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REVIEW AND SUGGESTIONS ON CONDITION OF HISTORICAL STRUCTURE

Shubham s kolhe[1*], Rohan Choudhary[2]

[1]*M. tech Student, Department of civil engineering, Sandip University, Nashik*
[2]*Assistant professor, Department of civil engineering, Sandip University, Nashik*

Abstract: This paper deals with reviews and suggestions on condition of the historical structure. Aim of study is to maintain structural integrity of an old age structure. To know the importance of historic architecture and preserving it is main objective of study. Inspection and condition survey of current situation of historic building is methodology adopted so that proper suggestions to be made for different conditions of structure. For maintain the structural integrity of any type of structure proper maintenance and care should be taken at regular interval so that structure would preserve for long time.

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Keywords: Structural audit, Heritage, Historical structure, Destructive tests, Compressive tests, Tensile tests, Material chemical analysis, Repairs and Rehabilitation.

1. INTRODUCTION

In many parts of India there are many historical structures are present. Some of are still in use and some of are ruin and deteriorated can't be used. As historical structure is part of cultural heritage that should be preserve by taking some initiatives. To maintain structural integrity and importance on heritage building proper maintenance work should be taken. There are many heritage buildings have reduced strength and being distress in due of weathering and improper measures taken. Further use of such deteriorated structure is continued it may endanger the lives and surrounding habitation. In such condition general health and performance of building must be checked according to standards. Structural audit is carried out. Structural audit is nothing but the checking health of existing structure. It is important to know the remaining life of structure.

Heritage Project Structure- "**Heritage Structures**" means a structure possessing architectural, aesthetic, historic or cultural values which is declared as **heritage** by a competent authority in whose jurisdiction such building is situated.

Figure 1 Heritage structure

Rehabilitation and repair of structures

Repair and rehabilitation are an art of civil engineering work which enable to Extend the service life of structure.

The success of repair activity depends on the identification of the root cause of the

deterioration of the concrete structures. If this cause is properly identified, satisfactory repairs can be done for the improvement of strength and durability. The figure 2 shows some of images regarding the historical structure i.e., front and back views of structure to observe current scenario of historical building.

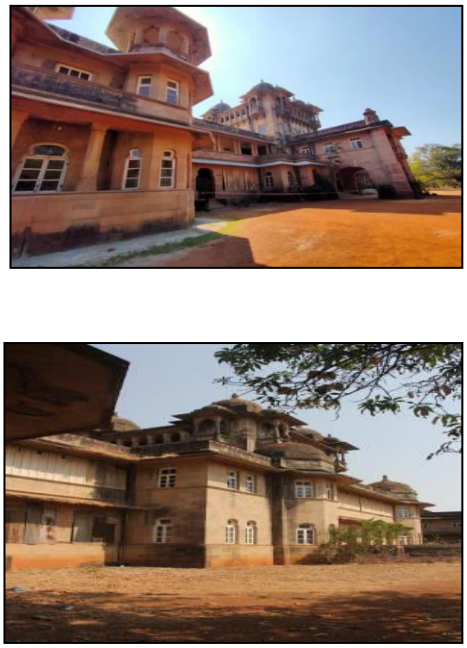

Figure 2 Jai Vilas Palace, Maharashtra, India

2. LITERATURE REVIEWS

Swapnil U Biraris et.al. (2017) Proposed their study on structural audit of old structures. They have explained what is structural audit? According to authors structural audit is overall health and performance check-up of building. It is important tool for knowing the real status of the old building to ensure whether premises are safe for humans or not.

Purpose of structural audit was explained to ensure importance of structural audit. How structural audit is carried out what are general step to be taken to perform audit is mentioned in their study. Destructive and non-destructive test were explained, there types and importance were explained. General Format of Structural audit has been shown and grades were explained in research.

Researchers concluded, that as per the preliminary inspection and general discussion it is recommended to carry out audit on deteriorated buildings, relationships between pulse velocity, rebound hammer, and compressive strength are obtain by conducting tests[1].

Bhagyashri Langar et.al. (2019) Researchers have discussed structural auditing on old buildings which have reduced their strength and stability due to various reasons. During the life span of structure building is reduce its strength because of material deterioration. According to researcher's structural audit is an analysis of building in which diagnosis of cracks and damages carried out. In structural audit visual survey is carried out or NDT is carried out if it is necessary and then all the observations and recommendation are listed out audit report. Authors have mentioned some important objection such as to identify structural fault, material deterioration, compute critical area of structure, current strength of building. General methodology was adopted, structural audit by visual inspection, structural audit by tapping observation, structural audit by non-destructive testing and final draft of audit report was shown at last to make report understand by observer.

Authors have concluded in this paper, structural audit in important and highly responsible activity which related with humans' lives. Structural health check-up is needed periodically and it is necessary to check serviceability of structure on regular basis. Repair is suggested based on investigation and in-depth studies of problem in building[2].

A.B. Mahadik et.al. (2014) Researchers has

studied that, there are many buildings period 30+ years and earlier have reduced reduce strength due course of time and ageing of structure. Material goes on deteriorating, unexpected load cause physical damages to structure. If further use of such deteriorated structure is continued it may endanger the lives and surrounding habitation.

Researchers have concluded in this paper; Structural audit helps to implement maintenance and repair work timely which helps in extending life of structure as well as helps in creating awareness amongst civil engineer and ensure safety of human beings[3].

K.R Sonawane et.al. (2015) Researchers have intended the case study of Nashik residential building, Maharashtra, India. The general health and performance of building depends on its quality of maintenance. As building grows old ageing, expose to environment can affect the health of structure. Therefore, researcher made advice to monitor periodically by conducting structural audit. Purpose of study was to see practical approach of structure audit on old residential building. Building was audited by visual inspection and NDT were carried out by authors. According to Bye-law no 77 for co-operative housing societies, when age of building up to 15-30 years structural audit is necessary. If the age of structure is more than 30 years structural audit should be carried out once in 3 years rather than it should be carried out once in 5 years. All structural members were audited distress in RCC, ingress of water, plaster was observed during tests.

Authors have concluded in this paper; 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[4].

B. Dadasaheb et.al. (2013) Many parts of the country have suffered earthquake in last three decades. In costal part of South India faced Tsunami. In first three earthquakes it was found that many of damaged structures were built in non-engineered masonry techniques**.** Unreinforced masonry structures are the most vulnerable during an earthquake. Normally they are designed for vertical loads and since masonry has adequate compressive strength, the structures behave well as long as the loads are vertical. When such a masonry structure is subjected to lateral inertial loads during an earthquake, the walls develop shear and flexural stresses. The strength of masonry under these conditions often depends on the bond between brick and mortar (or stone and mortar), which is quite poor. This bond is also often very poor when lime mortars or mud mortars are used. A masonry wall can also undergo failure in-plane shear, if the inertial forces are in the plane of the wall. Shear failure in the form of diagonal cracks is observed due to this. However, catastrophic collapses take place when the wall experiences out-of-plane flexure. This can bring down a roof and cause more damage. Masonry buildings with light roofs such as tiled roofs are more vulnerable to out-of-plane vibrations since the top edge can undergo large deformations. It is always useful to investigate the behaviour of masonry buildings after an earthquake, so as to identify any inadequacies in earthquake resistant design. Studying types of masonry construction, their performance and failure patterns helps in improving the design and detailing aspects[5].

S. Raja Subramaniam (2016) Authors has reviewed some research paper related to repair and rehabilitation of heritage structures. According to

author repair and rehabilitation plays a vital role in building application. It is a best solution to maintain integrity of structures, in case of heritage projects. He had studied some of major problems on well know heritage structures and suggested best solutions for the problem studied. Finally, he concluded comprehensive study of repair and rehabilitation of heritage buildings. The existed problems and its reported solutions are finely reviewed [6]. Table no 1 shows the trade of between costs, lifetime and adaptability of method on condition of problems.

Rohit Newale et.al (2017) In this paper Authors has studied that, the need of structural audit is for maintenance and repair of existing structures whose life has exceeded the age of 30 years to avoid any mishaps and save valuable human life. There is demand of appropriate action and measures for all such building structures to improve its performance and restore desire functions of structures which may leads to increase its functional life. Paper deals with different parameter of structural audit including visual inspection, non-destructive testing, and core sampling testing. It also comprises different repair and retrofitting measures to be used for buildings after structural audit.

To recognize the type of structural defect, material deterioration, signs of structural distress and deformation, alteration and addition in structure. There were some phases of model development decided by researchers like to identify the cause and source of distress, visual observation, tapping observation, NDT methods, internal and external area of building was studied and results were interpreted.

Authors have concluded, defects of structural members are due to combined effects of carbonation, corrosion and effects of continuous drying and wetting. The result of visual survey prompt us to conclude the distress is wide spread and is an ongoing process and so needs to be stopped at this stage to avoid collapse of structure[7].

S.P. Patil et.al. (2020) Authors have discussed that; structural audit must be carried out following audit norms, methods of non-destructive testing and codal provisions. The structural auditing will help to implement maintenance and repair work timely which leads to extend life of structure and safety of the occupants. Different parameters were studied including visual inspection, Non-destructive testing, Core sampling and testing. It emphasizes on different repairs and retrofitting measures to be used for building after structural audit. What is meant by structural audit, rehabilitation and their techniques for repairs and rehabilitation of concrete structures were explained precisely. Authors have mentioned some important objection such as to identify structural fault, material deterioration, compute critical area of structure, current strength of building. General methodology was adopted, structural audit by visual inspection, structural audit by tapping observation, structural audit by non-destructive testing.

Researchers have concluded in this paper, the defects of structural member are due to combined effects of carbonation, corrosion and effect of continuous drying and wetting. The result of visual survey prompt us to conclude the distress is wide spread and is an ongoing process and so needs to be stopped at this stage so as to avoid complete collapse of the structure. According to author retrofitting is best method of modification of existing structure to make them more resistant. These intend to maximize strength and utility on structure [8].

Yash Agarwal et.al. (2018) Authors have studied literature review on structural audit on various structures. Aim of researchers was to study various structure, its condition, structural audit of critical section, examine the overall structures include bridges, RCC buildings. Purpose of study involves determining the real time status condition of the building, to calculate remaining life of building, to protect human life, to comply the standard codes.

Authors made conclusion; Structural audit is necessary after certain period of time. There are bye-laws provided for the time period after which the auditing of any structure is compulsory. The auditing is commonly carried in two ways visual inspection and NDT methods[9].

Romeu Vicente et.al. (2018) Researchers has studied that, Historical construction are an important part of the cultural heritage, because of architectural value and evidence of building techniques. Their conservation over the centuries is a responsibility of our society, in order to pass on to future generation. Structural safety of historical construction is most important to permanent long-term action and utility of structure. The diagnosis of the present conditions of building shows the remaining life of the structure and result shows whether structure needs repair or not. The general aim of the intervention is to preserve an architectural heritage element of symbolic meaning not only for the university of Coimbra but also for the city, through the strong physical presence is has in the landscape and for its socio-cultural meaning. Purpose of study includes conservation of heritage tower, restoration work, seismic assessment and preservation of historical structures. General methodology (survey framework of heritage valued construction) involved outline and definition>preparation phase>implementation>field work (survey and inspection, recording testing)>off site work>drafting report>final report. Material, mechanical and modal characterization was created for overall identification of current status of the tower.

Researchers have concluded in this paper, the preservation of cultural heritage assets should consider both the monitoring of slow processes like material deterioration, environmental affects, climatic change which effects on structures and risk associated with natural hazard. Some of major and important steps were concluded at last to make understand each and every process of intervention [10].

Nenad sekilarac et.al. (2020) The aim of Authors has been to establish an effective method for the restoration of the historical buildings and their reuse and sustainable renovation in term of energy efficiency, in accordance with modern needs and conservation requirements while maintaining authentic appearance.

Authors say Cultural heritage is more than just a traditional memory of the past that has a particular significance in the life of the nation; it is also an active resource for the future. Although precious cultural heritage resources are reusable, they are neither renewable nor replaceable. The subject of this research is the restoration of the dining room within the zica monatery property in term of energy efficiency and modern conservation requirement. The objectives involve use of site conditions for the protection and preservation of the historical buildings without negative affecting the environment as well as the management of the site, improving knowledge of preserving heritage buildings and methods of restoration, improve energy efficiency in restoration. Methodology was adopted such as on-site observation, case study a

method, designing and defining criteria for conservative protection, analysis of building material, and restoration of the building retaining authentic appearance.

Authors have concluded in this paper, application of selected construction measures in accordance with conservation requirements, in order to improve energy efficiency and comfort conditions of the building, enables an uninterrupted connection between cultural heritage and modern needs while maintain the original purpose and authentic visual appearance of building [11].

J.M. Sadamate, et.al. (2017) In this paper Authors have studied different parameters of structural audit including visual inspection, NDT methods, core sampling and carbonation testing. Different method of repairs and retrofitting measures were studied after structural audit. Objectives involves to know history of various component of buildings, to study and use visual inspection methods, use of NDT methods, repair and retrofitting methods to the building. Methodology, Visual inspection followed by destructive and non-destructive test were carried out, concrete test like rebound hammer test, ultrasonic pulse velocity test, core sampling test were performed. Chemical test was performed to know the chemical attacks like carbonation and pH of concrete.

Authors have concluded, during performing NDT test it is observe that various columns and beams whose quality and strength is doubtful for that jacketing should be done. Core test conclude grade of concrete used in construction. Results of carbonation indicate probability of corrosion in future. And for good condition of building proper retrofitting should be done [12].

Patil S.R, Prof Sayyed G.A (2015) In this paper Authors has studied that, performance of the building depends on its quality of maintenance as a building grows old, ageing use and exposure to environment can affect the health of the building significant. There is demand of appropriate action and measures for all such building structures to improve its performance and restore desire functions of structures which may leads to increase its functional life. Paper deals with different parameter of structural audit including visual inspection, non-destructive testing, and core sampling testing. It also comprises different repair and retrofitting measures to be used for buildings after structural audit.

To recognize the type of structural defect, material deterioration, signs of structural distress and deformation, alteration and addition in structure. There were some phases of model development decided by researchers like to identify the cause and source of distress, visual observation, tapping observation, NDT methods, internal and external area of building was studied and results were interpreted.

Authors have concluded, defects of structural members are due to combined effects of carbonation, corrosion and effects of continuous drying and wetting. The result of visual survey prompt us to conclude the distress is wide spread and is an ongoing process and so needs to be stopped at this stage to avoid collapse of structure [13].

Antonio Costanzo, et.al. (2013) In this paper Authors has studied that, the conservation of architectural heritage usually requires a multidisciplinary approach involving a variety of specialist expertise and techniques. The aim of researchers was to concentrate on NDT methods rather than to concentrate on destructive test.

Combined use of TLS and IR thermography was aim to apply on historical structures. Today local communities and civil societies give an increase importance to their historical and cultural heritage, shows great interest in preservation and conservation. Authors say conservation through destructive techniques should avoided to preserve integrity of cultural heritage and development of non-destructive and non-contact techniques becomes crucial important. Firstly, acquisition of data it allows derived other information from different disciplinary. In order to do so authors have used TLS and IRT technologies is acquire cloud points to prepare 3D model and to find out cracks, deterioration, and kind of materials, hidden elements and misalignment.

Authors have concluded, the designed survey, combining both sensors, improved the knowledge of the conservation state of monument. Two sensors used separately for each of separate role and their use made diagnosing easier and perfect results were achieved. Hidden elements in the masonry can be found out with some different techniques [14].

Sanjeev Kumar Verma, et.al. (2013) In this paper Authors have explained importance of testing and quality check-up of structure of different stages of structural life. Proper maintenance of structure requires different techniques and new method of inspections. Researchers have made some important reviews on Non-destructive testing methods. The main objective was to understand what are NDT methods? Where and why, they are to be used? Best suitable method for each and every condition and situation are been mentioned. Advantages and disadvantages of methods are been described. Different Parameter measured, NDT methods, Advantages, Limitation and its principle has been mentions by authors.

Authors have concluded, NDT plays an important role in condition assessment of existing structures and show whether structures need urgent development or not. Major advantage of NDT methods has been recognized as their capability to test in situ. NDT provides useful information by revealing hidden or unknown defects and repair or replacement of or structures can be planned according to NDT results [15].

C. Natarajan, et.al. (2010) Reports the Rehabilitation of St. Lourdes Church, Tiruchirappalli which was built in the year 1890. The author faced various problems such as mold stains and water damage, cracks in the outer brick surface and decay of bricks in the inner surface and erosion on the roof surface. These are also caused due to poor waterproofing, seepage of water and water logging.

Researchers made with conclusion that; the 100-year-old gothic style St. Lourdes church is a historic landmark in Tamil nadu. Lime mortar is best source of rehabilitation and restoration of structure. The lime mortar also allows building to ventilate, so that water can evaporate naturally. Major deterioration is caused due water effects, due to weathering it leaves vegetation on structure which later converts into stain. Author has suggested that include complete seal proofing of roof vaults and corrosion protection coatings, which should be applied to the lime mortar surfaces [16].

Er. Sumit Shringi, et.al. (2018) Proposed their case study on rehabilitation and reconstruction of buildings based on information gathered from local building organization. In current scenario of building research, repair, rehabilitation plays a vital role as it serve important building applications. It helps in maintaining structural

integrity, in case of heritage structures. The major defects reported are discussed and a suitable and economical solution was delivered through this case study. Deterioration due to environmental effects, new functional and modification to structure and damages due to accidents was observed. Methodology involves restoring and conserving structure, restoration of damaged RCC, consolidation of columns, beams by pressure grouting low viscous epoxy, jacketing of column using micro-concrete, warping and coating with carbon fibre, finally protective coating on the surfaces.

Authors have concluded comprehensive study of repair and rehabilitation of structures. Existed problem were studied and review was reported finely. The best therapy suggested by researchers is to carry preventive maintenance regularly. Identify the cause of deterioration apply the best solution for its cause. It is also necessary to define to define how ongoing deteriorative factors should be monitored given the effects of such processes on the rehabilitation of the structure [17].

Nur Liyana Othman, et.al. (2015) Proposed their case study on moisture problems and building defects. Moisture problem is any visible, measurable or perceived outcome caused by excess moisture indication indoor climate problems or problems of durability in building assemblies caused by various leaks of water. Aim of study was to observe the moisture effects on structure and study building defects caused by moisture. Objective included study effects of moisture and finding solution for defect cause on structure due to moisture. Methodology involves identifying moisture problems, to analyze defects related to the moisture problems.

Authors have concluded that moisture problem is one of the serious causes of building defects. Findings would provide and interesting view of moisture problems that affect the hospital functional performance. Based on finding, it is suggested that these problems should be highlighted during early project development. For hospital building, the issue of safety especially in term of providing environment that is free from unnecessary viruses and bacteria should be the main concerns of stakeholders [18].

Abdul Rehman (2011) Intended his case study on three historic buildings namely the Sholamur garden, Shish mahal and Jahangir tomb which were built in the year 1640, located at Lahore. He underwent various defects in the building such as, severe damage of perimeter wall, deterioration of beams caused due to termite attack and seepage of water from the roof. Stones in the tomb got deteriorated due to fungus, moisture content and air pollution. Bricks on edge pavements were damaged. Growth of vegetation was also found on the rear side of the building.

Author concluded that there is shortage of skilled craftsmen has been observed at all conservation projects. This shortage occurred due to limited conservation activity in the past [19].

3. OBJECTIVES

1. To identify areas of structural faults.
2. To know the history of the various component of buildings.
3. To know the importance of old historical structure its architectural concept, old age aesthetic views.
4. To know the best fitted solutions for such historical structure to preserve them for long term.

3. METHODOLOGY

Figure 4 External inspection

1. Selection of heritage structure

Jai vilas palace, Maharashtra palace built in 1940. It is historical structure choose for purpose of reviewing the current condition of structure after 80-90 years of built as shown in Fig.1.

2. Visual inspection

The building structure was investigated floor by floor for both internal as well as external done for structure shown in fig.1. Fig no 3 and 4 shows more detail about the same.

Figure 3 Internal inspection

3. Condition survey

It is an Examination of concrete for the purpose of identifying and defining area of distress and their sources.

4. To identify

4.1 Cause of distress.

4.2 Their sources.

Figure 5 Steel reinforcement samples

Figure 6 Deteriorated and destructed slab

5. RESULT AND DISCUSSION

It is been observed that due to lack of maintenance the condition of structure is devastated. Due to cracks developed on wall and other structural components it led to growth of vegetation, which ultimate results in growth of more crack and finally results into destruction. Due to heavy rainfall and improper drainage system, there was no path for passage of water, it caused water accumulated which cause leakage problem. So proper waterproofing should be done to avoid such problems.

6. CONCLUSION

According to the visual inspection, condition survey of structure, observation of structure material it is concludes that repairs are required to the building structure.

1. During visual inspection it was concluded that 70-80% area of structure was unfit for use, as it was risky for accommodation.
2. During condition survey of structure, it was concluded that the slabs, beams walls and plastering was destructed and was unable to sustain further weathering and load carrying capacity structure was lowered.
3. It is concluded that the steel in slab which were exposed due to cover failure and steel bar was corroded 80-90%. Visually it was seen that 10 mm diameter bar was reduced to 2-3 mm and some were broken into pieces.
4. Proper plastering and crack filling are been done after all result so that water capillary action breaks and growth of vegetation would stop on wall and chajjas.
5. The roots of vegetation were removed with wired brush and all deeper cracks were filled with concrete mortar.
6. Proper waterproofing, plastering, painting on wall and retrofitting works can extend life of structure and can be used for accommodation.

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