

STRUCTURAL AUDIT – A CASE STUDY OF EDUCATIONAL BUILDING

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Abstract - In case of Construction Industry the life cycle of a structure can be divided by in to four important phases those are as Architectural planning, Structural planning, Construction and Maintenance. Every structure has its own Service life it should stand firmly on its position. But because of giving less importance to the maintenance collapsed mechanism has increased day by day and structure are getting collapsed before its service life is completed which leads to the lose of properties and life of human beings. There for it is suggested that to overcome the failure of structure it is necessary to do the structural audit and find the lacunas in the structure also find out the root causes of faulty mechanisms to avoid future problems.

Key Words: Structural Audit, Lacunas, Collapsed Mechanism, Life Cycle.

1. INTRODUCTION

In India there are many old structures which have reduced the strength due to change of climate and different weathering conditions but the future use of such deteriorated structure is continued it may endanger to human being and animal so appropriate action should be implemented to improve the performance of structure and restore the desired function of structure. Thus Structural Audit of such type of buildings is necessary also timely maintenance /repairs also important. This will lead to prolonged life of building and safety of occupants. The Competent authority like Municipal Corporation must issue the notices to such building/ structures which is having age more than 30 years and under maintenance. Also they have to do Mandatory Structural Audit and submit Structural Stability Certificate of existing property within 30 days the issue of notice. Structural audit should highlight and investigate the area of distress and recommend quick remedial and preventive measures. Also it should cover structural analysis of existing structure and find the critical components for all types of loading. It helps to improve strength of structure with cost effective solutions and appropriate maintenance program.

This paper related to study the different parameters of structural audit like Visual Inspection, Tapping Inspection, Non Destructive Test [NDT], Destructive Test, UPV Test...etc.

It also emphasizes on different repairs and maintenance, Retrofitting, Rehabilitation....etc. measures to be used for structural audit.

1.1 Structural Audit of Building

Structural Audit is nothing but the overall Health Performance, Checking up of Building like a Doctor examines the Patient. It ensures that the building and its premises are safe and have no risk. It gives analysis of structure and provides necessary suggestion for appropriate repairs and retrofitting measures for the building to provide better service life. This Audit should done by experienced and Licensed Structural Consultants.

1.2 By-Laws

Structural Audit is mandatory for all CHS [Co-op Housing Society] and its provisions are as given in Bylaw No-77. The society shall cause "Structural Audit" of the building as follows.

- 1- For Building aging between 15 to 30 years once in 5 year.
- 2- For Building aging more than 30 years once in 3 year.

1.2 Objective of the Project

- To understand the real condition of the Building.
- Protect the life of human being and animal from structural failure.
- To know the Current Health of building and to protect the future life.
- Awareness of residents to under the seriousness of the problems and to suggest the remedial measures for strengthen or repairs, rehabilitation of the structure.
- To identify any signs of material deterioration.

2. METHODOLOGY AND INVESTIGATION

1- Study of plan, all Structural drawings, details, if not available the plan should be prepared.

2- Visual Inspection

The building was investigated by Floor by Floor for observation and external area of the building some of the column, beam and slab within the structure were observed for a range of defects such as spalls, seepage cracks and crazing....etc.

All the defects were marked on the observation sheets with approximate repairs which formed the total data of the structure.

3-Tapping Observation

Some of the column and beams inside the flats were subjected to Tapping by hammer. The hollow sound was recorded. This was evaluated for remedial measures.

4- Non Destructive Testing [NDT]

In addition to Visual Inspection and Tapping Observation the quality and strength of structural components can be determined by the use of various Non-Destructive Test. There are various NDT instrument used in concrete members which determines the present Strength and quality of concrete. The result of these is useful in finding out the treatment to be given to the structural members and various types of the test available in the market those are as below.

A) Rebound Hammer Test

To measure the surface Hardness of Concrete.

B) Half Cell Potential Method

To assess probability of corrosion in the embedded steel.

C) Ultra Sonic Pulse Velocity Test

To assess homogeneity of the concrete to assess strength of concrete qualitatively to determine structural integrity.

D) Repairs

The repairs should be as per Standard Procedure given in respective code. The maintenance work should carried out as per mentioned.

E) Identification of distress area of structure

Based on the above inspection analysis and test results the report concluded the critical areas that need immediate repairs and maintenance, retrofitting, rehabilitation. The report is prepared on the maintenance required.

3. RESULT AND DISCUSSION

3.1 Structural audit report of Case Study

Table -1: Case Study- Basic Information of RCC Building.

Sr. No.	Building/Structure	Details
1	Name of Building / Structure	N.D English Medium School
2	Address	Pune [MH] [INDIA]
3	-Mode of Use -Type of Structure	Educational Building RCC Structure
4	No. of Stories	G+2

5	Year of Construction	1990 [29 yrs old]
6	Previous Structural Audit	None
7	Floor Height	3.6 m
8	External Wall	Brick Wall
9	Internal Wall	Brick Wall
10	Balconies	3 Nos. [West Zone Side]
11	Mode of Survey	Visual Inspection , Tapping Observation , Non-Destructive Test.
12	Inspected Area	External Wall, Internal Wall, Terrace, Beams, Columns, All Class Rooms. [In case of Civil ,Mechanical and Electrical Engineering point of View]
13	Units Locked	None
14	Survey Disallowed in Units	None
15	Miscellaneous /Special Things	None

Table -2: Visual Inspection Report

Sr. No.	Inspected Components	Remarks
A]	SUB- STRUCTURE	-----
1	Foundation Strata	Soft Strata observed on 2.20m and Hard Strata Observed on 2.40m depth
2	Settlement of Footing And Column	No Settlement of Footing and Column Found
3	Cracks in Column , Walls ,Joints	Minor Cracks are found on Column, Walls.
B]	PLINTH-LEVEL	-----
1	Joint at plinth	Minor Cracks Found
2	Swelling Problem	Not Found
C]	SUPER- STRUCTURE	-----
1	Cracks in Columns / Rusting of Steel / Exposed Steel	Normal Rusted steel, Broken reinforcement, and cracks in column is visible below slab ,balcony and junction of beam and column
2	Cracks in External Walls	Minor Inclined cracks are developed
3	Cracks in Internal Walls	Minor Vertical cracks are developed
4	Leakages and Dampness in External and Internal Walls	Normal dampness observed on inside wall
5	Slab	Some cracks and Leakages are found on slab
6	Overhead Water-Tank	Found Normal Leakage

		and rusted steel
7	Colour of Building	Found Fade
8	Tiles , Skirting and Dados	Major Breakages found
9	Condition of Plumbing system	Some Leakages found near the junction of pipes
10	Electrical Wiring	Open Fitting found in poor condition
11	Condition of Doors Windows , Ventilators , and fasteners	Found good in operating condition
12	Electrical Equipment's like, Fans, Tube-Light, Exhaust Fans, Switches, Electrical Boards..etc	Overall performance of all mentioned items are found Good and Satisfactory
13	Condition /Performance of Lift.	Lift not available
14	Condition of Rain Water Harvesting System [RWH]	Not Available
15	Condition of Sewage Treatment Plant [STP]	Not Available
16	Under Ground Water Tank	Found Minor plaster cracks.
17	Sanitary Facility Condition	Satisfactory
18	Building Last Repair details	Before 1 yr.
19	Cost of Repair	5.0 Lac
20	Items Repaired	Coloring , Drainage system, Plumbing System, Water Proofing for slab, Underground water tank cracks repairing

Table -3: Non -Destructive Test [NDT]

Components	No.	Strength of Component in Mpa	Avg. Strength in Mpa	Remark
COLUMN	C1	34	36 Mpa	Very Good Layer
	C2	33		
	C3	37		
	C4	35		
	C5	37		
	C6	40		
BEAM	B1	32	30 Mpa	Good Layer
	B2	36		
	B3	22		
	B4	30		
	B5	32		
	B6	30		
SLAB	S1	22	25 Mpa	Good Layer
	S2	28		



Photo -3: Non-Destructive Test [NDT] on Column and Slab in Building.

3.2 Limitations of Case Study

The case study of Educational Building is done on the Basis of Visual Inspection, Tapping Observations and Rebound Hammer Test. The rough idea from the result is that the structure requires minor repairs as early as possible. But for detection of Technical damages or defects at specific and particular components of building Proximal Remote Sensing Tools [PRST] should be used.

3.3 Discussion

From the above investigation we have come across to the result that the structural Health condition of educational building is good. But with the study of NDT test we have investigated that the some Structural components are suffering from class three damage. According to CPWD [Central Public Work Department] class three damage for observation like spalling of concrete cover, structural cracks...etc. in which principal repairs are required.

This principal work must start quickly to avoid further damages in structure. This includes strengthening of column, water proofing, and rectification of leakages. Quality



Photo -1: Visual Inspection of Cracks and Damages of Plaster in Building.



Photo -2: Visual Inspection of Leakage in Building.

of RCC found good in as per the result of rebound test performed at various locations. Delay in repair works will affect the quality and quantity of work due to continuous deterioration of structure.

1-Ingress of Water- Ingress of water due to lack of chajja was observed on North Zone of Building.

2- Water Proofing- Lack of regular maintenance was observed in slabs.

3-Plaster- Due to Environmental effects i.e. Thermal Instability Spalling of Concrete has occurred at all internal and external wall.

4-Doors and Windows- Lack of regular repairing of Doors, windows and glasses are observed in some class rooms.

4. RECOMMENDATIONS

1-The structure needs Rain Water Harvesting System [RWH] so that the water will not ingress in to slab in rainy season and slab leakage problems will be solved.

2- The Structure needs Sewage Treatment Plant [STP] so that the seepage of waste water which impacts on footing will be less and odour problem nearby the area will be reduced.

3- Replacement of all Tube lights in to LED Bulbs that saves the energy.

4- Installation of Solar energy plant is mostly required.

5-Periodic maintenance should be there like three months minor and six months major maintenance.

6-Retrofitting, Rehabilitation, Propping are required where ever is necessary.

7-Installement of Updated fire-fighting / fire Extinguisher system should be adopted.

8-Requirement of extra Exit at East and North zone of the structure and also provides necessary ventilation at that zone.

9- Refuge Area must provide to the all old Buildings as well as new buildings in case of fire and Emergency.

10- Structural Audit of Newly constructed building should do following way-

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

11-Government of Maharashtra must do the structural Audit Mandatory to all Municipal Corporations and Local authority having building age more than 30 years.

12- Government must appoint a "TAC COMMITTEE" [Technical Audit Committee] to check the Audit reports submitted and the remedies implemented.

13- It's a "High Time" something is done to in Built Durability and Sustainability into every new construction.

5. CONCLUSIONS

While doing the Structural Audit and various Non-Destructive Test [NDT] it has been concluded that the Structural Audit of all old buildings having age more than 30 years must be necessary.

Principal repairs are mostly required at various levels. Any delay in Structural repair works will result in more deterioration and maintenance will become more and more.

Minor cracks should be repairs by injection of Epoxy or by using Grouting Method so that the building appears to be quite good and major structural distress is not observed in different components of building.

The Effective implementation of Auditing enhances the life span of Structure present deterioration of building leading to Sustainability.

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