Study on Rehabilitation of RCC Building With Case Study

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Abstract- *Buildings and other structures have a certain useful life, which depends on the specifications adopted.The large numbers of monuments, which are cherished heritage structures have stood well over a period of time. But some of these have shown signs of distress due to age, aggressive natural environment/industrial pollution etc. Further,distress gets aggravated due to overloading and misuse of buildings. A few buildings have also failed due to faulty design or construction.The life cycle of building can be broadly divide into four phases i.e. architectural planning, structural design, construction, maintenance. In most of building at most care is taken in first three cases but maintenance is forgotten. Ignorance to maintenance causes severe structural distress in building over period of time. Most of the building constructed in last 23 to 30 years is in severe structural distress and needs to repair, hence these building needs a periodical survey from structural point of view to asses from structural health. Based on this survey a decision regarding the structural health of building and repair required can be taken. This project with methods of estimating the audit of existing structures whose life has crossed the age of 30 years. Such an investigation can be carried out using the following methods: a) Visual examination b) Non Destructive Testing c) Partial Destructive Testing. This project covers the study of Structural Auditing of Residential Building .*

Keywords- Structural audit, Structural Engineering, NDT method, Structural Evaluation Program

I. INTRODUCTION

Large stocks of existing structures and infrastructure are deteriorated with use and time and might have passed their design life and require retrofitting and rehabilitation. The cost of retrofitting various infrastructures is estimated in the lakhs of rupees. To overcome the ill effects caused by these deteriorated buildings Repair and Rehabilitation works are carried out from time to time. Many of the existing structures were designed to codes that have since been modified and upgraded. Change in use or higher loads and performance demands require modifications and strengthening of structural elements. Concrete construction is generally expected to give trouble free service throughout its intended design life. However, these expectations are not realized in many constructions because of structural deficiency, material deterioration, unanticipated over loadings or physical damage. Premature material deterioration can arise from a number of causes, the most common being when the construction specifications are violated or when the facility is exposed to harsher service environment than those expected during the planning and design stages.

II. RESEARCH METHOLOGY

Steps to be followed in Structural Auditing

STEP 1: It is imperative that we must have Architectural and Structural plans of the buildings. It will be helpful if we have detailed structural calculations including assumptions for the structural design.
STEP 2: If the Architectural plans and Structural plans are not available, the same can be prepared by any Engineer.
STEP 3: Inspection of the Building
STEP: 4 Preparation of Audit Report: On the basis of inspection of building an Audit Report is prepared.
STEP 5: Tests Recommended: It is important that various tests are carried out in the old buildings. This will give an idea about the extent of corrosion, distress and loss of strength in concrete & steel.
STEP 6: Highlight the critical areas and how to go for repairs.

Case Study of R.C.C. Building

The damages observed were excessive spalling of concrete, formation of wide cracks, excessive corrosion, falling of-fenders etc. In general, it was observed that various structural elements after these have been exposed/chipped off showed much more deterioration than was observed at the time of the site survey.

1. Structural Audit Report:-

Basic Information

Type of Structure - RCC Building of G+4 floors
Address - Pune
Type of Structure – RCC
No of wings & stories - 4 storied
No & type of apartments - 18 flats
Description of Building
Year of construction-Aug 1987
Age- 33 years
Effects of monsoon – Yes

2. Report on Non Destructive Testing Of R.C.C. Members

- **Non Destructive Tests**

Non-destructive testing (NDT) methods are techniques used to obtain information about the properties or internal condition of an object without damaging the object. Non-destructive testing is a descriptive term used for the examination of materials and components in such way that allows materials to be examined without hanging or destroying their usefulness.

- **The Rebound Hammer Test:**

The Schmidt rebound hammer is basically a surface hardness test with little apparent theoretical relationship between the strength of concrete and the rebound number of the hammer.

- **Ultrasonic Pulse Velocity Test**

This test involves measuring the velocity of sound through concrete for strength determination. Since, concrete is a multi-phase material, speed of sound in concrete depends on the relative concentration of its constituent materials, degree of compacting, moisture content, and the amount of discontinuities present. This technique is applied for measurements of composition (e.g. monitor the mixing materials during construction, to estimate the depth of damage caused by fire), strength estimation, homogeneity, elastic modulus and age, & to check presence of defects, crack depth and thickness measurement.

- **Effect Of Reinforcing Bars:**

The pulse velocity in reinforced concrete in vicinity of rebar's is usually higher than in plain concrete of the same composition because the pulse velocity in steel is almost twice to that in plain concrete.

Table:Velocity Criterion for Concrete Quality Grading as per IS 13311-1992(PartI)

Sr.No.	Pulse velocity by crossprobing (Km/sec)	Concrete quality grading
1	Above 4.5	Excellent
2	3.5 to 4.5	Good
3	3.0 to 3.5	Medium
4	Below 3.0	Doubtful

- **Carbonation test :-**

CO2 present in the atmosphere reacts with the hydrated cement minerals to reduce the alkalinity of the concrete and increase the risk of reinforcement corrosion. Carbonation of concrete results in increase in strength and reduction in permeability.

- **Rebar Locator:-**

The reinforcement bar is detected by magnetizing it and inducing a circulating "eddy current" in it. After the end of the pulse, the eddy current dies away, creating a weaker magnetic field as an echo of the initial pulse.

Result

Convolution is the first layer to extract features from an input image (image). Convolution preserves the **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	SAI Apartment
2	Address	Pune [MH] [INDIA]
3	-Mode of Use -Type of Structure	Residential Building RCC Structure
4	No. of Stories	G+4
5	Year of Construction	1987 [33yrs 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 ElectricalEngineering 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	Color 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

NON DISTRUCTIVE TESTS-

Fig 7 : Non-Destructive Test [NDT] on Column and Slab in Building

(Rebound Hammer Test)

Test results of Rebound Hammer Number:

Table4: Rebound Hammer Testing Result

Sr No	R1	R2	R3	R4	R5	R6
1	19	19	24	42	36	38
2	25	20	25	42	37	38
3	23	20	26	41	40	37
4	22	19	26	42	37	37
5	23	19	26	42	39	38
6	22	20	25	42	40	38
7	22	19	25	43	40	37
8	22	21	24	43	41	37
9	23	21	25	43	40	38
10	22	19	25	42	41	37
Mean	22.3	19.7	25.1	42.2	39.1	37.6
D.L.	150	150	150	150	150	150
B.L.	247	311.5	365.5	830	710	760
Fck	11	13.8	15.3	36.88	31.5	33.8

Ultrasonic Pulse Velocity Test-[IS13311 Part-1]

This test involves measuring the velocity of sound through concrete for strength determination. Since, concrete is a multi-phase material, speed of sound in concrete depends on the relative concentration of its constituent materials, degree of compacting, moisture content, and the amount of discontinuities present.This technique is applied for measurements of composition (e.g. monitor the mixing materials during construction, to estimate the depth of damage caused by fire), strength estimation, homogeneity, elastic modulus and age, & to check presence of defects, crack depth and thickness measurement.

Fig.Ultrasonic Pulse Velocity Testing Machine

Test Result of Ultrasonic Pulse Velocity Rest-

Sn	V	V	V	Mean	D.L.	B.L.	Fck
1	2825	2916	2913	2884.67	150	562.5	25
2	3350	3585	3218	3384.33	150	669.8	29.77
3	3625	3632	3218	3491.66	150	720	32
4	4241	4213	4007	4146.33	150	841.5	37.4
5	4411	4444	4117	4324	150	875.5	38.4
6	4625	4525	4417	4522.33	150	893.2	39.7

Testing Results of Hall 2 and Hall 7

1. **Beam 1 of hall 2:**

Table 6: Readings of Beam 1 of Hall 2

Sr no	R.N.	Mean	UPV	Fck
1st support	26 28 27	27	2620	20.3
Mid span	25 27 27	26.33	2729	20
2nd support	26 28 24	27	2645	20.3

2. Beam 2 of Hall 2:

Table 7: Readings of Beam 2 of Hall 2

Sr no.	R.N.	Mean	UPV	Fck
1st support	26 28 27	27	2620	20.3
Mid span	25 27 27	26.33	2729	20
2nd support	26 28 24	27	2645	20.3

3. Beam 3 of Hall 2:

Table 8: Readings of Beam 3 of Hall 2

Sr no.	R.N.	Mean	UPV	Fck
1st support	28 28 27	27	2620	20.3
Mid span	25 27 27	26.33	2729	20
2nd support	29 28 24	27	2445	20.3

III. CONCLUSION

From the consideration of all the above points we concluded that the defects of structural members are due to combined effects of carbonation, corrosion & effect of continuous drying and wetting. The result of visual survey prompt us to conclude the distress is wide spread and is an ongoing process and so needs to be stopped at this stage so as to avoid complete collapse of the structure. Therefore Rehabilitation of the RCC members and will constitute the following steps

- Periodic maintenance of structures is essential.
- Each and every problem should be properly analyzed and then the appropriate repair methods undertaken.
- Primary design of the building reflects its performance in long run.
- Each repair technique is suitable only for the particular application for which it is meant for.
- Cost should not be significant planning factor in rehabilitation though it is a deciding factor.
- Due to moisture, walls get patch off and brick walls losses its strength, so the mentioned repair works for bricks and plaster of walls is well recommended.
- Propping the structure wherever necessary
- Removing loose/disintegrated concrete
- Cleaning the affected steel
- Adding steel wherever necessary

IV. FUTURE WORK

- Future work will developed a energy harvesting system for gained a significant rolled and interest in recent years due to the widespread availability of inexpensive, low cost and low power RF chipsets and microcontrollers that could form the core of a wireless bridge sensor system.
- After implementation of non distructive tests, the methods of rehabilitations will be suggested according to the condition of building/structure such as Grouting, Shotcrete/Guiniting, Epoxy Resins and Epoxy Mortar, RCC Jacketing, Fiber Wrap Technique, Stiching,
- After the successful implementation of the above mentioned methods, the life span of structure or building will increase.

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