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Structural Audit

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Abstract : *Civil Engineering Industry is one of the oldest industries which provide a basic infrastructure to all the human beings. Structures can be any kind it can be Historical, Heritage Structure, Residential building, Commercial building or an Industrial building. Every structure has its own service life, and within this service life it should stand firmly on its position. Ex- A Taj Mahal in Agra in India which is one of the oldest structure and a Wonders of the World, and still stand on its position very efficiently. But this not a condition about the today's Structures. A collapsed mechanism has increased and today's Structures are getting collapsed before there service life is completed. Therefore, it is advisable to monitor it periodically by taking a professional opinion. Structural Audit is a preliminary technical survey of a building to assess its general health as a civil engineering structure. It is usually initiated as the first step for repair. In this Project a Root Cause of a faulty mechanism of structure and a preventive measures to overcome a failure of this structures.*

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

I. Introduction

The general health and performance of a building depends on its quality of maintenance as a building grows old, ageing, use (or misuse) and exposure to the environment can affect the health of the building significantly. Therefore, it is advisable to monitor it periodically by taking a professional opinion. Structural Audit is a preliminary technical survey of a 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 the periodic health checkup recommended for older people. A methodology for Structural Audit was first presented by the Indian Society of Structural Engineers.

"Structural audit is the inspection or examination of the building, to evaluate the strength so as to improve its appropriateness, safety, efficiency".

This extent of damage or deterioration greatly depends on the quality of work at the construction stage. 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**.**

Fig No-1

Fig.No-2

II. Need of Structural Audit of Building

A Norm According to the model bye-law no. 77 for co-operative housing 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 and 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.

The certificate, issued by a structural engineer registered with BMC, will have to be submitted within a year after a building completes 30 years. For any corrective repairs suggested by the commissioner, the owner or occupants will be asked to submit the structural stability certificates again after a specific period suggested by him. If found unsafe, he has been given the authority to issue a notice to the owner to submit a structural stability certificate within 30 days from the date of notice. It will be binding on owners to carry out corrective repairs to the satisfaction of the commissioner. The certificate, issued by a structural engineer registered with BMC, will have to be submitted within a year after a building completes 30 years.

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III. Object of Project

In this project the fundamental principles of NDT methods are considered in some detail with a view to establishing a definite role for them in the Structural Evaluation Program. Part of this role is the setting of agreed standards & guidelines both for the execution of each surveying method in the field and the interpretation of the physical data obtained as an integral part of the investigation program.

IV. Methodology and Investigation

4.1. Condition survey-

Conditional survey is an examination of concrete for the purpose of identifying and defining area of distress. The objective of condition surveys of a building structure is:

A) To identify**:-**
1. Causes of distress
2. Their sources.

B) To assess:-
1. The extent of distress occurred due to corrosion, fire, earthquake or any other reason.
2. The residual strength of the structure.

C) To priorities the distressed elements according to seriousness of repairs

D) To select and plan the effective remedy.

4.2. Stages for Condition Survey:-The condition survey has following stages.

1. Preliminary inspection.
2. Planning
3. Visual inspection
4. Field and laboratory testing.

V. Structural Audit Report

A] Case Study of R.C.C. Building

Basic Information

Type of Structure - RCC Building of G+4 floors
Address - Pune
Type of Structure – RCC
No of wings & stories - 4 storied (4 flats from 1st to 4th floor each and having two flats at ground floors)
No & type of apartments - 18 flats

Description of Building
Year of construction-Aug 1987
Age- 27 years
Effects of monsoon - Yes

5.1 Visual observations

The building was investigated flat by flat for observation and external area of the building. Some of the column, beams & slab within the section were observed for a range of defects such as cracks, spells, crazing, seepage etc. All the defects were marked on the observation sheets with approximate repair area which formed the total data of the structure.

5.2. Tapping observations

Some of the column & beams inside the flat were subjected to tapping by hammer. The hollow sound was recorded in the observation sheets as follow, which was evaluated for remedial measures.

5.3. Non-Destructive Observations

Some of the column & beams inside the rooms and the passage areas were subjected to Tests by Ultrasonic Pulse Velocity. The readings were recorded which were evaluated further for remedial measures.

B] Report on Non Destructive Testing Of R.C.C. Members

1] Inspection & testing: - The aim of testing was to arrive at the general quality of concrete, rather than evaluating each RCC Members in detail. Hence, a few RCC members at random were tested. Ultra Sonic Pulse Velocity (UPV) measurements were taken for Columns, Beams.

2] Corrosion: - Rusting of Iron and steel is the most commonly process of corrosion.

Any corrosion of reinforcement results in the formation of rust, which occupies a volume of about 2.2 times that of iron from which it is formed. This corrosion product has literally no place to go so that it produces large internal pressure as high as 1 ton /square inch around the concrete resulting in longitudinal cracks parallel to reinforcement and cracks in the concrete.

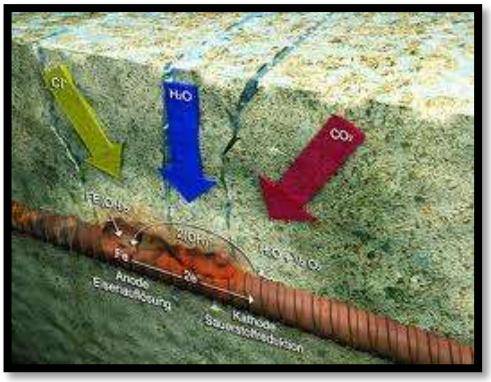

Fig No -3. Corrosion of Reinforcement

Fig.No-4 Spalled cover concrete & exposed cover Reinforcement

VI. Observations

6.1. External

Structurally the building appears to be unsound and few structural members show major distress signs at external face & internal area of the building,

- The Building is of RCC frame and brickwork / block masonry. RCC Columns and Beams show corrosion based cracks at many places.
- The exterior face of the building shows cracks, crazing, and delamination in plaster.

- Beam & column adjoining to wall delamination is noticed at various places on the facade of the building.
- All these defects propagate to seepage and leakages. Seepage near any R.C.C. members leads to further propagation of defects like rebars corrosion, etc.
- Other important problem in the building appears to be the seepages from the dead walls & entire exteriors, more prominent on the south & west sides of the building. The level of damage is more on the account of the south west sides due to atmospheric direction of monsoon.
- Due to these problems, the condition of the building appears to be quite leaky and structural distress is observed in most of the corner columns & beams.

6.2. Plaster

- External plaster acts as a skin on the RCC frame and the brick / block work, the most vulnerable part is the joints between the RCC and brick work
- Major cracks observed accelerating the passage of water through the wall resulting in seepages inside flats.
- The building is crack filled but not painted; which has to be attended periodically to avoid further distress in the building.
- At many places joints between RCC members and brick / block work have separated and water is found to be seeping inside.
- Most of the plaster in the building sides which are not exposed to monsoons directly, the extent of seepage is lesser than the side's facing monsoon.
- Due to forces of weather and carbonation in some places, plaster has deteriorated.

VII. Recommendations

- Looking into all aspects of the building maintenance and as per our detailed survey, we suggest that the building needs to be thoroughly repaired and painted in a planned manner.
- For any RCC framed structure the RCC components are like the bones in a body and hold the entire load of the body and any damage to the same has to be rectified immediately and cannot be left unattended for long period of time.
- To bring the RCC components to their near original strength the same have to be repaired by polymer modified mortar method.
- The RCC members originally deteriorated due to ingress of water and to prevent it happening **again** all sources of leakages must be stopped completely.
- Plaster acts like a skin to the bones in a RCC structure, but the skin also needs to have a raincoat and the same is provided by a good quality resin based coating.

To stop the ingress of water the following steps have to be taken.

a) Structural Repairs (Wherever Necessary).
b) External Plaster(Patch)
c) Crack Filling/Joint Filling.
d) External Drain down take Plumbing (Wherever Necessary).
e) Terrace waterproofing by using non destructive method.
f) Dead wall / Internal Terrace parapet wall plaster repairs.

VIII. Conclusions

Structural Defects: 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 on going process and so needs to be stopped at this stage so as to avoid complete collapse of the structure. There for Rehabilitation of the RCC members and will constitute the following steps

- Propping the structure wherever necessary
- Removing loose/disintegrated concrete
- Cleaning the affected steel
- Adding steel wherever necessary

- Applying Passivator coat to the steel
- Applying Bond Coat and doing Polymer /Micro Concrete treatment depending on the requirements
- Finishing with new plaster

The condition of the building appears to be quite bad and major structural distress is observed in some of the columns and beams of the external walls.

Micro Concrete Repairs to R.C.C. Column, Beam, etc.: In terms of to restoration of extensive damages in R.C.C. micro concrete: micro concrete is a very high strength mix design concrete, its factory made product. its dry powder in grey color more like cement constitutes cement as a one component & other's graded fine aggregate, additive in powder form & free flowing agent, because of this micro concrete can placed in less thickness & mix. Material can travel in narrow gape & having self leveling properties, so that it provides very smooth & uniform finish. Strength equivalent to 35 m concrete can be achieved in only three day setting / placing time. After overnight setting de shuttering is possible.

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