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Structural Audit of S.M. D. Bharati High School Arni

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Abstract

The structural life cycle has four significant phases: structural planning, architectural planning, construction, and maintenance. Structures are given a certain service life, but improper maintenance results in premature degradation, particularly in ageing buildings. Neglect at S.M.D. Bharati High School in Arni has resulted in serious degradation, showing how structural audits with frequent check-ups are essential. With permission from the principal, a structural audit was done for locating defects and causes, just like routine health check-ups. This prevents collapse and aids in early detection of defects for maintenance. New advances in technology, such as Non-Destructive Testing (NDT), are enhancing accuracy and speed in structural assessment. With infrastructure getting older, structural health monitoring has grown due to the potential for economic as well as safety hazards. This project underlines the need for continued research and adaptation of modern standards to provide long-term safety, sustainability, and proper administration of civil structures.

Keywords: Structural Audit, NDT, deterioration, Defects, Structural health monitoring etc.

1 INTRODUCTION

In India there are many old buildings which have reduced strength in due course of time. If further use of such deteriorated structure is continued it may endanger the lives of the occupants and surrounding habitation. Appropriate actions should then be implemented to improve the performance of structures and restore the desired function of structures. Thus, it is more important to perform structural audit of existing buildings and to implement maintenance/ repaire work timely which will lead to prolonged life of the building and safety of the occupant. To act more responsible and preventive towards the dilapidated buildings, the municipal corporation must issue notices to the buildings and co-operative societies which are more than 30 years old to carry out mandatory structural audit and submit the audit report. Structural audit should highlight and investigate all critical areas and recommend immediate remedial and preventive measures. It should cover the structural analysis of existing frame and find critical elements for all types of loadings. It also helps in delivering a strong building structure with cost effective solutions and appropriate maintenance program. This project deals with study of different parameter of structural audit including visual inspection, and non-destructive testing. It also emphasizes on different repairs and retrofitting measures to be used for buildings after structural audit. In our construction industry non-destructive testing methods are used to examine the compressive strength of concrete because they are important alternative to a destructive test, and in the meantime, are relatively easy to conduct and are economical. If destructive methods are used in the lab, the resulting compressive

strength results would not accurately represent the quality of in situ cast concrete. In this project, we investigated the structural integrity of reinforced concrete structures through the application of Non-Destructive Testing (NDT) methods. Two NDT techniques, namely the rebound hammer test and ultrasonic velocity test, were employed to assess the condition of the structures. The rebound hammer test was conducted to evaluate the surface hardness and integrity of the concrete, providing insights into its compressive strength and potential areas of deterioration. Additionally, the ultrasonic velocity test allowed us to measure the propagation speed of ultrasonic waves through the concrete, aiding in the detection of voids, cracks, and other anomalies within the structure Based on the results obtained from these NDT tests, we analyzed the structural health of the reinforced concrete elements. If indications of distress or deterioration were identified, we explored various repair techniques to address these issues. Through our study, we aimed to provide valuable insights into the condition of reinforced concrete structures .By employing NDT methods, we were able to accurately assess the structural health and make informed decisions regarding the implementation of retrofitting measures.

Testing core sample from an existing structure is a better way to examine the concrete quality. However, it is sometime not feasible to take core sample on site. Oftentimes, the drilled sample or the concrete structure might be damaged during the drilling process. So, Non-Destructive Testing are good alternative to measure the compressive strength of concrete the Rebound Hammer and Ultrasonic Pulse Velocity tests are the two popular Non- Destructive Testing method that can be used to estimate the compressive strength of concrete or concrete structure.

Objective

- To perform preliminary inspection of the school building.
- To investigate the structural distress and deformation of S.M.D. Bharati.
- To identify signs of Material deterioration & also identify types of defects by visual inspection.
- To test the strength of building elements by using Non-destructive testing and based on it to find out extent of damages and severity.

2. METHODOLOGY

1. Performing preliminary inspection of the school building and preparing the architectural, structural plan of the school building.

2. Visual Inspection

The building was investigated floor by floor, including external areas, to observe structural conditions. Various defects were identified in columns, beams, and slabs, including spelling seepage cracks, and crazing. All observed defects were documented on inspection sheets, along with approximate repair recommendations, forming a comprehensive dataset for the structure.

3Non-Destructive Testing (NDT)

i. Rebound Hammer Test
ii. Ultrasonic Pulse Velocity Test.
iii. Half Cell Potential Test.
iv. PH Test.

v. Carbonation Test.

These methods help to detect issues that are not immediately visible on the surface.

i) Rebound Hammer Test: It is a non-destructive testing method of concrete which provide a convenient and rapid in direction of the compressive strength of concrete. The rebound 13 hammer is also called as Schmidt hammer that consist of a spring-controlled mass that slides on a plunger with in a tabular housing. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This test is done to assess the quality of concrete by rebound hammer test method as per IS: 13311 (Part 2) – 1992.

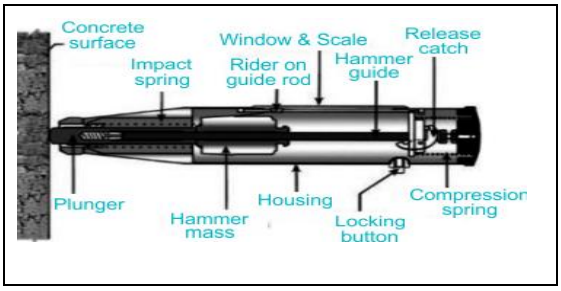
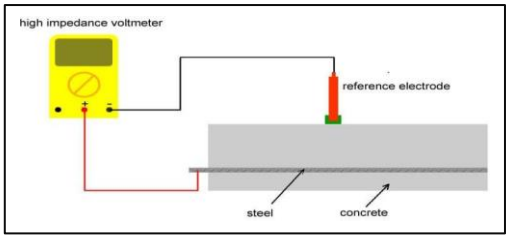


Fig No. 1 Rebound Hammer

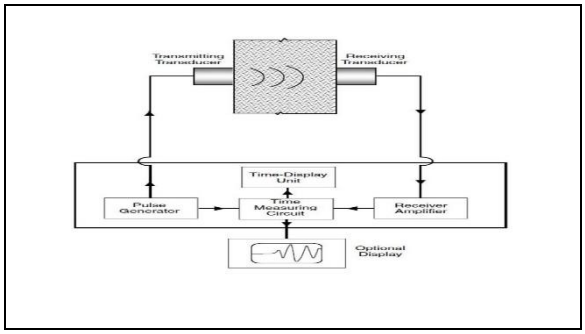
ii) Half-Cell Potential Test:-The half-cell potential test is the only corrosion monitoring technique standardized in ASTM C876 – 15: Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete. It is used to determine the probability of corrosion within the rebar in reinforced concrete structures.

Fig No. 2 Half Cell Potential Test



iii) Ultrasonic Plus Velocity Test:- It is one of the non-destructive test methods based on the transmission of the ultrasonic pulse in the component or materials like concrete, steel, etc. The ultrasonic testing method is based on the use of equipment composed of transducers which produce and receive the ultrasonic wave of 0.01 to 60 MHz the pulse (wave) depends on the density and the elastic properties of the materials of RCC structure. This test is done to assess the quality of concrete by ultrasonic pulse velocity method as per IS: 13311 (Part 1) – 1992. The underlying principle of this test is – The method consists of measuring the time of travel of an ultrasonic pulse passing through the concrete being tested.

Fig no 3 Ultrasonic Plus Velocity Test



iv) PH Test:-Test Although concrete typically begins its life at highly pH of about 13 but when it is exposed it fall as reaction occur between carbon dioxide from the atmosphere and alkalis in the concrete, this process is known as carbonation and over the period pH value of about 8.5.The PH meter test is an important parameter to indicate the alkalinity level of concrete.

Fig no 4 pH Test

v) Carbonation Test:- This test determines the depth of carbonation in concrete the depth of carbonation is estimated by the change in color profile. Carbonation of concrete is a process through which the carbon dioxide from the air penetrate into the concrete and reacts with calcium carbonate. In the presence of moisture, CO2 changes into dilute carbonic acid which attacks the steel and increases the acidity if the concrete, thus leading to corrosion of embedded steel.

Fig no 6 Carbonation Tes

3 RESULT AND DISCUSSION

3.1 Structural audit report of school building.

Table -1: Basic Information of school Building.

SR NO	BUILDING /STRUCTURE	DETAILS
1	Name of building	S.M.D. Bharati High School Arni.
2	Address	ARNI , YAVATMAL

		MAHARASHTRA (INDIA)
3	-Mode of use -type of structure	Educational building RCC Structure
4	No of story	G +1
5	Year of construction	1997
6	Previous structural audit	None
7	Floor height	3.6m
8	External wall	Brick Wall
9	Internal wall	Brick Wall
10	Mode of survey	Visual Inspection, Tamping Observation, Non Destructive Testing.
11	Inspection area	External wall, Internal wall, Terrace, Column, beam of all class rooms.[In case of civil, mechanical and electrical engineering point of view]
12	Previous Maintenous work	Before 1 yr.
13	Miscellaneous /Special Things	None

3.2 Visual Inspection

Visual inspection is an extensive evaluation of a building's current condition in Bharati schools such as structural defects, harmful substances, and regulatory compliance. They are conducted for determining cracks/deflections in walls, water leakages, and durability in concrete. Dampness in a wall is evaluated along with fluctuating loads in the building which could have been imposed.

Table -2: Visual inspection Result

SR NO	DEFECT	IMAGE	CAUSES
1	Cracks on Slab		Poor ConcreteCuring Uneven Sub-grade

2	Crack on Column		Due to elastic deformation, shrinkage, and creep in RCC column Due to Seepage
3	Crack on Beam and Chajja		Due to corrosion of reinforcement Due to provision of insufficient reinforcementcovering
4	Crack on Wall at Door frame joint		Initial shrinkage of a brick work.
5	Damp-ness of wall		Due to leakage in plumbing system Defective parapet wall, window seal
6	Paint Peeling		Poor surface pre-paration, moisture damage, and the use of incompati- -ble or low-quality materials.
7	Honey Combing of Column		Use of larger size aggregate in excessive amount Improper Compaction of Concrete.

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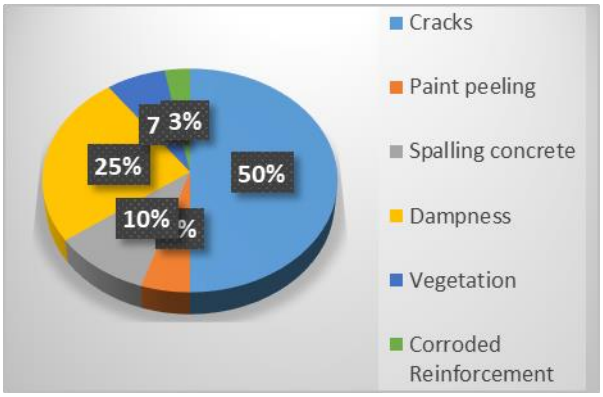


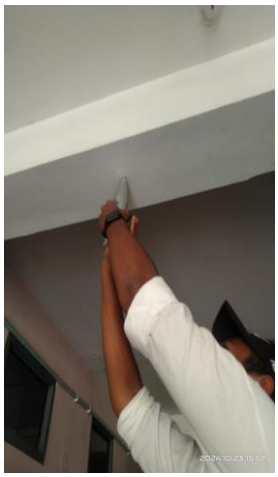
3.3Non -Destructive Test [NDT]

I) Rebound Hammer test.

Table no.3 Rebound Hammer test Results

Rebound Hammer Results			
Rebound Value (Ranges Obtained) & Direction	Number of Reading	Average Rebound Number	Approximate Compressive strength (As per manufacture's chart/calibration chart N/mm2)
Columns, Beams and Slabs (RCC)			
39-43 →	27	33	In range from 17 to 37 but not less than **17**
32-35 ↑	18	35	In range from 16 to 28 but not less than **16**
27-30 ↓	9	28	In range from 22 to 25 but not less than **23**

II) Ultrasonic Pulse Velocity.

Performing Rebound Hammer Test

Table No. 4 Ultrasonic Pulse Velocity Test.

Component		Pulse Velocity (Km/Sec)	Avg. Pulse Velocity (Km/Sec)	Remark
Beam	1	3.1		Satisfactory But loss of integrity Is suspected
	2	3.5	3.3	
	3	3.3		
Column	1	3.7		
	2	3.5	3.7	Good to very good, slight Porosity may exist
	3	3.9		
Slab	1	3.1		

	2	3.0	3.1	Satisfactory but loss of integrity is suspected
	3	3.3		

Performing Ultrasonic Pulse Velocity Test

III) Half Cell Potentiometer Test

Table No 5 Half Cell Potentiometer Test Result.

Sr No	Structural Member	Avg. Half Cell Potential Test Result
1	Beam	-315

IV) Ph and Carbonation Test.

Table No. 6 Ph and Carbonation Test.

Sr. No	Location	Member	Observation Carbonation test	Observation Ph test

1	GF N C1	Chajja	Surface carbonation found	8.5
2	GF S B1	Beam	Surface carbonation found	8.3

DISCUSSION

The investigation has concluded that the overall structural health condition of the bharati school building is good. The NDT test has shown that some structural components have Class three damage, as per CPWD guidelines. This includes issues like spalling of concrete cover and structural cracks, which require important repairs. To prevent further damage, these repairs should begin as soon as possible. The necessary work includes as Strengthening of columns, Waterproofing and Fixing of leakages. The quality of RCC was found to be good based on the rebound hammer test, UPV Test conducted at various locations. However, delaying the repairs may lead to further deterioration, affecting both the quality and extent of work needed.

4 RECOMMENDATIONS

- Hairline cracks in the external plaster have been observed at different levels of the school building. These cracks allow rainwater to seep in, increasing the risk of dampness inside the class rooms.
- For the Dampness Treatment Prepare a slurry coating by mixing 25-30% water with Dr. Fixit Wonder Proof 1 and apply it to the affected areas to prevent further moisture ingress
- To fill voids, cracks, and some structural joints**,** injection grouting should be carried out to restore integrity and prevent further deterioration. Implementing the Rainwater Harvesting System will help divert rainwater effectively, reducing the risk of water ingress into the slab during the rainy season and preventing slab leakage problems.
- If we see spalling of concrete at different location like chajja , beam ,column ,wall etc. Then we use polymer modified concrete for re-plastering the structural element.
- Structural Audit of Newly constructed building should do following way-

Structural Audit	Age of Building.
Structural Audit First.	After 3 yrs.
Second Structural Audit	After 5 yrs.
Third Structural Audit	After 10 yrs.
Fourth Structural Audit	After 15 yrs.

5 CONCLUSIONS

1. We have done structural audit of Bharati school building in two ways such as by Visual Inspection and by Non-Destructive Test. By visual inspection we have seen different types of defects i.e. dampness, different types of cracks, honeycombing, effloresces .etc.

2. After observing that we have prepared the Architectural plan then we performed Non-Destructive Test and find out the compressive strength ,Quality of Concrete, acidity or alkalinity of concrete and rate of carbonation, and corrosion of reinforcement.
3. According to Architectural Health Index the overall condition of building is good.
4. During Rebound Hammer Test And Ultrasonic Pulse Velocity Test Verious column beam and slab are found to have medium to good quality and strength as per as 13311 part 1 and part 2 the reading shows in table 3 and 4.
5. The average compressive strength of concrete based on rebound hammer test is observed may varies by ($^{+}_{-}$) 25% of the result obtained .
6. Surface carbonation found in beam with reduction in the Ph of concrete cover,and Half-cell potentiometer testing was conducted to assess potential corrosion in the reinforcement.

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