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CONDITION ASSESSMENT OF POLICE QUARTERS

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ABSTRACT: The buildings are designed for lifespan of at least 80 years. But, due to extreme weathering condition causes damage to the building. To assess this damages and problem in building condition assessment is required. The Condition Assessment report is very crucial in decision whether to repair the structure or to demolished it and rebuild. This paper contains Condition Assessment report of an old building situated in Nagpur. The report is based on visual inspection and test results of Rebound Hammer Test, Ultrasonic Pulse Velocity Test, Half-cell Test, pH Test and Cover-meter Test.

KEYWORDS: Condition Assessment, NDT method

I. INTRODUCTION

It has been found that most of the buildings as a structure in India is aged more than 30 years. The building is designed to last about for 80 to 100 years but structure goes through some amount of deterioration with time. It is necessary to take care not only during construction but also after the construction for the long life of the building. In recent years there is significant growth of infrastructure but also there is upsurge in the cost of construction. It can be economical to repair than to demolish the structure and rebuild it. To understand whether the building or structure is habitable and serviceable for future, condition assessment is required to be carried out time to time throughout the life span of the building.

The main objective this paper is to show the assessment done on an old building situated in Police line Takli, Nagpur. The assessment is based on Ultra Sonic Pulse Velocity test, Rebound Hammer test, Half-cell test, pH test and Cover Meter test, apart from this test Visual inspection is also done. With this assessment the decision can be made whether or which section requires repairs, renovation or replacement.

II. **Fig.1.1** Lal Imaarat 06 **E**

Condition Assessment is a health and performance check-up of the structure. Assessment can be done by performing visual inspection and some tests on structure. These tests can be destructive or non-destructive based on the requirement. By assessment we can identify all the problems in the structure which may result in total collapse of structure or may be cause further damage. Only after the total assessment we can decide whether to demolish the structure and rebuild it or to provide remedial measures.

III. BY-LAWS AND GUIDELINES

As per clause:no77 of Maharashtra By-Laws of Co-operative Housing Societies
The society shall cause the Structural Audit of the buildings of the society once in 5 Years for the building ageing 15 to 30 years and once in 3 years if the building is aged 30 years. But Structural Audit can be done earlier if the condition of the building is suspected bad.
The assessment is to be done by licensed engineer who have required expertise.

IV. METHODOLOGY

The Condition Assessment consist of

1. Visual Inspection
2. Rebound Hammer Test
3. Ultra Sonic Pulse Velocity Test
4. Half-cell Test
5. pH Test
6. Cover Meter Test

4.1. VISUAL INSPECTION

Before starting Visual inspection, it is necessary to have general information and all engineering drawing of the building. The visual inspection of building should include all the visible defects or deterioration. A visual inspection report should be explicated and should reveal the following:

i. Cracks in RCC components such as columns, beams, slabs, lintels, loft and parapets. Cracks in internal and external plaster. Cracks in walls.
ii. Disintegration of concrete.
iii. Exposed reinforcement and corrosion in reinforcement.
iv. Leakages from terraces and from sanitary blocks.
v. Dampness in wall.
vi. Growth of vegetation on structure.
vii. Status of other components like doors and window panels and their frame.

Fig.4.1.1 Reinforcement Exposed in

Fig.4.1.2 Deterioration of Column

Fig.4.1.3 Cracks in the Parapet Wall

Fig.4.1.4 Seepage in the walls

4.2. REBOUND HAMMER TEST

To determine surface hardness of concrete rebound hammer test is carried out. This test is purposed by Swiss engineer Ernst Schmitd. This test is easy to operate, it requires only free surface. The rebound number obtained from rebound hammer used to determined compressive strength of concrete. Compressive strength can be computed from concrete test hammer chart provided by the manufacturer of rebound hammer. The test is not most reliable NDT as it is affected by number of practical factors. The procedure is adopted is as13311:(part II).

Fig. 4.2.1 Rebound Hammer Apparatus

Fig.4.2.2 Testing on Column

TABLE 1REBOUND HAMMER FOR QUALITY OF CONCRETE GRADING

Sr. No	Average Rebound Number	Quality of concrete
1.	>40	Very Good Hard Layer
2.	30 to40	Good Layer
3.	20 to 30	Fair
4.	<20	Poor Concrete
5.	0	Delaminated

4.3. ULTRASONIC PULSE VELOCITY TEST

The Ultrasonic Pulse Velocity test carried to determine the homogeneity of concrete and presence of cracks and voids in concrete. The velocity of the pulse through concrete is primarily related to its density and modulus of elasticity. If there is internal crack in concrete, the pulse velocity will be lower as compare to ideal concrete block. The of measurement of ultrasonic pulse velocity are as follows,

a) Direct method
b) Semi-direct method
c) Indirect method

Computed compressive strength from this test is not much reliable as the statistical confidence of the correlation is not very high due to number of parameters influencing the test. IS Code 13311 (Part 1):1992 provides velocity criteria for concrete quality grading are given in table

As per IS 13311 (Part 1): 1992, if quality grading is "doubtful" then it may be necessary to carry out further tests.

Fig. 4.3.1 Ultrasonic Pulse Velocity Apparatus

TABLE 2 VELOCITY CRITERIA FOR QUALITY OF CONCRETE GRADING

Pulse Velocity	**Quality of Concrete**
>4.5 Km/sec	Excellent
3.5-4.5 Km/sec	Good
3.0-3.5Km/sec	Satisfactory
<3.0 Km/sec	Doubtful

4.4 HALF CELL TEST

Half-cell Test is performed to determine the severity of corrosion activity in reinforcement. A voltmeter is connected between the reinforcement and Cu-CuSO4 reference electrode the concrete surface. The test is derived from the fact that reinforcing steel and surrounding concrete acts as a half cell of the battery cell

parameter. The rebar acts as a conductive electrode and the surrounding concrete as conductive electrolyte. As the corrosion is a electrochemical process, potential difference will be proportional to percentage of corrosion.

Fig. 4.4.1 Half-cell Testing

TABLE 3 CRITERIA FOR HALFCELL TEST

Measured Potential (mv)	**Probability of steel corrosion activity**
>-200	Less than 10%
-200 to -350	Uncertain
<-350	More than 90%

4.5 pH Carbonation Test

pH test is performed to determine the pH and amount of carbonation in the concrete. Portland cement is alkaline in nature as it has pH of 11. Low pH accelerate corrosion in reinforcements. Low pH also affect concrete as the Portland cement is not able to withstand most of the acidic compound. As the pH of concrete decrease below 6.5, deterioration of concrete increases. To measure the pH of concrete, the sample is extracted in the form of powder by drilling through concrete with depth of 40 mm and 80 mm. The sample is tested by using a standard pH meter.

Carbonation of concrete occurs when carbon dioxide from air and water reacts with calcium hydroxide present in concrete to form calcium carbonates. Carbonation in concrete is a threat to durability and strength of concrete. Carbonation reduces the pH of concrete and increases its porosity. Carbonation may penetrate slowly from concrete surface but presence of cracks in structure will increase the rate of carbonation as the cracks provides passage for water and contamination. The method to determine the extent of carbonation in concrete requires solution of Phenolphthalein and Ethanol diluted in distilled water. The solution is sprayed on a fresh fracture surface of concrete. In case of non-carbonated concrete the indication colour will be pink and for carbonated concrete it will be colourless.

Fig.4.5.1 Depth of Carbonation

Fig.4.5.2 Phenolphthalein Indicator

TABLE 4 VELOCITY CRITERIA FOR QUALITY OF CONCRETE GRADING

Indication	**pH**	**Remark**
Pink	>9 Alkaline concrete	Non-Carbonated Concrete
Colourless	< 9 Acidic concrete	Carbonated Concrete

4.6 COVER METER

A cover meter is a device which is used to determine the cover provided in the concrete. Cover is the distance measured from the concrete surface to the nearest surface of the reinforcing bar. The cover meter is based on electromagnetic pulse induct technology to detect reinforcement. Cover meter test is very useful where structural drawing is not available. The protection of rebar from corrosion depends on cover provided.

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Fig. 4.6.1 Cover Meter Testing

V. Results

BUILDING INFORMATION
Name- Lal Imaarat 06
Type- RCC building G+3 Floor
Location- Nagpur
Number of apartments- 32
Age of building- 41 years
Mode of use- Residential
Mode of survey- Visual Inspection and NDT

TABLE 5 REBOUND HAMMER TEST RESULT

Sr.no.	Description	No. of points	Rebound Hammer Test		
			Max.	Min	Average
Ground Floor					
1.	Column	7	31	19	25
First Floor					
2.	Column	7	28	20	24
Sr.no.	**Description**	**No. of points**	**Rebound Hammer Test**		
			Max.	**Min**	**Average**
3.	Beam	2	24	22	23
4.	Slab	1	24	24	24
Second Floor					
5.	Column	4	28	19	23.5
6.	Beam	2	22	20	21
7.	Slab	1	22	22	22
Third Floor					
8.	Column	4	32	21	26.5
9.	Beam	2	22	20	21
10.	Slab	1	24	24	24

TABLE 6 ULTRASONIC PULSE VELOCITY TEST RESULT

Sr.no.	Description	No. of Points	Ultrasonic Pulse Velocity (Km/sec)		
			Max.	Min.	Average
Ground Floor					
1.	Column	7	3.4	3.3	3.35
First Floor					
2.	Column	7	3.4	3.2	3.3
3.	Beam	2	2.93	2.79	2.86
4.	Slab	1	3.05	3.05	3.05
Second Floor					
5.	Column	4	3.4	2.6	3
6.	Beam	2	2.47	2.44	2.45
7.	Slab	1	2.81	2.81	2.81
Third Floor					
8.	Column	4	3.4	3.3	3.35
9.	Beam	2	2.85	2.76	2.805
10.	Slab	1	2.727	2.727	2.727

TABLE 7 HALF CELL TEST RESULT

Sr.no.	Particulars	Half Cell
1	Column A05	-315
		-326
		-348
		-350
		-306
		-434
		-470
		-408
		-410
2	Beam 02	-296
		-305
		-280
		-320
		-252
		-326
		-285
		-244
		-388

TABLE 8 pH CARBONATION TEST RESULT

Sr.no.	Description	Potential (mv)		pH
		40 mm	80 mm	
1.	Column A06	-121	-142	8.25 to 10.75
2.	Column A08	-139	-149	9.35 to 11.35
3.	Column A04	-127	-139	10.97 to 11.99
4.	Column A02	-197	-112	8.70 to 11.55
5.	Column B08	-107	-139	9.11 to 10.77

TABLE 9 COVER METER TEST RESULT

Sr. no.	Description	Cover Meter (mm)				
1.	Column A06	24	26	30	36	45
2.	Column A08	24	42	48	30	36
3.	Column A04	16	20	26	30	28
4.	Column A02	36	40	50	55	30
5.	Column B08	35	20	26	36	30
6.	Column C02	24	24	32	36	25

VI. OBSERVATION

1. Bad quality of material used while construction.
2. High seepage observed at kitchen, toilet and bathroom walls.
3. High vegetation at the backside of the building, in the kitchen sink, sanitary pipe.
4. High corrosion in column, beam and slab at maximum location.
5. The building has any construction deficiencies.
6. Slab leakage is also observed.

VII. CONCLUSION

1. It is observed that Ultrasonic Pulse Velocity result with direct, indirect and semi-direct method indicates that the readings are between (Refer to IS 13311(PART I):1992). The quality of concrete is medium and doubtful at maximum location.
2. As per Rebound Hammer Test (Refer to IS 13311(PART II):1992). The readings are in the range of. The quality of concrete is poor concrete.
3. As per pH carbonation concrete maximum corrosion of reinforcement is observed. Carbonation depth has reached up to the reinforcement level. It is observed that the pH of cover concrete is reduced but the passive layer over the reinforcement is intake.
4. As per the Half Cell potentiometer test on reinforcement it is observed that all the readings are ranged from this indicates corrosion has started in reinforcement and exceed the acceptable limit.
5. From all the observation and results it is necessary that the existing structure is needed to be repair and retrofitting immediately.

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