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Non Destructive Testing of Old R.C.C. Framed Structure

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Abstract - *In India there are various old structures that are at the verge of damage. With due course of time the structure becomes weak as the strength of concrete gets reduced. The reasons that can be considered for this reduced strength are poor quality of construction, improper maintenance, improper design mix, unskilled workmanship etc. Therefore the condition and performance of building must be checked from time to time. Non Destructive Testing is the appropriate solution to this issue. It enhances the performance of any existing structure. Non Destructive testing help to assess the health of structure & how much repairs, rehabilitation & retrofitting is required to bring back the structure in safe stable condition. In this case study non destructive testing is adopted to assess the condition and quality of concrete for 30 years old R.C.C. framed structure which is situated Nagpur. Various NDT methods such as Rebound Hammer Test, Ultrasonic pulse velocity test and Half cell potentiometer test have been performed. Based on all test results & visual inspections it is found that the structure needs to be repair & retrofit.*

Key Words: Non Destructive Testing, Rebound Hammer Test, Ultrasonic Pulse Velocity Test, Half Cell Potentiometer Test.

1.INTRODUCTION

1.1 Non Destructive Testing of Structure

The Non Destructive Testing (NDT) is a technique that are used to find out the defects in structure with or without destroying any part of the structure.

As we know concrete reduced strength due to over age of structure, poor quality of construction material, unskilled workmanship, improper maintenance, improper design mix etc. therefore it is necessary to check the condition, quality of concrete & performance of structure from time to time. The Non Destructive testing offers proper solution for these issues.

Non destructive testing offers significant advantages like, defects can be detected without damaging or destroying the part of structural components, the equipments are easy to handle and it gives appropriate results with the help of NDT. It requires to understand the various methods available, their capabilities and limitations, knowledge of the relevant standard and specification for performing the test. These techniques can be used to monitor the reliability of the item of structure throughout its design life.

1.2 Objective of the Case Study

The objective of present case study is to obtained the Non Destructive Testing of 30 years old R.C.C. Framed structure with Rebound Hammer Test to know the probable Compressive Strength, Ultrasonic Pulse Velocity Test for access the condition of structure & Half cell Potentiometer Test to know the availability of corrosion in reinforcement and visual inspection.

2. METHODOLOGY

2.1 Visual Inspection

Visual inspection is the first step in NDT method to evaluation of concrete structure that are visually accessible, it gives an idea about overall condition of structure when investigate thoroughly. The detail visual inspection were carried out on different members of the structure and we have observed Reinforcement exposed at various location, corrosion, major and minor cracks, honeycombing, deterioration of concrete etc.

Fig -1: Reinforcement exposed, corrosion, cracks observed in Column.

Fig -2: Reinforcement exposed, corrosion, cracks observed in Column.

2.2 Rebound Hammer Test

Rebound hammer test is the surface hardness test when the plunger of rebound hammer pressed against the concrete surface it gives the probable compressive strength of concrete.

In 1948 Ernst Schmidt a Swiss Engineer develop a device for testing concrete. The device measures the rebound value R. There is a specific relation between this value and the hardness and strength of concrete.

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 impact direction of hammer are horizontal, vertically upward or vertically downward. As per IS:13311 Part-2, the probable accuracy of prediction of concrete strength in a structure by rebound hammer test is +/-25%.

TABLE -1: rebound criteria for quality of concrete grading

Average Rebound	Quality of Concrete
>40	Very Good hard layer
30-40	Good
20-30	Fair
<20	Poor concrete
0	Delaminated

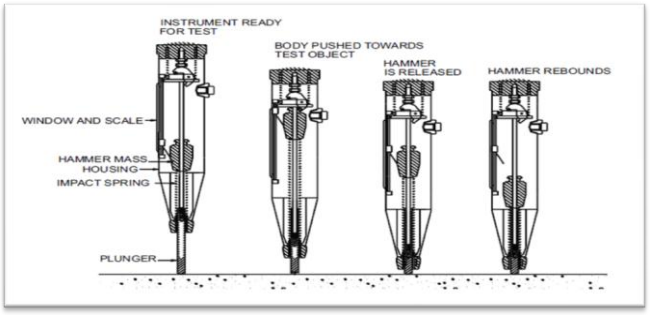

Fig -3: Rebound Hammer Test.

Fig -4: Rebound Hammer Test.

2.3 Ultrasonic Pulse Velocity Test

Ultrasonic Pulse Velocity Test is used to established the quality of concrete, presence of cracks, voids and other imperfections in structure.

This is one of the most commonly used method in which the ultrasonic pulses generated by electro-acoustical transducer are transmitted through the concrete & measuring the time taken. Distance of path length divided by the transit time gives the pulse velocity of concrete member being tested. The ultrasonic pulse velocity is influenced by path length, lateral dimension of specimen tested, presence of reinforcing steel, and moisture content of the concrete.

The methods of measurements of ultrasonic pulse velocity through concrete are

a) Direct Transmission (Cross Probing).

b) Semi-Direct Transmission

c) Indirect Transmission (Surface Probing)

The instrument used for testing is Pundit Lab (30610001) UPV Instrument (Proceq) (Made in Switzerland).

TABLE -2: Velocity Criteria for Quality of Concrete Grading

Pulse Velocity	Quality of Concrete
Above 4.5 Km/Sec	Excellent
3.5 - 4.5 Km/Sec	Good
3.0 - 3.5 Km/Sec	Satisfactory
Below 3.0 Km/Sec	Doubtful

Fig -5 Ultrasonic Pulse Velocity Test Machine.

Fig -6 Ultrasonic Pulse Velocity Test.

2.4 Half Cell Potentiometer Test

Half cell potentiometer test is used determine the probability of corrosion associated with steel in concrete. The apparatus given by ASTM C876 which include copper/Copper Sulphate electrode or silver / silver chloride electrode for half cell test.

Half cell makes electrical contact with concrete by means of porous plug and sponge. One end of wire is connected to steel reinforcement and other end is connected to standard electrode and readings are noted as seen on voltmeter. More negative value indicated the higher is the bar corrosion.

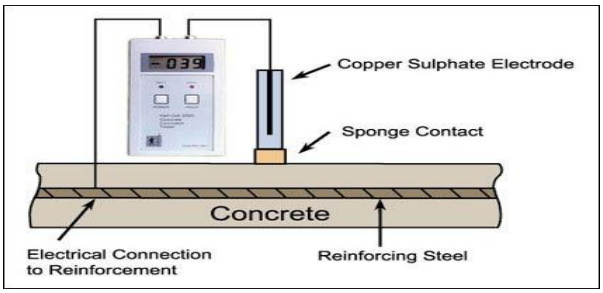

Fig -7 Schematic View of Half Cell Potentiometer

[http://civilonline2010.blogspot.com/2010/09/half-cell-electrical-potential-method.html]

TABLE -3: Corrosion Condition of Reinforcing Bar

Copper / Copper Sulphate	Corrosion Condition
> -200 mV	Low (10% chances)
-200 to -350 mV	Intermediate
< -350 mV	High (<90 %)
< -500 mV	Severe Corrosion

Fig -8 Half Cell Potentiometer Test.

3. TEST RESULTS

3.1 Rebound Hammer Test Results

Sr. No.	Description	No. of Points	Rebound Hammer Test		
			Max.	Min.	Average
Ground Floor					
1.	Column	114	31.67	15	23.33
2.	Beam	18	30.33	27	28.66
3.	Slab	12	29.66	29.33	29.49
First Floor					
4.	Column	12	31	29	30

Second Floor					
5.	Column	14	32.57	31.71	32.14
Third Floor					
6.	Column	12	33.66	32	32.83
Fourth Floor					
7.	Column	12	36	32	34

As per Rebound Hammer Test results it is observed that maximum readings are confirming to M10 to M15 grade of concrete that indicated the poor quality of concrete.

3.2 Ultrasonic Pulse Velocity Test Results

Sr. No.	Description	No. of Points	Ultrasonic Pulse velocity Test (Km/SEC)		
			Max.	Min.	Average
Ground Floor					
1.	Column	98	3.53	1.4	2.46
2.	Beam	20	1.98	1.13	1.55
3.	Slab	17	2.3	1.4	1.85
First Floor					
4.	Column	7	2.3	1.87	2.08
Second Floor					
5.	Column	12	2.3	1.33	1.81
6.	Beam	4	1.94	1.87	1.90
Third Floor					
7.	Column	10	3.3	2.47	2.88
Fourth Floor					
8.	Column	14	3.3	2.83	3.06

As per Ultrasonic Pulse Velocity test results it is observed that maximum readings are below 3.0 Km/sec that indicated the quality of concrete is doubtful.

3.3 Half Cell Potentiometer Test Results

Sr. No.	Description	Half Cell Potentiometer Test	
		Half Cell Readings (mV)	Average (mV)
1.	Column No..-C1	-355, -346, -321, -272, -241, -232, -223, -216, -168	-263
2.	Column No..-C2	-319, -317, -315, -250, -247, -240, -238, -224, -212	-262
3.	Column No..-C8	-341, -333,-321,-308, -302,-291,-279,-269, -263	-300
4.	Column No..-C9	-360, -359, -341, -332, -258, -245, -235, -218, -217	-285
5.	Column No..-C12	-501, -499, -418, -400, -397, -357, -348, -345, -343	-400
6.	Column No..-C16	-399, -320, -318, -305, -242, -237, -236,-211, -209	-275
7.	Column No..-C17	-339, -321, -315, -301, -297, -295, -287, -279, -277	-301
8.	Column No..-C21	-458, -441, -435, -408, -397, -391, -383, -380, -371	-407

As per Half cell Potentiometer Test results maximum readings are in between -262 and -407 that indicate there is severe corrosion at most of the locations.

4. CONCLUSIONS

In this paper various Non Destructive Tests have been performed on existing structure such as Rebound Hammer Test, Ultrasonic Pulse Velocity Test and Half cell Potentiometer Test including visual inspection.

As per the visual inspection, Rebound Hammer test & Ultrasonic Pulse velocity test results it is observed that various columns readings whose strength and quality of concrete is doubtful for such columns jacketing should be done.

According to the half cell potentiometer test results severe corrosion are observed at most of the location.

Test results Conclude that Repairs and Retrofitting should be done as per the specification to maintain the existing structure in good condition.

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