

# STRUCTURAL AUDIT BY KANYA SHALA

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**Abstract:** Structural Audit is commissioned by appointing a Consulting Structural Engineer registered with the Municipal Corporation of Greater Mumbai (MCGM or BMC). The Consultant carries out as a visual survey of the building covering its faces, stilts, staircase, terrace, flats, shops and ancillary structures such as pump room, compound wall, etc. Critical observations, probable causes of distress, remarks on structural health and recommendations for further action are given in the Structural Audit Report. Useful for loan application to bank, useful for insurance claim. Additional proof of sound structure before purchase or sale flat. Members can understand the exact status/condition of their individual flat. Easier to convince, to get co-operation and fund from members. On the strength of authentic reports even after some years if problem arises you can contact consultants or contractor for rectifications.

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## I INTRODUCTION

Structural Audit refers to health check-up of building for the safety. The health and performance of a building depends on its quality of original construction and quality of maintenance. As a building goes older & older it shows wear and tear due to ageing, use, misuse or overuse, exposure to the weathering / environment and structurally unplanned modifications and additions, which do affect the health of the building significantly. It's basically for ensuring that the building and its premises are safe and under no risks. It is a preventive proactive step. As saying goes "stitch in time saves nine". If regular building health check-ups are done, it enables to the consultant to analyze the condition & situation of the building and suggest what cost effective and corrective action can be taken without losing operation and use. It is a great saving and helps in creation a very conducive and pleasant working atmosphere for the workers / users.

Therefore, it is advisable to monitor the building health 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. It should be done periodically.

This to create awareness amongst the civil engineers, residents and owners of building towards the health examination of existing concrete buildings called as Structural Audit.

In India there are many old buildings which have reduced strength in due course of time. If further use of such deteriorated structure is continued it may danger the lives of the occupants and surrounding habitation. Appropriate actions should then be implemented to improve the performance of structures and restore the desired function of structures. Thus, it is utmost important to perform structural audit of existing buildings and to implement maintenance & repair work timely which will lead to prolonged life of the building and safety of the occupant. To act more responsible and preemptive towards

The dilapidated buildings, the municipal corporation must issue notices to the buildings and co-operative societies which are more than 30 years old to carry out mandatory structural audit and submit the audit report. Structural audit should highlight and investigate all critical areas and recommend immediate remedial and preventive measures. It should cover the structural analysis of existing frame and find critical elements for all types of loadings. It also helps in delivering a strong building structure with cost effective solutions and appropriate maintenance program. Structural Audit refers to health checkup of building for the safety. The health and performance of a building depends on its quality of original construction and quality of maintenance.

Structural Audit is an overall health and performance checkup of a building like a doctor examines a patient. It ensures that the building and its premises are safe and have no risk. It analyses and suggests appropriate repairs and retrofitting measures required for the buildings to perform better in its service life. Structural audit is done by an experienced and licensed structural consultant. 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. Structural Audit is an important tool for knowing the real status of the old bldgs. 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.



As per clause No.77 of revised Bye-Laws of Cooperative Housing Societies : “The Society shall cause the ‘Structural Audit’ of the building as follows For building aging between 15 to 30 years once in 5 years. For building aging above 30 years once in 3 years

## II LITERATURE SURVEY

A.B. Mahadik and M.H. Jaiswal studied structural audit of existing buildings. 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 mishaps and save valuable human life. The concrete is widely used as construction material being inexpensive, easy for construction, applications and because of its high strength-cost ratio. More than ever, the construction industry is concerned with improving the social, economic and environmental parameters of sustainability. In India, from 1980 onwards the infrastructure industry witnessed stepping up of public investment and growth in infrastructure industry which results in construction of new multistorey concrete apartments which are now in the age of thirty plus years. There are many buildings during this period and earlier have reduced strength in due course of time because of structural deficiency, material deterioration, unexpected over loadings or physical damage. If, further use of such deteriorated

structure is continued it may endanger the lives of occupants and surrounding habitation. 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 lead 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 structural audit must be carried out following auditing norms, methods of non-destructive testing and code provisions. The structural diagnosis is vast, important and highly responsible job which is connected with lives of human beings. It is mandatory and advisable to carry out the periodical structural audit of the buildings by professional experts and act immediately through recommendations provided in audit report. The success of repairs and restoration is always based on thorough knowledge, correct diagnosis and in-depth studies of problems in building, proper repair practices and finally socio-economic considerations. The effective implementation of auditing enhances the life span of structure, prevents deterioration of building leading to sustainability.

B.H Chafekar, O.S Kadam, K.B Kale, S.R Mohite, P.A Shinde, V.P Koyle studied structural audit of existing building and concluded that

- i. For any load bearing or framed structure structural audit is necessary.
- ii. From structural audit overall inspection of structure carried out and it is beneficial to decide remedial measures to any type of structural defects and damages.
- iii. For every structure once in five years structural audit is necessary.
- iv. 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.
- v. Government also make compulsory for structural audit for buildings which are more than 30 years old in Maharashtra.

## III FACTORS CAUSING BUILDING DISTRESS

The reason for distress during service is the lack of maintenance of the building which results in deterioration/aging of materials and structural components leading to corrosion and cracking.

Buildings or structures are damaged at different grades of damage when they experience extreme loading conditions like in severe earthquakes or cyclonic storms for which they are not designed.

They may also fail if the building including the foundation is not properly designed and constructed following the standard Codes of practice. An impression exists that taller structures are seismically unsafe in comparison with low-rise buildings. On the contrary, when properly designed and built, taller structures are generally safer. It is to be noted that most lives were lost in Kachchh (Gujarat) earthquake of 2001 in one and two storeyed masonry buildings. Hence, all buildings have to be built safe.

Inadequacy of design and poor quality of construction and maintenance are therefore the main reasons for the distress seen

in buildings during service or under natural hazards. This is because building codes and byelaws are not conscientiously followed in design and quality of construction, nor in maintenance.

The current [Indian standard (I.S.)] building codes and guidelines in India have been tested and found effective in achieving safety of the residents during the last six earthquakes (Uttarkashi 1991 to J & K 2005). Hence not following these codes in design and construction is sure recipe for distress in future.

Poor detailing of reinforcement in RC structural members and joints

Poor quality of construction

Corrosion of reinforcement due to aggressive environment

Settlement or differential settlement of foundation

Extreme and unforeseen loading

**3.1 Main objective of condition assessment are to place the building into one of the following three categories:**

The building has not shown any signs of distress and It satisfies all the safety and serviceability requirements according to relevant Codes of practice, hence no action is needed towards retrofitting.

The building is seen to be deficient (or distressed) but it can be repaired and strengthened to satisfy the Codal safety requirements or performance criteria set by the user.

The building is badly damaged. It is to be demolished and a new building may be built, build back better.

**3.2 Main steps of condition assessment will be:**

To record the damage if any, and find out the causes for distress  
To assess the extent of distress and to estimate the residual strengths of structural components and the system including the foundation.

To plan the rehabilitation and retrofitting/strengthening of the building.

**3.3 Typical visible distress detrimental to the safety of buildings:**

Cracks in RC beams (Fig.1), Columns (Fig 2), slabs, masonry walls (particularly if the walls are load bearing walls) (Fig. 3), spalling of concrete, sagging of beams or slabs (Fig.4), and tilting of columns or RC frames (out of plumb) (Fig. 5) and major failure of structural members (Figs.6 to 10) are the typical types of crucial damages that will require structural repairs to bring back the lost strength. Such actions will need to be done along with retrofitting if that is also decided for the building in question.



**Fig.1 Diagonal cracks of the beam and failure at the column top**



**Fig.2 Column failure (absence of tiers, buckling of longitudinal bars)**

#### IV METHODOLOGY OF CONDITION ASSESSMENT

Condition Assessment of the Building Envelope provides a guideline and methodology for assessing the condition and performance of existing building envelope systems and components, as well as identifying problematic and dysfunctional elements. Because the adaptive reuse, rehabilitation, and improvement of existing buildings have assumed a more prominent role in meeting national needs, the ability to accurately assess the conditions of a building is imperative. Failures of the building envelope can result in safety and health problems, as well as structural damage. Proper evaluation of the building envelope is often the first step toward stabilization and rehabilitation of the building. This Standard is a compilation of basic information, procedures, and references; it will be an asset to the investigator developing a logical approach to the assessment of the building envelope in order to focus on fundamental defects rather than outward symptoms.

Condition assessment and evaluation is generally carried out in two levels:

##### **4.1 Preliminary/rapid/visual investigation:**

There are mainly three components and steps,  
Collection of information and details about the building design, construction, utilization, and maintenance in the past  
Visual inspection of condition at site and recording details of distress

Evaluation of safety against the provisions in building codes or specified performance criteria

##### **4.2 Detailed investigation**

Need and actions:

When the construction drawings about the building giving the layout and the structural details of the system (including the specifications of materials used) and its foundation are not available, detailed investigations have to be conducted about the total structural system besides of course the details on type, location, and severity of damage or distress in various members and the system.

Measurements may have to be made on the existing building to note the dimensions of the structural elements. Properties of

structural materials, namely, concrete, steel reinforcement and masonry, in the representative structural members, will be necessary by conducting Non-Destructive Testing (NDT) in the field and by carrying out laboratory investigations on samples collected from the field. Details of soil profile and its characterization have to be obtained by collecting data or by conducting necessary geotechnical investigations. These details are necessary for analyzing/evaluating the safety of the building and to recommend retrofitting/strengthening measures.

#### V CONCLUSIONS

From visual survey, photographs, observations & instrumentation the following conclusion were made,

1. From non-destructive test by rebound hammer the compressive strength of bricks is less than 10 kg / cm<sup>2</sup> i.e. very poor for load bearing structure.
2. The strength of mortar sample collected from wall cracks is considerably reduced.
3. Wide range of vertical & diagonal cracks are observed in brick wall indicates poor supportive compressive strength.
4. Differential settlement is observed in flooring indicates settlement of floor feeling material.
5. Stone lintel above openings is separated from walls causing sag & horizontal cracks in wall. Further sag will considerably reduce the strength of wall above.
6. Considerable patches of fungus & dampness in the wall creates unhygienic condition in the premises & ultimately it will cause reduction in strength of wall.
7. Considerable sag in Mangalore tile roofing & decreased in strength of supportive wood work will further cause failure of roof.

From the overall observations above it is come to conclusion that Primary Health Center building's backside part is having wide cracks in load bearing wall, dampness in wall, growth of fungus, settlement in floor, reduction in binding capacity of mortar are in such an extent that it is beyond repairable condition, The front part is also having vertical and diagonal cracks, loss of connection between walls at joint, sag in roof, sag in walls above Kadappa lintel damping in wall etc. if repaired will not hold good for more than 2-3 years. The structure is not design to resist earthquake force, Since Hospital building are very important structure it shall be safe in any natural calamity it shall not have any unhygienic condition Hence it is suggested that the existing building to be demolish and an earthquake resistance building to be constructed. As per new code provisions so that it can resist any natural calamity like earthquake.

The observations and deterioration described in this report relates to the findings of the team as on the dates of observations of investigation and hence any further hypothesis should be done under the reference of this document.

#### REFERENCES

- [1]Manual of Core Cutter supplied by M/S Hilti India Pvt. Ltd.
- [2]Manual of Digital Ultrasonic Measuring Tool supplied by M/S BOSCH India Ltd.
- [3]By v. M. Malhotra Head, construction materials section Mineral sciences laboratories Canada center for mineral and energy technology
- [4]CH3\_Ultrasonic\_pulse\_velocity\_methods, copyright 1996 chapman & hall
- [5]Scheme for Certification of Design (Building Structures) Procedures for Auditing the Activities of Approved Bodies and Approved Certifiers, November 2011