To Analyse the Structural Stability of Building on Heavy Rainfall Area

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Abstract – Structural audit is an overall health and performance check-up of building .It is important to the building to check their safety and they have no risk. It is process of analyses of building And this process suggest a appropriate repairs and retrofitting measures required for the building to perform better in its service life, structural audit is an important tool for knowing the real status of the old building. Currently, safety of old buildings which is present in heavy rainfall area is one of the critical issues in India though, there are many practises to conduct structural audit of such buildings. The need of structural audit is for maintenance and repairs of existing structure whose life has exceeded the age of 30 years to avoid mishaps and save valuable human life. The concrete is widely used as construction material being inexpensive, easy for construction, application and because of it high strength-cost ratio. More than ever, the construction industry is concerned with improving the social, economic and environmental parameters of sustainability.

Keywords: Structural Audit, Non-destructive Test, Repair and Controls, Audit Standard.

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1) INTRODUCTION

India is a heritage of old buildings and a structure, rapid infrastructural development from 1980, has resulted in construction of many new multi storied building. This buildings have age more than 30 years.in due course of time this buildings have reduced strength due to material deterioration, unexpected overloading, structural deficiency or physical damages and heavy rainfall. If, further use of such deteriorated structure is continued it may cause of severe loss of life and property. Structural Audit is the overall Health Checkup of a building to ensure that the building is Safe and has no risk. It also suggests some Repair and Retrofitting measures required to increase the Serviceability of the building. The Audit highlights & investigates all the risk areas, critical areas of the Building and also suggests if building needs immediate attention. It also covers the structural analysis of the existing frame and pinpoints the weak structural areas. The Structural Audit is carried out by Appointing a Structural Engineer. He Examines the Structure by Visual Inspection of the Building and if required the Non Destructive Tests are carried out according to requirement of Structure. There is demand of appropriate actions and measures for all such building structures to improve its performance and restore the desired functions of structures which may leads to increase its functional life. The periodical structural auditing and diagnosis for health of existing buildings is thus utmost important for finding the present serviceability and structural viability of structures. The major issues in executing the Structural Audit are Peoples are not aware about the importance of the Audit. They do not come forward. There are many misconceptions about the audit such that the buildings will be demolished. Secondly there is no Standard or Legal Procedure to Carry out Structural Audit. It completely depends on knowledge and Experience of Structural Engineer.

2) LITERATURE REVIEW

- **B.H Chafekar "structural audit" international journal of civil and structural engineering research Vol.1, issue 1, pp:(42-46), month: Oct 2013-March 2014.**

Concluded that before going in detail about the structural audit is necessary to know about the structure. A structure is a system of interconnected elements to carry loads safely to underground earth. The health examination of concrete building called as

structural audit. The author shows different methods in paper: E.g. Visual inspection, non-destructive test.

- **A.B. Mahadik and M.H. Jaiswal " International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 5, Number 4 (2014), pp. 411-416"**

Concluded that to create awareness amongst the civil engineers, Residents and owners of building towards the health Examination of existing concrete buildings called as Structural Audit which help to implement Maintenance and repair work timely which leads to Prolonged life of the building and safety. The need of structural audit is for maintenance and repairs of Existing structures whose life has exceeded the age of 30 years to avoid any mishap.

- **J. bhattacharjee "REPAIR, REHABILITATION AND RETROFITTING OF RCC FOR SUUSTAINABLE DEVELOPMENT WITH CASE STUDIES" civil engineering and urban planning: An international journal (CiVEJ) Vol.3, No.2, June 2016**

Concluded that The construction material mainly reinforced concrete is being used extensively for various types of construction projects. However, the deterioration of Reinforced Concrete structures is recognized as a major problem worldwide. Apart from requiring regular maintenance, many structures require extensive Repair, Rehabilitation &Retrofitting. Over a period of time, as these structures become older, we find in them certain degradation or deterioration with resultant distress manifested in the form of cracking, splitting, delaminating, corrosion etc. Such deteriorated structures can be rehabilitated and retrofitted by using various types of admixtures & modern repair materials. The paper brings out the present state of concrete structures & the major areas where improvement is needed during its service life stage for sustainable development & also the method of carrying out Repair, Rehabilitation &Retrofitting. This has been brought in details in the paper along with Case studies, where the Author of the paper was directly involved in planning and execution of the jobs.

- **Swapnil U Biraris "Structural Audit of Old Structures" International Journal of Engineering Trends and Technology (IJETT) – Volume-43 Number-3 -January 2017**

Concluded that Structural audit is an overall health and performance check-up of buildings .It is important to the building to check their safety and they have no risk. It is process of analyses of building And this process suggest a appropriate repairs and retrofitting measures required for the buildings to perform better in its service life structural audit is an important tool for knowing the real health status of the old buildings.

3) PROBLEM STATEMENT

There are many significant reasons why we should be interested in structural auditing. The first one is to improve our understanding of the actual problems occur on structure due to heavy rainfall. Second one due to heavy rainfall old structures get damage, also settling and sinking of foundation, corrosion of metals, cracks etc. And ultimately failure of whole structure occurs. Therefore, for any load bearing and framed structures, structural audit is necessary.

4) OBJECTIVES

1. To find out the types of structural defects.
2. To identify any signs of material deterioration.
3. To identify any signs of structural distress and deformation.
4. To identify any alteration and addition in the structure, misuse which may result in overloading.

5) HOW STRUCTURAL AUDIT IS CARRIED OUT?

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 **-** A detailed

Inspection of the building can reveal the

Following:

1. Any settlements in the foundations.
2. Cracks in columns, beams and slabs.
3. Concrete disintegration and exposed steel Reinforcement's photographs can be helpful.
4. Slight tapping using hammer can reveal Deterioration in concrete.
5. Corrosion in reinforcement.

6. Status of Balconies – sagging, deflection, cracks.

7. Status of Architectural features viz. Chhajjas.

8. Cracks in walls indicating swelling in R.C.C. members or deflection or corrosion.

9. Leakages from terrace & Toilet blocks.

10. Leakages & dampness in walls resulting into cracks and corrosion.

11. Status of repairs & last repaired.

12. What was repaired?

13. How much was spent for repairs?

14. Building plans are available? When approved?

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 distress and loss of strength in concrete.

STEP 6: Highlight the critical areas and how to go for repairs.

6) METHODOLOGY

1. Destructive testing

To verify the integrity of a component, it is always possible to cut or section through the components and examine the exposed surfaces. components can be pulled or stressed and Pressurized until failure to determine their properties of strength and toughness. Materials can be chemically treated to determine their composition. These are some forms of destructive testing. Unfortunately this approach of destructive testing renders the component useless for its intended use as against non-destructive testing which can be performed on the components and machines without affecting their service performance.

2. Non Destructive testing

Non-destructive testing (**NDT**) is a wide group of analysis techniques used in science and technology industry to evaluate the properties of a material, component or system without causing damage. The terms Non-destructive examination, non-destructive inspection and Non-destructive evaluation are also commonly used to describe this technology, because NDT does not permanently alter the component being inspected, it is a highly valuable technique that can save both money and time in product evaluation, troubleshooting, and research. Common NDT methods include ultrasonic, magnetic particle, liquid penetrate, radiography, remote visual inspection (RVI), eddy current testing.

3. Non-destructive Tests:

- Rebound Hammer Test.
- Pulse Echo Method.
- Impact Echo Method.
- Ultra Sonic Pulse Velocity Method.
- Probe Penetration Test or Windsor Probe Test.
- Ground Penetration Radar Method
- Carbonation Test.
- Half Cell Potential Meter Test.

Rebound Hammer Test

1. Schmidt Rebound Hammer Test is a most Common non-destructive test (NDT) performed on hardened concrete.

2. Schmidt Rebound Hammer Test method is most useful in checking the uniformity of concrete in laboratory as well as in the field.

3. It works on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges.

4. Theoretical relationship between the strength of concrete and the rebound number of the hammer.

5. The rebound value indicated by the hammer is related empirically to the compressive strength of concrete.

6. It is able to provide a quick estimate of the quality of concrete.

7. The Plunger is held perpendicular to the concrete surface and the body pushed towards the concrete.

8. This movement extends the spring holding the mass to the body. When the maximum extension of the spring is reached, the latch releases and the mass are pulled towards the surface by the spring.

9. The mass hits the shoulder of the plunger rod and rebounds because the rod is pushed hard against the concrete.

10. During rebound the slide indicator travels with the hammer mass and stops at the maximum distance the mass reaches after rebounding. The distance travelled by the mass. Expressed as a percentage of the extension of the spring is called rebound number.

11. The button on the side of the body is pushed to lock the plunger into the retracted position and the rebound number is read from a graduated scale is fitted on the body.

GENERAL FORMAT OF AUDIT REPORT

For structural auditing we have chosen a residential building situated at panchgani and an investigate can be carried out.

STRUCTURAL AUDIT REPORT

Name of Building: panchgani Vegetables market.

Name of owner: : municipal corporation panchgani.

Address: aurthor road, bhim nagar panchgani Maharashtra.

Contact no: 02168240244

Year of Construction: 1980

VISUAL INSPECTION

General Observations:

Sr. No	Description	Remark
1.	Type of building	R.C.C.
2.	Age of building	54 years
3.	Mode of use	commercial
4.	No of wings	1.
5.	no of stories	2
6.	No of Rooms.	10

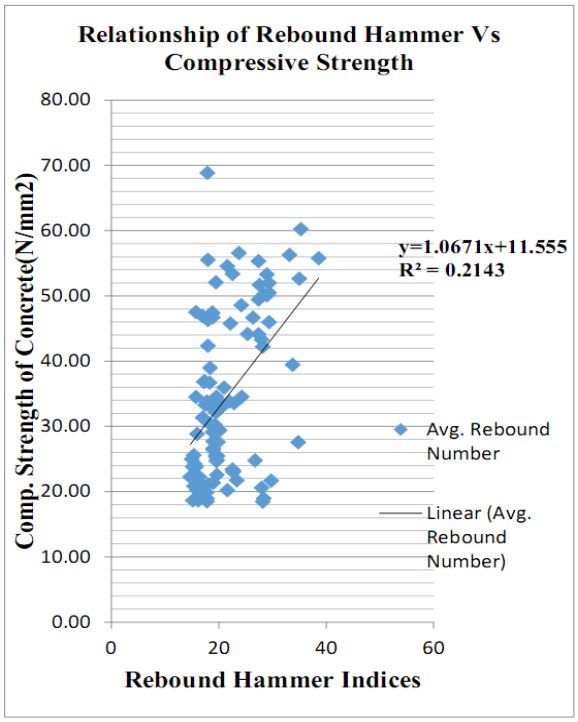
CRITICAL OBSERVATIONS:

Fig. 1 crack width 1-1.5 mm is found.

Fig. 2 Exposed reinforced found in column.

Rebound number and compressive strength of structural member.

Sr. no.	Area	Component		Avg. Rebound No.	Comp strength.
1.	Room No 1.	Beam.		17.4	30.11
		Colu mn.	Top	15	27.55
			Btm	16.8	29.47
		Slab.		19.3	32.14
2.	Room No. 2.	Beam.		18.5	31.28
		Column.	Top	18.02	30.78
			Btm	17	29.68
		Slab.		18.13	30.89
3.	Room No. 3.	Beam.		16.4	29.04
		Column.	Top	18.6	31.39
			Btm	20.2	33.10
		Slab.		20	32.89
4.	Room No. 4.	Beam.		13	25.42
		Column.	Top	15	27.55
			Btm	19.3	32.14
		Slab.		21	33.95
5.	Room No. 5.	Beam.		15.5	28
		Column.	Top	20	32.5
			Btm	19	32
		Slab.		17.6	30
6.	Room No 6.	Beam.		16.8	29.5
		Column.	Top	20.3	32.2
			Btm	21.5	34
		Slab.		15.2	27.5
7.	Room No 7.	Beam.		18.5	31.3
		Column.	Top	12.7	25
			Btm	13.5	25.5
		Slab.		21	33.2
8.	Room No 8.	Beam.		14.5	27
		Column.	Top	16.4	29.04
			Btm	13.3	25.3
		Slab.		16.8	29.5



From above graph an equation is obtained i. e. y=1.067x+11.555.

Sample calculation:

Average rebound number on column no. 5(critical) =15

y=1.067x+11.555

Where,

y=compressive strength of concrete.

x=average rebound number.

Y=1.067*15+11.555=27.566 N/mm2

Average rebound number on beam no. 17=13

y=1.067x+11.555

y=1.067*13+11.555=25.42 N/mm2.

Average rebound number on slab no.28=15

y=1.067x+11.555

y=1.067*15+11.555=27.56 N/mm2

7) RESULT:

The remarks of Structural Audit Report should be given in grades and colour coding instead of description so as to simplify it for Non-Technical person.

GRADE A: The said structure was safe but shall be strengthened by structural repairing.

GRADE B: Partial demolition and remaining part shall be strengthened by structural repairing.

GRADE C: Total demolition of the structure.

8) CONCLUSION:

From the consideration of all the above points we conclude that the defects of structural members are due to combined effects of carbonation, corrosion & effect of continuous drying and wetting due to heavy rainfall. 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. Above structure is externally defective but internally strengthened with reference of NDT. From the above information we found out the structure internally strong but somehow defective from external surface.

For any load bearing or framed structure structural audit is necessary. From structural audit overall inspection of structure carried out and it beneficial to decide remedial measures to any type of structural defects and damages. For every structure once in five years structural audit is necessary. If building older than 15 years, once in a 3 years structural audit should be done. However it is advisable to carry out structural auditing every 3 years regularly as many harmful modifications self-inflicted damages get also checked during auditing. Government also make compulsory for structural audit for buildings which are more than 30 years old in Maharashtra.

9) REMEDIAL MEASURES:

1. Propping the structure wherever necessary
2. Removing loose/disintegrated concrete.
3. Cleaning the affected steel.
4. Adding steel wherever necessary.
5. Applying Passivator coat to the steel.
6. Applying Bond Coat and doing Polymer /Micro
7. Concrete treatment depending on the requirements.

8. Finishing with new plaster.

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