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# Structural Audit of an Old Building

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**Abstract:** *Structural Audit is an examination of the total health of a building in order to check its strength and stability to ensure that it is safe, risk-free and habitable. Structural Auditing of an old building is important because improper construction, bad quality of material use for construction, inaccurate working by labour cause of all this sustainable capacity of building get decreases.*

*Now a days building life get decreases from 100 years to 60 years. Structural Audit helps to find the defect in building, it is useful to enhance the strength of building and gives proper idea after detail checking for strength of the structure. Non-destructive test help to know faults in structural members as well as internal condition of reinforcement and real strength of building also.*

*Performing the Audit of an old structure have to conduct NDT on structural element building like ultra-sonic pulse velocity, half-cell test, rebound hammer test, etc.*

*After know the result we will decide whether the building is safe or not if safe then remedial measure like repair will be provided to enhance the load carrying capacity of an old building.*

**Keywords:** *Non-destructive testing, Structural Auditing, Compressive Strength, Material, Quality of Concrete.*

## I. INTRODUCTION

A civil infrastructure is a model of linked, associated element that form together a system which can carry the external loads on it. As time goes structure get older and lessen its strength due to unpredictable load on it, deterioration of materials or physical damages.

Use structure with this defects it may cause dangerous loss of property and livings as well. That's why we have to maintain and scrutinize structure to prevent structure from future damage. To control this problem a structural audit have to do after 15 or 20 years to know the condition of building and materials used. Structural audit ensure that the building are guarded and haven't dangerous.

Structural audit consist of testing like Ultrasonic pulse velocity test, Rebound hammer test, pH test, etc. from this test result come to know the quality of concrete, strength of concrete and condition of reinforcement. According to this we can strengthening and modify structural element to regain its capacity and withstand longer.

Use of structural auditing in future can help in limiting damages to structure and life as well. This paper cover the study and type of tests conduct for structural Auditing of an old structure.

## II. OBJECTIVES

- A. Carried out various NDT method on the existing structure.
- B. Identification of the possible causes leading to the damages of the structure.
- C. Evaluate the amount of damages caused.
- D. To determine structures stability for future use.
- E. To find critical areas to repair instantly.
- F. To suggest corrective and preventive measure to increase strength of building and repairs of buildings.

## III. METHODOLOGY

- A. Study of architectural and structural drawing, design criteria of existing structure
- B. Visual inspection:- Visual inspection plays an important role while investigating the condition of building. In visual we inspect the building and find out the damages which we have observed visually.
- C. Non-Destructive Testing

- 1) *Ultra-Sonic Pulse velocity (UPV)*: As per IS 13311 (Part I) 1992 -The UPV measurement technique consist of determination of velocity of ultrasonic pulse through solid material. The density and elastic property of material on this pulse velocity depends. Type of testing direct transmission, indirect transmission and semi-direct transmission.

Sr. No	U.P.V (Km/sec.)	Quality of concrete
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3 km/sec.	Doubtful



Fig. 1. Ultra-Sonic Pules Velocity Test

- 2) *Rebound Hammer Test (RHT)*: As per IS 13311 Part II- The rebound hammer test used to check the compressive strength of concrete. A verifiable relationship has been determine between the absorbed by the concrete when given a high impact and its compressive strength. RHT is work on the principle of the rebound of an elastic mass.

Sr. No	Average rebound	Quality of Concrete
1.	>40	Very good
2.	30-40	Good
3.	20-30	Fair
4.	<20	Poor



Fig. 2. Rebound Hammer Test

3) *Half-Cell Test:* (IS 13311 (part II) 1992) the instrument measures the potential and the electrical resistance between the reinforcement and the surface to evaluate the corrosion activity as well as the actual condition of the cover layer during testing. The electrical activity of the steel reinforcement and concrete leads them to be consider as one half of weak battery cell with the steel acting as one electrode and the concrete as the electrolyte.



Fig. 3. Half Cell Test

D. Preparation of structural assessment and Audit Report.

E. Observing all NDT results to suggest preventive measure for repair and also suggest preventive method for increasing strength of building.

#### IV. RESULT

From visual inspection vegetation at some places, Seepage, cracks, black spots observed, Drainage also seen damaged.

##### A. Non Destructive Test results

###### 1) UPV test result

Sr. No.	Description	No. of Points	Ultra Sonic Pulse Velocity (km/sec)		
			Minimum	Maximum	Average
Ground Floor					
1.	Columns	25	1.01	4.85	2.93
2.	Beams	3	2.86	3.38	3.12
First Floor					
1.	Columns	6	3.02	4.92	3.97
Second Floor					
1.	Columns	2	3.06	3.86	3.46
Third Floor					
1.	Columns	3	2.61	3.44	3.02



2) *Rebound Hammer Test Result*

Sr. No.	Description	No. of Points	Rebound Hammer Test		
			Minimum	Maximum	Average
Ground Floor					
1.	Columns	25	20	40	30
2.	Beams	3	16	36	26
First Floor					
1.	Columns	7	18	32	25
Second Floor					
1.	Columns	3	16	26	21
Third Floor					
1.	Columns	4	16	32	24

3) *Half Cell Test Result*

Sr. No.	Description	Half Cell Test	Average
1.	Columns	-264, -314, -234, -272, -286, -315	-280
2.	Columns	-355, -346, -321, -272, -241, -223	-293
3.	Columns	-412, -407, -401, -395, -370, -388	-396
4.	Columns	-232, -221, -215, -192, -237, -156	-208
5.	Columns	-399, -320, -318, -305, -242, -237	-304
6.	Columns	-288, -265, -222, -185, -243, -286	-248

**V. CONCLUSION**

As per the non-destructive testing carried out on above mentioned structure, it is observed that the ultrasonic pulse velocity results with indirect, direct & Semi direct methods indicates that maximum readings are between 2.01 Km/Sec to 4.35 Km/sec (Refer to IS 13311 (Part 1) 1992). “Non-destructive Testing of concrete methods of test, Ultrasonic Pulse Velocity” The quality of concrete is Medium & Doubtful at some locations and good at some location.

As per the Rebound Hammer test Ref. IS 13311 (part II) 1992 “Non Destructive Testing of concrete-methods of test, Rebound Hammer”. The maximum readings are confirming to M12 to M15 grade concrete.

As per half-cell potentiometer test on reinforcement it is observed that the readings are between – 178 MV to –399 MV which indicates the active corrosion has started in reinforcement.

Based upon all the non-destructive test results it is observed that columns at Ground level are damaged. Major cracks are observed in columns and reinforcement is exposed at various locations. Hence it is recommended to repair & retrofit the structure as per methodology and specifications.

**VI. SUGGESTION**

From visual inspection report it is suggested that to fill the cracks by means grouting method like Micro Fine Cement Grout to Columns, Epoxy Resin Grout to Column, etc.

Column having less strength detected by NDT test, for increasing the strength jacketing of column as per IS 15988:201 can be provided.



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