</tr>
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</table>
Rebound Hammer (IS 13311 (Part 2) : 1992)
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Checking of Apparatus:

It is necessary that the rebound hammer is checked against the testing anvil before commencement of a test to ensure reliable results. The testing anvil should be of steel having Brinell hardness of about 5000 N/mm. The supplier/manufacturer of the rebound hammer should indicate the range of readings on the anvil suitable for different types of rebound hammers.
Procedure of Obtaining Correlation Between Compressive Strength of Concrete and Rebound Number:

The most satisfactory way of establishing a correlation between compressive strength of concrete and its rebound number is to measure both the properties simultaneously on concrete cubes. The concrete cube specimens are held in a compression testing machine under a fixed load, measurements of rebound number taken and then the compressive strength determined as per IS 516 : 1959.
PROCEDURE:

- For testing, smooth, clean and dry surface is to be selected. If loosely adhering scale is present, this should be rubbed off with a grinding wheel or stone. Rough surfaces resulting from incomplete compaction, loss of grout, spalled or tooled surfaces do not give reliable results and should be avoided.

- The point of impact should be at least 20 mm away from any edge or shape discontinuity.
Rebound Hammer (IS 13311(Part 2): 1992)

**PROCEDURE:**

- For taking a measurement, the rebound hammer should be held at right angles to the surface of the concrete member. The test can thus be conducted horizontally on vertical surfaces or vertically upwards or downwards on horizontal surfaces. If the situation demands, the rebound hammer can be held at intermediate angles also, but in each case, the rebound number will be different for the same concrete.

- Around each point of observation, six readings of rebound indices are taken 2nd average of these readings after deleting outliers as per IS 8900: 1978 becomes the rebound index for the point of observation.
Rebound Hammer (IS 13311( Part 2 ) : 1992)

The rebound numbers are influenced by a number of factors like types of cement and aggregate, surface condition and moisture content, age of concrete and extent of carbonation of concrete.
The ultrasonic pulse velocity method could be used to establish:

1. The homogeneity of the concrete,
2. The presence of cracks, voids and other imperfections,
3. Changes in the structure of the concrete which may occur with time,
4. The quality of the concrete in relation to standard requirements,
5. The quality of one element of concrete in relation to another, and
6. The values of dynamic elastic modulus of the concrete.
Ultrasonic Pulse Velocity
(IS 13311( Part 1 ) : 1992)

**Principle of Test :**

- The ultrasonic pulse is generated by an electroacoustical transducer. When the pulse is induced into the concrete from a transducer, it undergoes multiple reflections at the boundaries of the different material phases within the concrete.

- A complex system of stress waves is developed which includes longitudinal (compressional), shear (transverse) and surface (rayleigh) waves. The receiving transducer detects the onset of the longitudinal waves, which is the fastest.
Ultrasonic Pulse Velocity
(IS 13311 (Part 1) : 1992)

Principle of Test:

- Because the velocity of the pulses is almost independent of the geometry of the material through which they pass and depends only on its elastic properties, pulse velocity method is a convenient technique for investigating structural concrete.

- The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good.
Ultrasonic Pulse Velocity
(IS 13311 (Part 1) : 1992)

**Principle of Test:**

- In case of poorer quality, lower velocities are obtained. If there is a crack, void or flaw inside the concrete which comes in the way of transmission of the pulses, the pulse strength is attenuated and it passes around the discontinuity, thereby making the path length longer. Consequently, lower velocities are obtained.

- The actual pulse velocity obtained depends primarily upon the materials and mix proportions of concrete. Density and modulus of elasticity of aggregate also significantly affect the pulse velocity.
Ultrasonic Pulse Velocity
(IS 13311( Part 1 ) : 1992)

- The apparatus for ultrasonic pulse velocity measurement shall consist of the following:
  - a) Electrical pulse generator,
  - b) Transducer - one pair,
  - c) Amplifier, and
  - d) Electronic timing device.
Ultrasonic Pulse Velocity
(IS 13311( Part 1 ) : 1992)
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- **Influence of Test Conditions**
  - Influence of Surface Conditions and Moisture Content of Concrete
  - Influence of Path Length, Shape and Size of the Concrete Member
  - Influence of Temperature of Concrete
  - Influence of Stress
  - Effect of Reinforcing Bars
The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation, etc, indicative of the level of workmanship employed; can thus be assessed using the guidelines given in Table 2.

**Table 2 Velocity Criterion for Concrete Quality Grading**

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Pulse Velocity by Cross Probing (km/sec)</th>
<th>Concrete Quality Grading</th>
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<tbody>
<tr>
<td>1.</td>
<td>Above 4.5</td>
<td>Excellent</td>
</tr>
<tr>
<td>2.</td>
<td>3.5 to 4.5</td>
<td>Good</td>
</tr>
<tr>
<td>3.</td>
<td>3.0 to 3.5</td>
<td>Medium</td>
</tr>
<tr>
<td>4.</td>
<td>Below 3.0</td>
<td>Doubtful</td>
</tr>
</tbody>
</table>

Note — In case of "doubtful" quality it may be necessary to carry out further tests.