

Structural Audit of Building: A Structural Health Analysis of Building

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Abstract - In Our country there are as many as old aged structures which have reduced the capability of performance day by day as the result of climatic adverse actions and distinct weathering moves however nearby upcoming use of such deteriorating structural elements may be very drastically harmful for the living being staying out there because the overall strength of elements went down notably. As a consequence the structural audit of such structural elements becomes too much vital. Structural audit can result in extended existence of those deteriorating structural elements and as a result in increasing probability of safety of structure and the people staying there. If the age of the structural elements constructed is about twenty five years then the regulating municipal organization files the legal form of written document for structural audit of such particular structural elements for structural audit also provides the affected place of faults and additionally offers corrective form of few remedial & repair measures for prevention of similarly probable occurrence of strain in structure. After performing audit priority for the repair should be given according to the severity of defect found.

Key Words: deteriorating structure, structural audit, repair, defect, strain

1.INTRODUCTION

A safety audit process involves inspection, testing and suggestion for remedial work of deteriorating structures due to increasing life span of structural elements. In addition to that audit provides evaluation of the enterprise's building or any residential building protection against failure and some other important necessary safety reports and documentation to decide that shall we or shall we not restore health of structures on which testing has been done. Protection audits are useful due to the fact they encourage the regular evaluation of building elements everyday make certain that there must no longer further deterioration of structural elements with the aid of certain remedial works.

The project audit is frequently systematic observation of various parameters of building components like rebound hammer test visual inspection which is done by visual inspection, knocking structural elements, Ultrasonic Waves Pulse Velocity Meter, detrimental test and so forth. A safety audit is a established system in which data is accrued regarding the performance, effectiveness, and

reliability of a enterprise's general structural fitness. Safety audits serve many useful other application few of their functions listed below:-

1. They may be automatically carried out to decide whether the organisation is in compliance with protection law and rules. It shall be carried out with the aid of representatives of a concerning authority or with the aid of regular practicing business enterprise itself.

2. Structural audit used to find out the weaknesses in their protection guidelines provided by the concerning authorities and scientific approaches. Those audits are then used as a manual for designing action or as we can say that safety and protection plans or necessary actions to discover corrective moves that shall must considers so that structural health of the building can be restored. In this paper, an structural audit on a 30 year old building has been performed with a practicing firm and results so obtained are given.

1.1 Structural audit of building:

Structural Audit is the all certain thing that standard fitness and overall working test-up of a structural elements. Similar as what a physician examines an affected person due to some kind of the illness. It guarantees that the structural element which is constructed before and its premises are much secure towards the extreme damage and don't have any hazard. It analyses and indicates suitable maintenance and retrofitting measures required for the structural element on which different test have been carried out. To carry out higher in its whole carrier existence, Structural audit is carried out by means of an skilled and certified structural representative.

To assemble an object with structural integrity, an engineer shall first bear in mind structural element's mechanical characteristics, which include that the, power, weight, hardness, and elasticity, after that he must take corrective actions and shall decide the scale and form essential for the structural elements to face up to the preferred load for a protracted existence. Non-structural measures are measures now not concerning bodily construction.

Following are some enterprises applicable for Structural Audit:

- 1) Material and food production companies
- 2) Structural work and Engineering companies.
- 3) Manufacturing companies.

1.3 Aim:

To study and perform structural audit of a building.

1.4 Objectives:

- 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.
- To suggest remedial measures to restore structural health of building.

2. LITERATURE REVIEW

Literature review has been done by performing various research papers through various journals and articles.

Kamal kant Jain^[1] et.al.-

This paper suggest that working details of visual Inspect, Tools to carry out Visual Inspection and various process which are involved in the visual inspection this paper provides guidelines about performing the visual inspection work. This paper most importantly explains about the defects cause in earthquake prone zone and provides details about it

Douglas E Ellsworth^[2] et.al. -

This paper deal with the Condition for Structural failure, Effects of chemical agents on structural components. This paper gives the experimental studies confirmed that increasing bearing capacity of strengthened concrete (R/C) frames with the aid of introducing grouting of epoxy sealant to fill chosen bays for the rehabilitation of broken Building elements.

Maria Valeria Piras^[3] et.al. -

From this Paper I referred the parameter on which visual inspection is done. Visual inspection is done by the means of past experience gained by the concerning engineer and various research article published in the field of structural auditing of a building. The visual inspection process starts with the assessment of cracks, spalling over the surface of any kind of walls, columns, slab and all other structural as well as non structural components of building. It includes

quantifying the moisture over the walls and other members. In the process of visual inspection tentative cause also noted downs itself while doing it.

Jorge Furtado Falorca^[4] et.al. -

From this Paper I Referred Building Integration of Elements particularly R/C concrete is getting utilized considerably for numerous sorts of Building Activities .But the deterioration of Strengthen that is r/c material Concrete Elements is identified as a primary trouble globally.

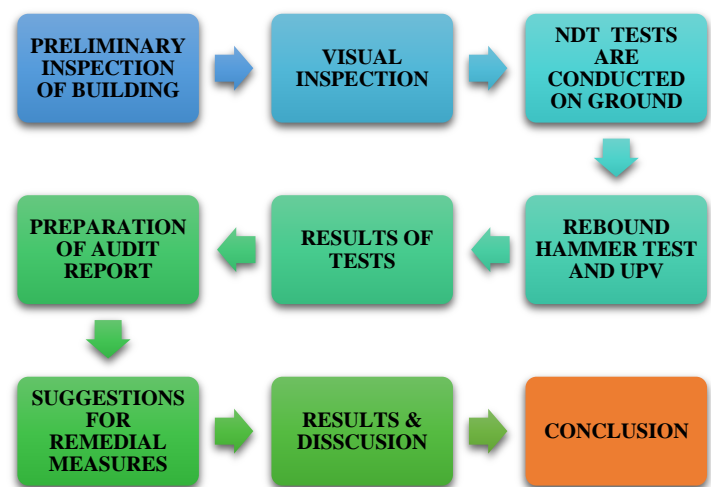
Ni Nyoman Kencanawati^[5] et.al.-

From this paper I referred the principal used in the UPV test. Ultrasonic wave is passed though the structural element which is to be inspected by the means of transducer and the distance is fixed between transducer and the receiver. When wave pass through it time period get noted inthe display and as we know the distance between transducer and receiver we can then find out the velocity of the wave and based in the velocity state of concrete at present condition can be found out.

A Ndagi^[6] et.al. -

This paper offers to create consciousness within the civil engineer associated with residential building, public buildings, Critical construction projects , bridge structures In regards to the fitness evaluation of concrete Structure are the Analyses in the same way general physician test's ill person. Physician after testing gives causes of illness and then prescribe medicines that is remedial measures for concerning illness same as him structural audit process is followed.

3. METHODOLOGY



4. SITE DETAILSES

Site Name: Siddhivinayak Park Co-Operative Housing Society

Address: S/R Mo 257 A, Part No 3b, Hadapsar, Pune – 411006 Maharashtra,India.

Description of Premises :

“Siddhivinayak Park Co-Operative Housing Society” Consisting Main Gate on North East side. Society Consisting of 5 No's of Residential Building Along With 14 No's of Shops. Shops Are Located in Wing A Only. Building Name as A, B, C1, C2 & D Consisting of Ground Parking Floors + 3 Upper Floors For Residential Purpose. RCC Water Tanks Are Partly Elevated From Ground Level And Located In Between Wing A - B, Wing B – C1 And Wing C2 - D.

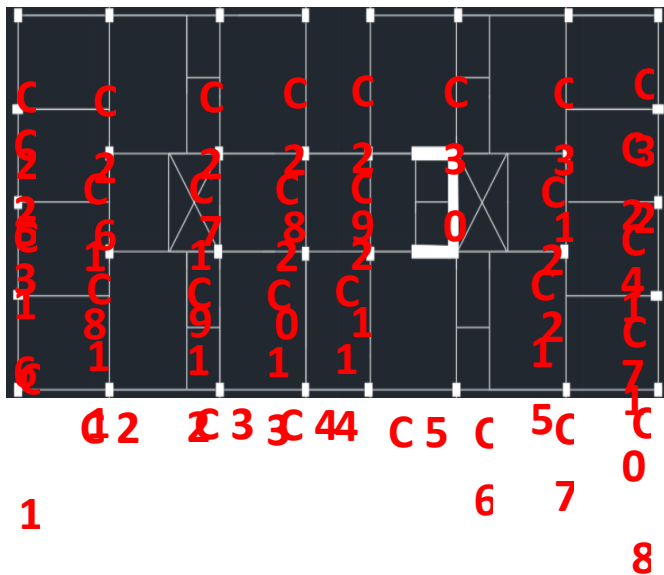


FIG No.1. Coulum Plan For Building

TABLE -1: Column sizes

Column Name	Column Size
C1,C2,C3,C6,C7,C8,C11,C12,C15,C16,C17,C18,C19,C22,C25,C26,C27,C30,C31,C32	300X450mm
C9,C10,C23,C24	350X230mm
C4,C5,C13,C14,C20,C21,C28,C29	230X350mm

4.1. Visual Inspection of Buildings:



Image 1: Peeling of colour is observed at A-03 flat



Image 2: Dampness and Colour Peeling in C1 06 flat

TABLE -2: Critical Observations

Location	Observation	Suggestion	Remark
Stair case Block	Colour Peeling Is Observed On Side Walls.	Recolor The Wall Under Expert Technical Supervision.	Less Critical
Roof Floor Level	Cracks And Uneven Slope is Observed On Terrace Slab.	Remove The Water proofing And Redone The Same Under Expert Technical Supervision To Avoid Cause of Dampness on Top Floor Flats.	Super Critical
Parking Floor Columns	NDT Testing Report is Poor For Columns Nos. C1, C2 And C3 in Building D.	Refer : Annexure C & D.	Super Critical

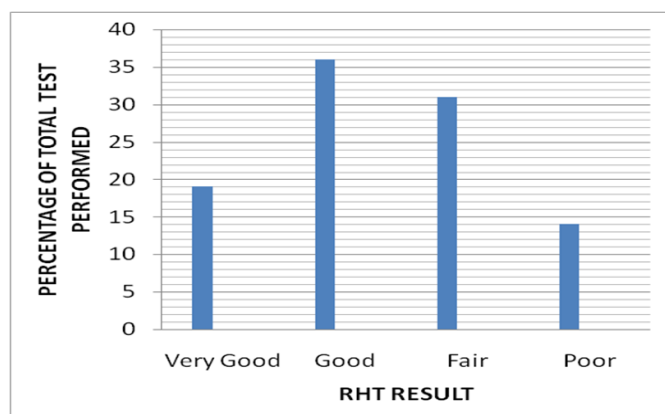
Compound Wall	Crack is Observed On Compound Wall At Many Places	Cracks Shall Be Sealed With Crack Sealant & Kept Under Observation.	Critical
External Area of Building	Plaster Cracks Are Observed At Many Places On External Face Of Building Which Causes Dampness on Walls on Inner Surface.	Cracks Shall Be Sealed With Crack Sealant & Kept Under Observation To Avoid Cause of Dampness.	Super Critical
External Area of Building	Plumbing Duct Area, Leakage of Pipes Are Observed Along With Vegetation Growth.	Damaged Pipes Shall be Replaced And Vegetation Shall be Removed periodically.	Super Critical

4.1. Non Destructive Tests

4.1.1. Rebound Hammer Test

RHT is performed based on the (Clause 3.2, Page No. 1, IS 13311 Part 2). The hammer first calibrated on previously known strength of concrete and test is performed on various structural elements.

Based on the RHT done on the site and comparing it with the IS Code 13311 Part 2 literature review and past project on the firm it is found out that;



Graph-1: RHT Results Performed on various parts of structure

On performing Rebound Hammer Test it is found that 14% of total Structural Elements Tested are comes under the poor condition while 19% of them are falls under Very

Good Category of Condition as per Is 13311:2009 part 2 (from Graph 1)

4.1.2. Ultrasonic Pulse Velocity Test

The principal used in the UPV test. Ultrasonic wave is passed though the structural element which is to be inspected by the means of transducer and the distance is fixed between transducer and the receiver. When wave pass through it time period get noted in the display and as we know the distance between transducer and receiver we can then find out the velocity of the wave and based in the velocity state of concrete at present condition can be found out. **(Page No. 2, IS 13311 Part 1)**

Based on the UPV Test done on the site and comparing it with the **IS 13311 Part 1**Code literature review and past project on the firm it is found out that;



Pie Chart 1: Results of UPV Test performed on various elements

On performing UPV Test It is found out that 7% of the tested elements falls under category of Doubtful while 21% of them are falls under Excellent category as per IS 13311:2009 part 1 (from Pie Chart 1)

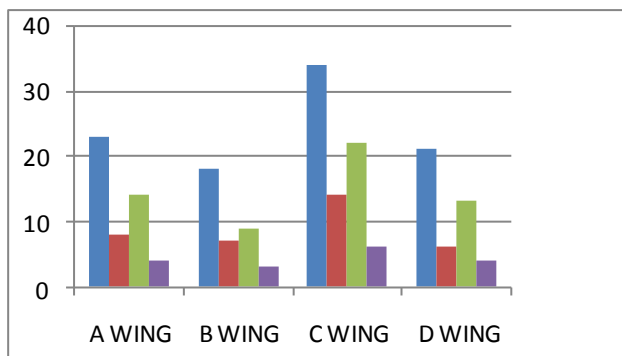
4.2. General Remedies & Guidelines

- Drainage area chambers must be vacant every chock Up. Time to time supervision of concerning area must be carried out. Damaged/ Deterioration Shall be rectified. Brick work broken for access to vent duct, OHWT Levels shall not be allowed in any case.
- External Plaster/Hairline Cracks observed at different levels, Rain water Seeps From these cracks and chances of dampness increase inside of Flats. Hence, Periodic observation and

rectification of such cracks shall be filled with crack sealant.

- For the dampness in the area add 25-30% water to Dr. Fixit Wonder proof 1 to make a slurry coating.
- To fill the voids, cracks some joints Injection Grouting is to be carried out.
- Maxtreat Fibrenet C is a carbon fiber composite system is used for to provide adequate strength to the structural elements such as beams, columns, bridges, slabs and walls.
- To cure spalling and damaged concrete in buildings, DUAL Shrinkage Compensated, Trowelable Fiber Reinforced Thixotropic Repair Mortar can be used

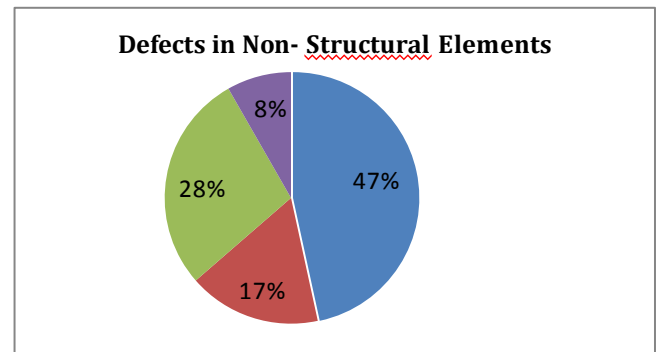
5. RESULTS AND DISCUSSION



Graph 2: On X axis wing is shown while on Y axis percentage vulnerability towards different parameters is shown

Blue Colour : Cracks
 Red Colour: Colour peeling
 Green Colour: Dampness of leakage
 Violet Colour: Vegetation

Structural Elements of Wing C building is more vulnerable towards the cracking of concrete defect which is around 34% of the total defects found (from graph 2).



Pie chart 2: showing comparison of structural defects

Blue Colour : Cracks
 Red Colour: Colour peeling
 Green Colour: Dampness of leakage
 Violet Colour: Vegetation

It is found out that among all the defects category Cracks are the most that is, 47% which defects due to vegetation found out to be least that is, 8% (from pie chart 2).

6. CONCLUSION

1. Overall health of Buildings based on visual inspection we can conclude that Wing A, B, C1, C2 & D in Society falls under is Average category and suggested remedial work shall be done.
2. Structural Elements of Wing C building is more vulnerable towards the cracking of concrete defect which is around 34% of the total defects found based on visual inspection performed
3. On performing Rebound Hammer Test it is found that 14% of total Structural Elements Tested are comes under the poor condition while 19% of them are falls under Very Good Category of Condition as per IS 13311:2009 part 2 (from Graph 1).
4. The average compressive strength of concrete based on rebound hammer test is observed may vary by $\pm 25\%$ of the result obtained.
5. On performing UPV Test It is found out that 7% of the tested elements falls under category of Doubtful while 21% of them are falls under Excellent category as per IS 13311:2009 part 1 (from Pie Chart 1)
6. Condition of the Building can be enhanced, after taking up repair works, as suggested. It is suggested that, repair works of **Supercritical** severity shall be taken up first, then those of **critical** severity .It is also suggested that, structural health of building shall be reviewed after 5 year.

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REFERENCES

- [1] Kamal kant Jain, Bishwajit Bhattacharjee “Visual Inspection and Condition assessment of structure : An innovative tool for structural condition assessment ” (ResearchGate, International Journal of three R’s Jan 2019)¹
- [2] Douglas E Ellsworth, Keith Ginnado “Guide for Visual Inspection of Structural Concrete Building” (US Army Corps of Engineering Construction engineering research laboratory July 2017) ²
- [3] Maria Valeria Piras, Fausto Mistretta, Luisa Deias , “A reliable visual inspection method for vulnerability assessment of hypostatic structure” (Research Article, Journal of construction Engineering, 2015)³
- [4] Jorge Furtado Falorca, João P. N. D, Miraldes. “New trends in visual inspection of buildings and structures” Research Article, Open Engineering, ResearchGate Journal, 2021 ⁴
- [5] Ni Nyoman Kencanawati , “The study of ultrasonic pulse velocity on plain and reinforced damaged concrete The study of ultrasonic pulse velocity on plain and reinforced damaged concrete ” , (MATEC Web of Conferences 195, CRMCE 2018, ResearchGate Journal)⁵
- [6] A Ndagi , A Umar, “Non-destructive assessment of concrete deterioration by ultrasonic pulse velocity ” (To cite this article: A Ndagi et al 2019 IOP Conf. Ser.: Earth Environ. Sci. 357 012015)⁶