



Structural Audit: A Case Study of Nasik Residential Building, Maharashtra, India

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ABSTRACT

The life cycle of building can be broadly divide into four phases i.e. architectural planning, structural design ,construction ,maintenance.In most of building atmost care is taken in first three cases but maintenance is forgotten. Ignorance to maintenance causes sever 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 paper deals with methods of estimating the audit of existing structures whose life has crossedthe age of 30 years.Such an investigation can be carried out using the following methods: a) Visualexamination b) Non Destructive Testing c) Partial Destructive Testing.

KEYWORDS

Rebound Hammer Test, Non Destructive Testing, Structural Audit

I] Introduction:

The general health and performance of building depends on its quality of maintenance. As a building grows old ageing, use (misuse) an exposure to the environment can affect the health of building significantly .Therefore it is advisable to monitor it periodically by taking professional opinion Structural Audit is preliminary technical survey of building to assess its general health as a civil engineering structure. It is usually initiated as the first step for repair this is similar to periodic health checkup recommended for older people. Structural audit is based on visual survey by competent consultant who lists his observations and recommendations in form of Structural Audit Report. The purpose of Structural Audit is to ensure regular assessment of buildings that the owners (managing committee of Corporative Housing Society) becomes aware of the structural deterioration of their buildings and they can make timely measures to repair or strengthen them.

Critical Observation, probable cause of distress, remark on structure are made. Base on observation structural health & recommendations are given in the structural audit report. Scope of the structural audit Services includes through inspection of entire building which includes:

1. Noting of all visible defects, deterioration and its quantification. These are marked on floor drawings from which estimate is worked out.
2. Diagnosis of damages
3. Suggest remedial measures
4. Submission of the conditions survey and structural audit report, priority wise estimate for rehabilitation, condition survey drawings, photographs.
5. Necessity of nondestructive testing will be decided after inspection of structure.

II]Literature Review:

Shah I. H. ^[1]has statedstructural audit is an important tool for knowing the real status of the old buildings. The audit should highlight and investigate all the risk areas, critical areas and whether the building needs immediate attention. If the bldg. has changed the user, from residential to commercial or industrial, this should bring out the impact of such a change. This Publication gives step by step guidelines for carrying out structural audit of old buildings.

Monteria. J., Pathak,N. J. ^[2]have estimated the soundness of existing structures whose life has crossed the age of thirty years. Concrete constructions are generally expected to give trouble free service throughout its intended design life. The deterioration of buildings can be a result of various factors including fire damage, frost action, chemical attack, corrosion of steel etc. during the life span of the structure. The investigation of soundness is thus essential for finding the present serviceability of the structure and its scope for future developments or for the change in its utilization

Balayssac J.-P., Laurens S., ^[3]have stated the management and maintenance of the built heritage is one of the main concerns of the owners of concrete structures. Combining NDT methods is currently considered as one of the most appropriate ways to improve the quality of the diagnosis of concrete structures. This paper describes a French project named SENSO (Strategy of non-destructive evaluation for the monitoring of concrete structures) devoted to developing a methodology for the non-destructive evaluation of concrete based on a multi-technique approach. The main objective of the project was to define the sensitivity of the techniques (ultrasonic's, radar, capacitive and resistivity) and the variability of the evaluation for each indicator concerned. **Villain.GéraldineSbartai,Zoubir Mehdi** ^[4]have implemented non-destructive techniques (NDTs) for surveying concrete structures in marine environments, non-destructive measurement results must be correlated with concrete durability indicators such as porosity and water and chloride contents. For this purpose, tests introducing two electromagnetic methods (GPR and the capacitive technique), as well as the impact-echo method, were run on six different concrete mixes containing various porosities, with five water content values and three chloride concentrations.

III] Methodology:

As we know concrete is widely used as a construction material because of its high strength-cost ratio in many applications. Concrete constructions are 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 and thus Civil structures like buildings, dams, bridges subjected to continuous deterioration over the years. For structural auditing we have chosen a residential building situated atNashik and an inves-

tigation can be carried out using the following methods: a) Visual examination b) Non Destructive Testing

IV] Structural Auditing Of Building:

Structural Audit is essential as it refers to health checkup of building. According to the model bye-law no. 77 for co-operativehousing societies, it is mandatory that if the age of a building is 15 to 30 years, a structural audit must be carried out once in five years.

For buildings older than 30 years it should be carried out once in three years. One may, however, go for it even earlier if one suspects the condition of the building to be bad. Perhaps monsoon/post monsoon is the best time to commission a structural audit since the seepage is more evident at that time.

Case study of residential building:

For auditing we have chosen a residential building at Lokmanya Nagar, Gangapur Road, and Nashik. Fig.1 and 2 show cracks exposing reinforced bars. Fig.3 indicates the structural plan of the building. Fig.4 shows the plan of the water line. Fig.5 shows the location of walls and chajjas. Basic information about the building is shown in table 1.



Fig.1 Cracks and exposed reinforced bar



Fig. 2: Crack in column and beam junction

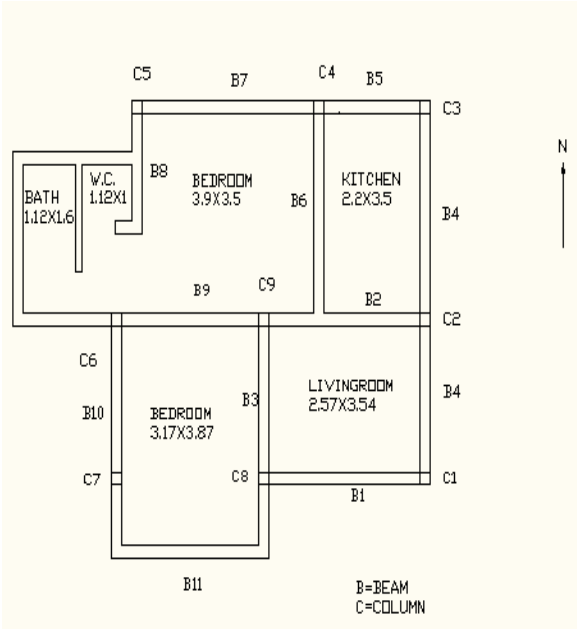


Fig.3 Structural plan of Building

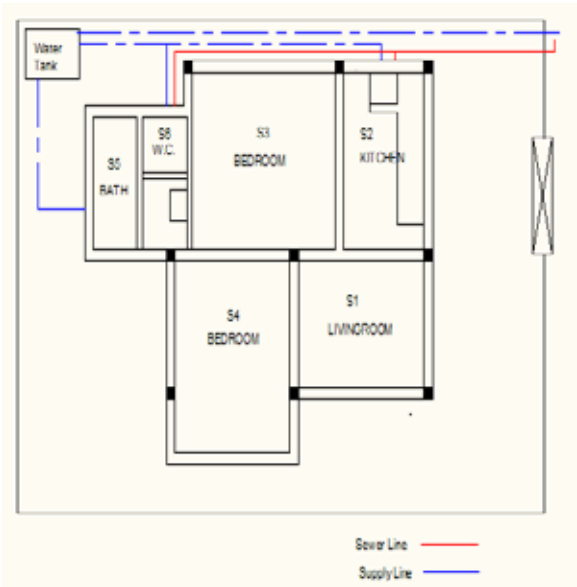


Fig.4 Plan of water line

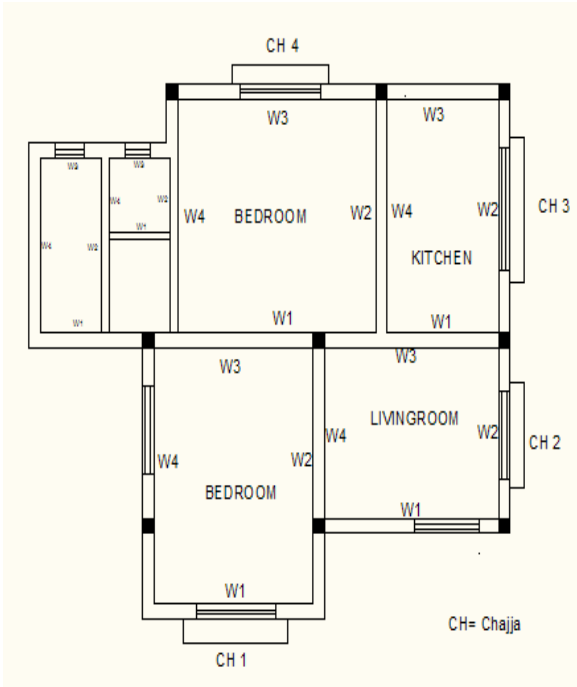


Fig.5 Location of walls and chajjas

Table 1: Information about Building

| Basic information | |
|----------------------------|---|
| Name of building | MaltiVinayak |
| Address | LokmanyaNagar,Gangapur Road, Nashik 422 003 |
| Contact Person | Swati Sakala |
| Building survey | |
| Name | MaltiVinayak |
| Mode of use | Residential |
| Type of structure | RCC Frame structure |
| No. of Stories | None |
| No. of staircase | None |
| No. of lifts | None |
| Previous Structural Audit | This is first Structural Audit |
| Description of building: | |
| Shape in Plan | Symmetrical |
| Floor Height(M): | 3m |
| External walls | Brick |
| Internal walls | Brick |
| Balconies | None |
| Lofts | Above toilet bath |
| Survey | |
| Mode of Survey | Visual inspection using scale ,tape |
| Area inspected | External building faces, terrace etc. |
| Building inspection | Internal observations are subject to following constraints: due to storage of goods some cracks were not visible. |
| Unit locked | None |
| Survey disallowed in units | None |
| Additional information | None |

Table 2: Critical observations check for crack width of external faces

| Sr. No. | Area | Cracks in | Crack width | Type of Crack |
|---------|------|-----------|-------------|---------------|
|---------|------|-----------|-------------|---------------|

| | | | | |
|----|-------------|-----------------------|--------|------------|
| 1. | Living room | Beam B ₁ | 0.2 cm | Structural |
| | | B ₂ | 0.4 cm | Structural |
| | | Column C ₁ | 2.6 cm | Structural |
| | | Wall W ₁ | 0.8 cm | Structural |
| | | W ₂ | 0.8 cm | Structural |
| 2. | Kitchen | Column C ₂ | 0.5 cm | Structural |
| | | C ₃ | 1 cm | Structural |
| | | Wall W ₃ | 0.5 cm | Structural |
| 3. | Bedroom 1 | W ₄ | 1 cm | Structural |
| | | Column C ₄ | 2.6 cm | Structural |
| | | Wall W ₅ | 4 cm | Structural |
| 4. | Bedroom | Beam B ₃ | 1 cm | Structural |
| | | Column C ₅ | 0.5 cm | Structural |
| | | Wall W ₆ | 0.5 cm | Structural |
| | | W ₇ | 0.3 cm | Structural |
| 5. | W.C. | Wall W ₈ | 0.5 cm | Structural |
| 6. | Bath | Wall W ₉ | 1.1 cm | Structural |
| | | W ₁₀ | 6 cm | Structural |

Table 3: Rebound number &compressive strength of structural member

| Sr. No. | Area | Cracks in | Rebound Hammer No. | Compressive Strength N/mm ² * |
|---------|-------------|-----------------------|--------------------|--|
| 1. | Living room | Beam B ₁ | 24 | 17 |
| | | B ₂ | 20 | 10 |
| | | Column C ₁ | 23 | 16 |
| 2. | Kitchen | Column C ₂ | 18 | < 10 |
| | | C ₃ | 22 | 13 |
| 3. | Bedroom 1 | Column C ₄ | 17 | < 10 |
| 4. | Bedroom | Beam B ₃ | 17 | < 10 |
| | | Column C ₅ | 20 | 10 |

Table 4: Rebound number &compressive strength of structural member for internal faces

| Sr. No. | Area | | Rebound hammer No. | Compressive strength N/mm ² * |
|---------|-------------|-----------------------|--------------------|--|
| 1. | Living room | Beam B ₁ | 22 | 13 |
| | | B ₂ | 10 | < 10 |
| | | B ₃ | 16 | < 10 |
| | | Column C ₁ | 26 | 19 |
| | | C ₂ | 26 | 19 |
| 2. | Kitchen | Beam B ₄ | 15 | < 10 |
| | | B ₅ | 18 | < 10 |
| | | B ₆ | 21 | 12 |
| | | B ₇ | 19 | < 10 |
| | | Column C ₆ | 18 | < 10 |
| | | C ₇ | 18 | < 10 |

| | | | | |
|----|-----------|-----------------------|----|------|
| 3. | Bedroom 1 | Beam B ₅ | 20 | 10 |
| | | B ₆ | 20 | 10 |
| | | B ₇ | 16 | < 10 |
| | | B ₈ | 21 | 12 |
| | | Column C ₄ | 17 | < 10 |
| | | C ₅ | 19 | < 10 |
| 4. | Bedroom 2 | Beam B ₃ | 17 | < 10 |
| | | B ₉ | 11 | <10 |
| | | B ₁₀ | 20 | 10 |
| | | B ₁₁ | 11 | < 10 |
| | | Column C ₆ | 13 | < 10 |
| | | C ₇ | 19 | < 10 |

is exposed to the atmosphere and get corroded.

➤ By overall inspection and all above aspects the building should be repaired.

V] Result and Discussion

Distress in RCC

Corrosion of reinforcement in chajja 4, column (C₆) .

Ingress of water

Ingress of water due to lack of chajja at hall was observed. The same thing was also observed in slab (S₁, S₂, and S3)

Plaster

Due to environmental effect i.e. thermal instability spalling of concrete has occurred at all internal and external walls.

Miscellaneous

Lack of regular maintenance of building was observed in building.

Structural repair and RCC

For beams, columns bond coat and polymer modified mortar for RCC member C₆, C₅C₉, B₁₁, B₁₀are required.

Conclusions

Structural Audit was done of building- MaltiVinayak.The construction of which was done during 1981- 1982.Structural auditing of building was done to knowing the strength, cracks and life of the building.

Following are the conclusions:

- Due to rebound hammer test it is found that compressive strength of column (C₂, C₃, C₄, C₈, C₁₀) and beam (B₂, B₃, B₅, B₇, B₁₀, B₁₁) is poor
- In chajja (CH 5) and column (C₆) of building reinforcement

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