

# To Study and Analyze the Various Structures by the Structural Audit

Jayesh V. Sadavare<sup>1</sup>, Swapnil S. Kumbhar<sup>2</sup>, Pranav G. Kusarkar<sup>3</sup>, Vishal B. Kamble<sup>4</sup>

Dept. of Civil Engineering, P.V.P.I.T. Budhgaon, Maharashtra, India.

\*\*\*

**ABSTRACT** - Reinforced cement concrete (RCC) as a construction material has come into use for the last one century. In India, RCC has been used extensively in the last 50-60 years. During this period, we have created large number of infrastructural assets in terms of buildings, bridges, sports stadium etc., which are lifeline for the civilized society. These have been created with huge investment of resources. We cannot even dream of recreating such assets out of limited national resources. It is, therefore, essential to maintain them in functional condition. Since, deterioration of RCC is a natural phenomenon and has started exhibiting in large number of structures, a systematic approach is needed in dealing with such problems. Identification of the causes of deterioration and consequent repair/rehabilitation strategy at optimum cost needs a scientific evaluation and solution.

*The first step in repairs and rehabilitation is the proper diagnosis for successful rehabilitation works. It deals with non-destructive evaluation techniques, laboratory tests and condition.*

**Key Words:** RCC Structures, Resources, Deterioration, Repair, Rehabilitation, Optimum cost

## 1. INTRODUCTION

Structural audit is the overall health and performance checkup of the building like doctor check the patient. Structural audit helps to understand the status of the old building. The Audit helps to highlight & investigate all the risk areas, critical areas and whether the building needs immediate attention. It covers the structural analysis of the existing frame and highlights the weak structural areas for static, wind & earthquake loads.

### 1.1 ABOUT STRUCTURE

A structure is a system of interconnected elements to carry loads safely to underground earth. The structural engineer will call legs of table as columns, the battens as beams and the ply sheet as slab. When series of tables are joined vertically and horizontally you get a building structure. As the material changes to concrete and steel instead of timber as heavier loads are to be sustained. The health examination of concrete building called as "Structural audit" or structural audit is an overall health and performance checkup of building like a doctor examines a patient.

Structural Audit is an important tool for knowing the real status of the old buildings

## 1.2 ABOUT AUDIT

The Audit should highlight & investigate all the risk areas, critical areas and whether the bldg. needs immediate attention. It should also cover the structural analysis of the existing frame and pinpoint the weak structural areas for static, wind & earthquake loads. If the bldg. has changed the user, from residential to commercial or industrial, this should bring out the impact of such a change. India is a heritage of old building and Structures. These buildings have age more than 30 years. These buildings have reduced Strength due to Material Deterioration. If, further use of such damage structure is continued it may cause severe loss of life and Property. Structural Audit is the overall Health Check-up of a building to ensure that the building is Safe and has no risk. It also suggests some Repair to increase the Serviceability of the building. It is necessary for maintenance and Repair of Existing Structure having age more than 30 years

## 2. SURVEY AND DATA COLLECTION

Visual inspection is done for the surface damages, cracks, flecking, coloration, local weaknesses, etc and their damage classification. Simple tools and instruments like Metal Detector, chisel and hammer, etc. are used.

- Visual inspection has covered area large of high distress cracks and their locations, moisture, abnormal variation in structure, algae, and fungus growth, efflorescence, etc.
- Also with special emphasis to structural members to understand the construction techniques adopted, materials used and to assess the present condition, impact of ageing distresses / damages on account of these.
- To record the distresses and assess the general condition of the structures.
- To record critical locations and highlight the same in the report.
- To collect photographic evidence of the locations where structural and non-structural distresses are observed.

### 2.1 STAGES

Following are the stages included in structural audit:

1. Preliminary Inspection,
2. Planning,

3. Visual Inspection,
4. Field and Laboratory testing

Using instruments we can conduct tests as well.

### 3. REBOUND HAMMER TEST:

**Principle:** Rebound hammer test method is based on the principle that the rebound of an elastic mass depends on the hardness of the concrete surface against which the mass strikes. When the plunger of rebound hammer is pressed against the concrete surface, the spring controlled mass in the hammer rebounds. The amount of rebound of the mass depends on the hardness of concrete surface. Thus, the hardness of concrete and rebound hammer reading can be correlated with compressive strength of concrete. The rebound value is read off along a graduated scale and is designated as rebound number or rebound index.

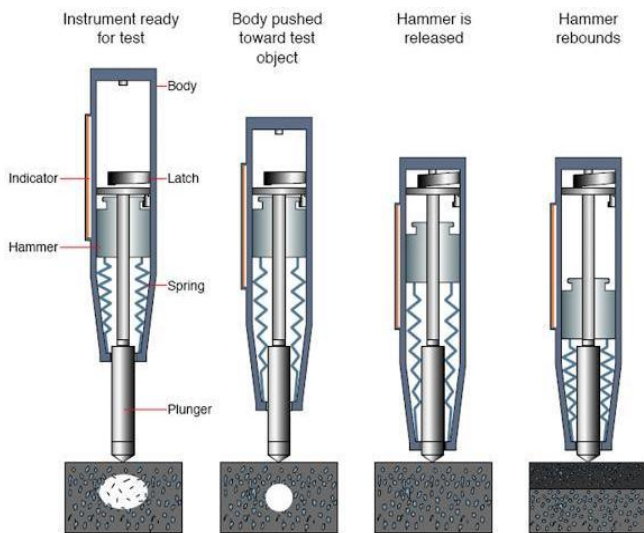


Fig1: Rebound hammer principle

### 4. ULTRASONIC PULSE VELOCITY

This is one of the most commonly used methods, in which the Ultrasonic pulse are transmitted through the concrete. The travel time is measured with an accuracy of +/- 0.1 microseconds. Transducers with natural frequencies of between 50 kHz to 150 kHz are generally used. This instrument basically is dependent on the Dynamic Young's Modulus, Poisson's ratio and Density of the material. Under certain specified conditions the velocity and strength of concrete are directly related.

There are three possible ways of measuring pulse velocity:

- Direct Transmission
- Semi-direct Transmission
- Indirect Transmission

( cross probing ) (Surface probing )

- The Direct & Semi-Direct Transmission is used mainly for predicting the Quality of concrete & Compressive strength & indirect transmission used assess the quality of surface concrete and measurement of crack depth.
- The transducers are placed on the smooth concrete surface to measure the time required for travel. A coupling media such as petroleum jelly, grease are applied to the surface to have good acoustical coupling.

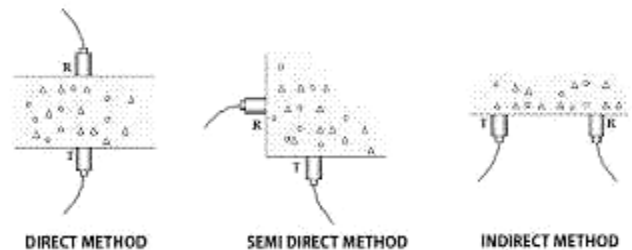


Fig2: Ultrasonic Pulse Velocity possible arrangements

### 5. MEASURING OF CRACKS

Cracks in a building are of common occurrence. A building component develops cracks whenever stress in the component exceeds its strength. Cracks are classified in to structural and non structural categories. The structural ones are due to faulty design, faulty construction or overloading which may endanger safety of buildings. The non structural cracks are due to internally induced stresses. Depending on width of crack, these are classified in to thin (< 1mm), medium (1mm to 2mm) and wide (> 2mm wide). Internally induced stresses in building components lead to dimensional changes and whenever there is a restraint to movement as is generally the case cracking occurs.

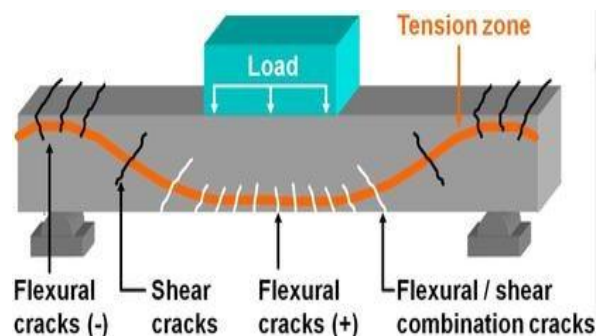


Fig.3 –types of cracks

### 6. CASE STUDIES

- 1.School Building
- 2.ESR
- 3.Market Building
- 4.Apartment

The tests were conducted on all above mentioned structures the test results of Rebound Hammer and UPV of ESR given as sample :

**Table -1:** Readings of Rebound hammer Test on Elevated Storage Reservoir

**Rebound hammer test**

SR.CO.	LOCATION	SIZE	REBOUND HAMMER READING										AVGERAGE		
1	D1	480X480	54	53	42	42	54	46	41	39	45	46	46	46	46.17
2	B1	480X480	34	34	34	32	38	31	45	42	39	34	50	40	37.75
3	A2	480X480	44	35	38	35	38	44	38	44	37	35	37	38	35.00
4	B3	480X480	38	34	37	37	40	40	40	38	34	37	39	40	37.83
5	C4	480X480	30	32	28	28	30	30	62	34	30	40	47	40	35.92
6	D3	480X480	45	44	44	42	46	46	34	30	30	34	32	36	38.58
7	A2	480X480	40	38	43	38	41	38	40	38	42	30	38	42	39.00
8	B3D3	480X480	38	40	40	44	42	39	38	37	40	41	35	34	39.00

[Rebound hammer test is the number of hardness]

**Table -2:** Readings of Ultra Sonic Pulse Velocity Test on Elevated Storage Reservoir

SR.CO.	LOCATION	METHOD	DISTANCE	TIME	VELOCITY
1	D1	DIRECT	480	158	3.03
2	B1	DIRECT	480	140	3.42
3	A2	DIRECT	480	360	1.33
4	B3	DIRECT	480	155	3.09
5	C4	DIRECT	480	270	1.77
6	D3	DIRECT	480	155	3.09
7	A2	DIRECT	480	360	1.33
8	B3D3	INDIRECT	150	510	0.93

[Velocity is in mm per millisecond]

**7. DETAILED OBSERVATIONS OF BUILDINGS / STRUCTURES:**

- 1) Structural Cracks
- 2) Honeycombing structure
- 3) Major Cracks with deterioration Seepage / Leakage through concrete
- 4) Deflection of Slab

**8. FUTURE SCOPE:**

**Model bye-law 77** says that structural audit is mandatory for those structures which completed 30 years from its construction.

Assistance for Execution of repairs / renovation works through successful tendered under their supervision, including main structure and all other connected services.

**9. RESULTS:**

During this exercise the structure was inspected thoroughly on several occasions to record, verify and study the modifications / additions made if any, to observe distresses,

level of malfunctioning and corrosion levels in the R.C.C. members.

The interpretation of test results are according to the IS 13311 (part 1 and part 2) :1992 is following:

**TABLE 3 QUALITY OF CONCRETE FROM REBOUND NUMBER**

Average Rebound Number	Quality of Concrete
>40	Very good hard layer
30 to 40	Good layer
20 to 30	Fair
<20	Poor concrete
0	Delaminated

**TABLE 4** Ultrasonic Pulse Velocity as per IS Code No. IS 13311(part- I): 1992 (table no. 2 Page no. 4)

Table 2 Velocity Criterion for Concrete Quality Grading		
Sl No.	Pulse Velocity by Cross Probing ( 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

**10. RECOMMENDATIONS:**

Based on results and observations we can give some remedial measures are as follows:

- 1) Steel jacketing
- 2) Grouting
- 3) Plastering
- 4) Steel plate arrangement at foundation

**ACKNOWLEDGEMENT**

We are greatly indebted to our guide Prof. M.V.Nagendra , for his unstinted support and valuable suggestions. We are grateful to them not only for the guidance but also for their unending patience and keeping our spirits high throughout. We express my sincere thanks to our beloved Head Of Department, Prof. V. T. Gaikwad and Principal Dr. D.V. Ghewade for being source of inspiration and providing us the opportunity to work on this project. We extend heartfelt thanks to all the teaching and nonteaching staff of the department of civil engineering and systems and network support of PVPIT for their assistance and co-operation. Finally, We would like to thank my parents and friends for

their moral support and encouragement throughout my academics.

**REFERENCES**

1. IS 13311(PART 1) :1992 Ultrasonic Pulse Velocity
2. IS 13311(PART 2) :1992 Rebound Hammer
3. KBP Civil Engineering services, PUNE- Mr.Chirag Kodnole (M.E.STRUCTURE)
4. Yashodhan Constrolab , Kolhapur
5. A.B. Mahadik, M.H Jaiswal,||Structural Audit of Building||,International Journal of Civil Engineering Research.ISSN 2278-3652 Volume 5,Number 4 (2014), pp.411-416.
6. B.H Chafekar, O.S Kadam, K.B Kale, S.R Mohite, P.A Shinde, V.P Koyle,||Structural Audit||, International Journal of Civil And Structural Engineering Research (IJCSER) Vol. 1, Issue 1, pp:(42-46),Month: October 2013-March 2014.