Preliminary Investigations into Effects of Corrosion and its Assessment in RCC Structures

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Abstract - *In this project, we have carried out the condition assessment and structural audit on the buildings by visual inspection and NDT {Non-destructive testing} due to poor quality of construction and the life span of building which is approximately near 50-60 years. Here we found out that the quality of concrete by UPV {ultrasonic pulse velocity} and rebound hammer. During the testing of building, we found that the strength of concrete of concrete is good. Quality of construction, construction method adopted, and quality control assurance measures have been verified to be stringent at the time of construction of building. Some more test has also been carried out using different non-destructing test methods like half-cell potential method, vibration test on building and moisture content test. Overall, the condition of building is found to be stable, serviceable, and sound for the purpose for which it is intended.*

*Key Words***: Structural Audit; Visual Inspection; Non-Destructive Test; Rebound Hammer; Half-Cell Potential; Vibration Test; Moisture Content Test**.

1.INTRODUCTION

Condition assessment of concrete for structural evaluation purposes has been started from last two decades mostly by visual examination, surface sounding and coring to examine internal concrete conditions. Condition assessments can be performed with NDT methods to provide information for the structural performance of the concrete, such as: Member dimensions; Location of cracking, delaminating and debonding; presence of voids and honeycomb; Steel reinforcement location and size; Corrosion activity of reinforcement; and Extent of damage, chemical exposure .In the present time, even in new construction projects the quality of construction is poor due to unskilled labor, improper work and leniency. This affects the strength, durability, and service life of the structure. The strength and the class of construction is inferior, it identifies the several defects in the various part of the structure. To solve this problem, we conducted the NDT (Non-Destructive testing). The NDT process is done without distressing the existing structure. And there by with the help of visual inspection and by using various test equipment and machine. In this project we carried out five type of test to identify the poor part of the building i.e. Schmidt rebound hammer test, UPV (Ultrasonic pulse velocity test), half-cell potential, vibration test, moisture content test & Visual inspection is done in this case.

1.1 Objective of the work

The main objective of present work is to implement condition assessment of Building, which is situated at Nagpur Maharashtra with Schmidt's Hammer Test, Ultrasonic Pulse Velocity Test, half-cell potential, moisture content ,vibration test, including Visual Inspection and assessing the firmness and safety of the structure to withstand for its remaining life which is done by Investigating the root cause of the problems by giving certain recommendation.

2. METHODOLOGIES

2.1 Significance of condition assessment

- To determine the feasibility of changing the use of structure and feasibility of enlarging the structure.

- To determine the structure adequacy and integrity of a structure.

- To evaluate the structural problem or distresses which result from, exposure condition, inadequate design, or poor construction practices.

- To determine the service life of existing structures.

2.2 Visual Inspection

In the visual inspection we have check all the three buildings i.e. building 1 having total area of 2705 sq. mtr, building 2 having total area of 2800 sq. mtr, building 3 having total area of 714 sq. mtr and have being inspected the whole structure for cracks, spalling and for the seepage and we observed the poor part of the structure in the building.

2.3 Rebound hammer test

A rebound hammer is an apparatus to find the compressive strength of the concrete of the existing structure without any disturbance, whereby the rebound of the spring-driven mass is measured after its impact on the concrete surface. The output of the rebound hammer is referred to as the rebound number and is correlated with the surface hardness of concrete. The internal mechanism of a typical Schmidt Hammer is illustrated in the plunger is pushed against the concrete, perpendicular to the surface. In this test, we find the rebound number using a hammer and to finding the compressive strength using the graph to find out the probable compressive strength of concrete as per IS13311 part II.

Fig -1: Rebound hammer testing and graph

2.4 Ultrasonic pulse velocity test

An UPV is Nondestructive check in which we find quality of concrete. Cracks in concrete structure is determined in UPV test. UPV consists of electrical device for reworking pulses, pulse generation circuit consisting of electronic circuit for generation of pulses. In this check pulse of unhearable is capable concrete structure and time taken by pulse is measured. Higher velocities indicate good quality concrete and continuity of the fabric and lower velocities indicate poor quality concrete and concrete with several cracks. There are 3 kinds of technique to use instrumentation to search out the rate i.e. Direct, Indirect & Semi direct technique that has been shown in below figures. Concrete quality is classified into four classes wonderful, Good, Medium & doubtful. As per IS 13311 (Part I) 1992 U.P.V. (km/sec.) Quality of Concrete for Direct technique Above 4.5 wonderful , 3.5 to 4.5 Good , 3.0 to 3.5 Medium , Below 3km/sec Doubtful.
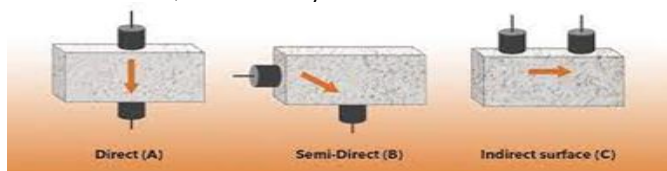

Fig -2: UPV Testing

2.5 Half-cell Potential test

This is an apparatus given by ASTM 876-91, which includes copper, copper sulphate half-cell, silver, silver chloride half-cell consisting of copper or silver electrode with high impedance voltmeter. Very little current flows through the circuit. Half-cell makes electrical contact with concrete by means of absorbent plug and sponge. If the bar is corroding electrodes would tend to flow from bar of half-cell. At the half cell electrons would be consumed in a reduction reaction that transform copper ion in copper sulphate solution into copper atoms deposited in rod. Voltmeter will show negative value. More negative the voltage, reading, the higher is the bar corrosion. Half-cell potential is also so-called corrosion potential meter, and it is open circuit potential because it is measured under no current.

Half-cell potential readings are indicative of probability of corrosion of measured Potential. Less than -200mv there is no or little corrosion. If potential is more than-350mv there is high corrosion. Corrosion activity is uncertain between -200 &-350mv.
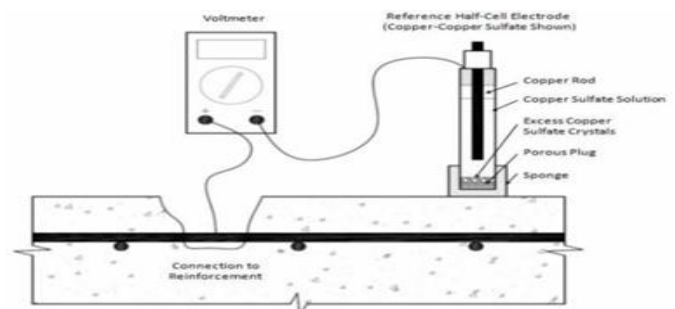

Fig -3: Half-cell potential testing

2.5 Vibration test

Vibration measurement was carried out in all the three building using the portable vibration meter and was checked as per is 148840:2000

The instrument displays measurement values in the state of Acceleration or Velocity or Displacement with different vibration frequency selection.

2.5 Moisture content test

Moisture content was determined by using digital moisture meter

3. Observation and result

- All the buildings are a Ground plus One storied structure with 500 mm thick External and internal walls at main Building 1 whereas 300 mm external wall and 150mm thick brick masonry walls at building 2 and building 3 with Precast RCC slab panels provided at top. In all building's plinth

protection was observed but at some places it is smashed.

- In general, the building has been constructed with proper quality control and supervision which is evident from lines and levels observed.

- The Ultrasonic Pulse Velocity (UPV) - Non Destructive Tests carried out with direct and indirect methods distributed on all the parts of buildings right from foundation to the roof of building. Total 146 UPV readings were obtained .The UPV tests indicated the overall quality of more than 65 % of concrete to be ranging from good to excellent. Referring to IS 13311 (Part I) 1992 "Non-Destructive Testing of concrete methods of test, Ultrasonic Pulse Velocity" , the quality of concrete is DOUBTFUL only in 20% of the readings which provide velocity less than 3 km/sec. The % indication about the quality of concrete is given in table no 1.

- The rebound hammer readings were obtained at 110 locations and a set of 6 observations were obtained at each location. As per Rebound Hammer test referring to IS 13311(Part II) 1992" Non-Destructive Testing of concrete-methods of test, Rebound Hammer" the reading of Rebound Hammer indicates average compressive strength of 14.90, 18.11, and 15.47 N/Sq.mm at Main building 1, building 2 and building 3 respectively indicating quality of in situ concrete is acceptable.

- Half-cell potential readings were obtained on embedded reinforcement after being exposed at 14 locations distributed over the area from foundation to roof. At each location four observations were taken. As per half-cell potentiometer test it is observed that the readings are in between -660MV to -395MV which indicates heavy corrosion in reinforcement, especially in the portions which are exposed to rains and chajja and canopy projections.

- Vibration readings were obtained at 14 locations near foundation level of all buildings. It is observed that there were no vibrations in the buildings as the zero value of acceleration was obtained from the portable vibration meter during test.

- Moisture Content readings were obtained at 14 locations on exposed concrete surface. At each location four observations were taken. As per moisture content test it is observed that the readings are in between 9.00% to 21.6%. It is commented that at some locations especially near washrooms and location of vegetation growth the moisture content is alarmingly high.

Table -1: Readings of UPV Testing

Readings of U.P.V Testing			
ESTIMATED QUALITY OF CONCRETE	OBSERVED RANGE OF VELOCITY	TOTAL READINGS =146	% QUALITY
Excellent	Above 4.5 km/sec	24	16.43 %
Good	3.5 to 4.5 km/sec	71	48.63 %
Medium	3.0 to 3.5 km/sec	21	14.38 %
Doubtful	Below 3.0 km/sec	30	20.54 %

4. CONCLUSIONS

Condition assessment technique is used to find out the condition of three different buildings in Nagpur, Maharashtra {INDIA} . The condition assessment techniques used are Rebound hammer, Ultrasonic pulse velocity method, Half-cell potential, vibration test, moisture content test.

Over all the condition of building is that quality of construction, but certain corrective measures are required. The condition assessment of building revealed that there is an urgent need of corrective measures to be taken it is strongly counseled to shield the terrace slab from further ingress of water. Extensive growth of vegetation growth of vegetation on all buildings which is loosening the masonry and allowing ingress of rain water causing dampness and corrosion. The vertical cracks shall be repaired by stitching method. All porch tops to be rectified for proper drainage arrangement because the stagnation of water on porch top is causing dampness as well as corrosion of reinforcement In view of high to moderate levels of corrosion of steel bars altogether different arrangement of water proofing is proposed i.e. providing lean to roof. Thus, using Nondestructive testing {NDT} the condition assessment of buildings are found out.

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