# TECHNIQUES OF NDT METHOD FOR CONCRETE STRUCTURE

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Abstract: - The deterioration of concrete structures in the last few decades calls for effective methods for condition evaluation and maintenance. This resulted in development of several nondestructive testing (NDT) techniques for monitoring civil infrastructures. NDT methods have been used for more than three decades for monitoring concrete structures; now it has been recognized that NDT plays an important role in the condition monitoring of existing RC structures. NDT methods are known to be better to assess and evaluate the condition of RC structures practically. This paper reviewed several available NDT methods developed and used in the last few decades.

*Key words: - Deterioration of concrete, Type of NDT Machines, methodology for NDT*

**Introduction**: -In buildings/Structures of more than 25-30years old, there are many type and numbers of reasons for Non-Destructive Testing (NDT) and these methods are used to Study the condition and also to check integrity of concrete structures without damaging or destroying the concrete with the goal of detecting flaws accurately and efficiently.

If used properly, nondestructive tests can form a vital link in the chain of testing and evaluation of concrete and concrete structures, which starts with crushing of 150 mm cubes and may end with load testing of finished structure.

For the NDT tests to monitor the service behavior of concrete structures over a long period, it was imperative that these tests be non-destructive. This approach, though new for the testing of concrete, had long been used in the testing of metals in petroleum exploration & refining projects. The direct determination of strength implies that concrete specimen must be loaded to failure; it becomes clear that non-destructive methods of testing cannot be expected to yield absolute value of strength.

These methods, therefore, attempt to measure some other property of concrete from which an estimate on its strength, its durability and its elastic parameters is obtained. Such properties of concrete are its hardness, rebound number and its ability to allow ultrasonic pulse velocity to propagate through it. The electrical properties of the concrete, allow us to estimate its moisture content, density, thickness and its cement content. Based on above, various nondestructive methods of testing concrete have been developed.

Popular Non Destructive Tests (NDT) for Concrete Used in field are:

1 Rebound Hammer Test- RH Test
2 Ultrasonic Pulse Velocity- UPV Test
3 Combined Method UPV & RH Test
4 Half cell Potential Method test
5 Cover meter

**REBOUND HAMMER TESTING**

The rebound hammer (such as the Schmidt Hammer) is Consist of a spring control hammer that slides on a plunger within a tubular housing. When the plunger is pressed against the

surface of the concrete, the mass rebound from the plunger. It reacts against the force of spring. The Distance travelled by the mass, is called rebound number. The Schmidt rebound hammer is basically a surface hardness tester & testing as per IS: 13311 (Part 2): 1992 & BS 1881: Part 202: 1986, the rebound of an elastic mass depends on the hardness of the surface against which mass strikes.

**Figure-1 - Rebound Hammer Testing**

The rebound hammer can be used on horizontal, vertical or inclined concrete surfaces provided a correction is made for the angle of inclination. Prior to testing, the rebound hammer should be calibrated using a calibration test anvil supplied by the manufacturer for that purpose. Correlations of rebound number should be developed where possible with the strength of partially destructive core testing and/or concrete cylinder strength results if they are available for the particular concrete mix.Figure-1 shows the example Rebound Hammer Testing.

**ULTRASONIC PULSE VELOCITY (UPV)**

The UPV method involves measuring the speed of travel of an ultrasonic pulse through concrete. This speed is influenced by the density and elastic modulus of the concrete. It is often used for relative strength assessments. The technique is most effective and economic for comparative assessments of quality (density) and detection of voids, delamination and under compacted and honeycombed areas because the pulse takes longer to travel around defective areas**.**

**Figure-2 Ultra Pulse Velocity Testing**

Velocity criterion for concrete quality grading is given by IS 13311 (Part-I):1992 Non-Destructive Testing on Concrete Structures is as under:

| Sr. No | Pulse velocity by cross probing | Concrete Quality Grading |
|---|---|---|
| 1. | Above 4.5 km/s | Excellent |
| 2. | 3.5 km/s to 4.5 km/s | Good |
| 3. | 3.0 km/s to 3.5 km/s | Medium |
| 4. | Below 3.0 km/s | Doubtful |

**Table-1- Showing Quality Grading of UPV**

**Applications of UPV Tests**

The pulse velocity method has been applied successfully in the laboratory as well as in the field. It can be used for quality control, as well as for the analysis of deterioration. The applications of the pulse velocity method on a concrete structure are:

1. Estimation of Strength of Concrete
2. Establishing Homogeneity of Concrete
3. Studies on the Hydration of Cement
4. Studies on Durability of Concrete
5. Measurement of Surface Crack Depth

6. Determination of Dynamic Modulus of Elasticity

**HALF-CELL ELECTRICAL POTENTIAL METHOD**

This test is used to assess the corrosion conditions in a reinforced concrete structure. The apparatus includes copper-copper sulphate half-cell, connecting wires and a high impedance voltmeter external cathode is provided in the form of copper rod and copper sulphate solution in the cell. Any point on reinforcement bar inside the concrete body functioning as anode when connected electrically to cathodic half-cell generates e.m.f. This is measured by connecting a milli voltmeter in the circuit

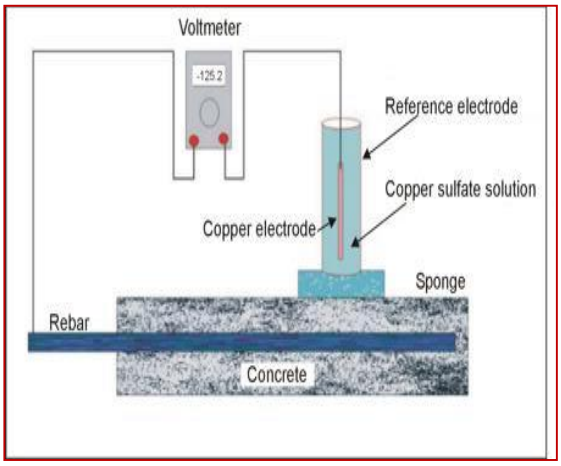


**Figure-3Half Cell Potential Test**

Half Cell Electrical Method is conduct for The possibility of active corrosion is found out according to guideline of Non-Destructive Testing on Concrete Structures - Half cell potential (mV) reading Percentage chance of active corrosion < -350 90% -200 to –350 50% > -200 10%.

**COVER METER**

The cover meter technique is the least complicated and least expensive of all the NDT techniques. This test is used to assess the location and diameter of reinforcement bars and concrete cover. Principle: based on the measurement of change in electromagnetic field caused by steel embedded in the concrete. Equipment: Photometers comprise a search head, meter and interconnecting cable. The concrete surface is scanned, with the search head kept in contact with it while the meter indicates, by analogue or digital means, the proximity of reinforcement.

**Fig.-4- Bar Locator and Cover Depth Meter**

**CONCLUSIONS:**

Various NDT methods based on different principles, with their individual merits and limitations, have been discussed. It has been recognized that NDT plays an important role in condition assessment of existing structures, and there has been an urgent need for developing standards for performing NDT methods and for interpretation of NDT results.

Major advantage of NDT methods has been recognized as their capability to test in situ. Great deal of expertise is required for interpretation of NDT field observations and test results. NDT provides useful information by revealing hidden or unknown defects, and repair or replacement of RC structures can be planned according to NDT results. Combination of different NDT methods available is a better way to assess the structures.

**DISCUSSION:**

An NDT method provides indirect results which can be related to various properties of concrete structures. In the last few decades NDT methods have been developed form rebound hammer to new sophisticated techniques based on propagation of waves in the concrete. With the development in software technologies and battery operated small computers, NDT methods are getting popular among researchers and engineers for quick evaluation and interpretation of results. In the future NDT methods can be useful for the various purposes such as for identifying deterioration levels and modeling the life of structures, extracting in depth information about material properties, and developing methods for combining the results of different NDT methods for better evaluation of condition of concrete structures.

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The table below shows the quality of concrete based on the average rebound number or rebound index.

| Average Rebound Number | Quality of Concrete |
|---|---|
| > 40 | Very Good |
| 30 -40 | Good |
| 20-30 | Fair |
| < 20 | Poor and/or Delaminated |

| | |
|---|---|
| 0 | Very Poor and/or Delaminated |

***Table 3. Probability of corrosion according to half-cell readings***

| **Half-cell potential reading, vs. $Cu/CuSO_4$** | **Corrosion activity** |
|---|---|
| less negative than -0.200 V | 90% probability of no corrosion |
| between -0.200 V and -0.350 V | An increasing probability of corrosion |
| more negative than -0.350 V | 90% probability of corrosion |