Rehabilitation of Ancient Structures

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Abstract

Existing buildings are subjected to processes of degradation with time, which leads to a condition in which they became unable to fulfil the purpose for which they were built. Sometimes, there is also the need to improve the conditions delivered by existing buildings or to adapt them to new functions. Furthermore, in the most developed societies, as they progress, the feeling grows that it is necessary to maintain the existing architectural heritage. As a kind of counterpoint to the changes caused by rapid technological evolution, it is really important to keep the existing built environment and passing it on to future generations. Rehabilitation of Ancient buildings is a way of sustainable development and also an act of culture. The most crucial aspect of the rehabilitation of existing buildings is their structural rehabilitation, i.e., their structural safety .However, assessment of the structural safety of existing buildings is, In general, a tough task because the methodologies used differ from those adopted in the design of new structures. Furthermore, the eventual strengthening of existing buildings can conflict with their cultural value. Therefore, the type of intervention on an ancient building will depend on its cultural value, ranging from simple maintenance, where the goal is not to change the cultural value of the building, to complex rehabilitation, when it is intended to improve the performance of the building.

I. INTRODUCTION

The maintenance, repair and rehabilitation of structures or structural components is a very important aspect with respect to their intended life. Rehabilitation of ancient buildings has become an issue of great importance around the world. In order to keep the structure in good condition such that it fulfils its desired purpose, the maintenance and repair is necessary. The maintenance of structure, if done properly and periodically, prevent structure from defects and hence prevent any repair work which may incur. It is observed that many structures fail earlier than the proposed life due to improper maintenance. Hence, proper maintenance is the key for a perfectly working structure providing all its purposes for its intended life. India, being a land of rich cultural heritage, is a treasure house of historic buildings and monuments. These structures get deteriorated with time due to ecological factors and improper maintenance which happens due to negligence**.**

II. DETERIORATION

The gradual disintegration of various components and their materials of a structure is termed as deterioration of that structure. The gradual disintegration may result due to exposure condition, weathering effects, destruction from soil and water, relative movements of different components etc. The resistance of materials to various agents (especially water) decides the rate of deterioration. If the resistance is high, the rate of deterioration is low and vice versa**.**

A. Categories of Deterioration:

The process of deterioration is divided in to four categories

1) Mechanical Deterioration:

The various errors acting on the structures such as impact loads, over load effect, fatigue of materials, wear and tear of materials are included in mechanical deterioration.

2) Physical Deterioration

The change in volume due to temperature variation, freezing and thawing, unexpected deformations, cracking etc. cause physical deterioration.

3) ***Chemical Deterioration***

Reaction of harmful chemicals which are present in construction materials.
Reaction of external harmful chemical substances with structures. Electro chemical process.

4) ***Biological Deterioration***

Bacteriological growth in any part or component of structure causing delay falls in this category.

B. Thermal Cracking

Thermal cracking may develop due to either temperature differentials generated by heat of hydrations or by environmental temperature.

III. SITE UNDER STUDY

The site under study is located at himayat sagar which is an ancient Islamic school with four rooms, a large corridor and a store room which is said to be around 300 years old. we can assume by visual examination that it is a structure made from surkhi pozzolan mix along with terracotta as a building material. The neglected structure is said to be deteriorated almost completely and is in need of immediate treatment.

DIMENSIONS OF LIVE SITE
TOTAL AREA = 400 SQYARD
ROOM 1 – 18x19.4 FEET
ROOM 2 – 17*17 FEET
COMMON ROOM – 18*19.4FEET
STORE ROOM -17*17 FEET
ARCH HEIGHT – 15FEET

A. Lime Mortar

It is composed of lime and an aggregate such as sand, mixed with water. Indian traditional structures built with lime mortar, which are more than 4,000 years old like Mohenjo-Daro is still a heritage monument of Indian civilisation. With the introduction of Portland cement during the 19th century, the use of lime mortar in new constructions gradually declined. This was largely due to the ease of use of Portland cement, its quick setting, and high compressive strength. However, the soft and porous properties of lime mortar provide certain advantages when working with softer building materials such as natural stone and terracotta

B. Terracotta

terracotta is the term normally used for sculpture made in earthenware, and also for various utilitarian uses including vessels , water and waste water pipes, roofing tiles, bricks, and surface embellishment in building construction Terracotta tiles have a long history in many parts of the world, Many ancient and traditional roofing styles included more elaborate sculptural elements than the plain roof tiles In India West Bengal made a speciality of terracotta temples, with the sculpted decoration from the same material as the main brick construction. By about 1930 the widespread use of concrete and Modernist architecture largely ended the use of terracotta in architecture.

C. Pozzolan

It is a friable volcanic material, found in thick beds of chunks and gravel-sized pieces in Latium and Campania and easily reduced to usable form It often has a distinct reddish or yellowish hue and has the property of forming hydraulic silicates in combination with lime, quartz sand, and water. The importance of pozzolan can be exaggerated, for some large Roman concrete buildings were built without it, but mortar made with it set readily under water, an advantage Roman engineers made good use

Natural pozzolans are the naturally occurring siliceous or siliceous and aluminous materials which in them- selves possess little or no cementations value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possess-ing cementations properties. Volcanic glasses,
volcanic tuffs, trusses, diatomaceous earths and some clays and

In fact, the name pozzolan comes from the town of Pozzouli in the foothills of Mount Vesuvius, in Italy, where the ancient Romans had produced a hydraulic binder by mixing lime with volcanic soil more than 2000 years ago

Whatever type of binding materials the ancient civilisations used, it can be seen that those structures built by ancient binders, particularly lime-pozzolan mixture have survived for several hundred years. lt can be claimed that even at that time architects were aware of the importance of the durability of binding materials and their mortars.

IV. EVALUATION TECHNIQUES

Depends on the type of the crack the evaluation of distress in cracks can be done by,

(i) Visual Examination

(ii) Non Destructive Testing (NDT).

A. Visual Examination

The amount of distress can be detected by the appearance on the structure. Whitening on the surface indicates sulphate attack. Discolouration or dirt indicates that the crack was present from a longer time. . The widest crack patterns on the surface indicates the maximum tensile stress zone. . Crack width can be measured using a instrument known as the crack comparator, . The locations of cracking, Rust staining, Deterioration of surface, Spalling can be noted. Electrical resistance thin films are also used to detect cracking movements. The cracks on surface are evaluated at atomic, sub micro, micro and macro levels. As we did a visual examination of the live site we could see discolouration along with dirt particles in many areas. This proves that the defect has been present from a long time.

B. Non Destructive Testing Methods

These tests do not cause any harm to the structure. NDT methods are the most powerful testing methods used for estimating the strength, durability and elastic parameters of the material. The parameters are obtained from the tests performed on the properties of the material which include resistance to penetration, hardness tests, Rebound hammer and Ultra sonic pulse velocity test.

NDT testing methods are very easy to perform but the test results obtained and analysis carried out for hardened properties of the material, It proves to be one of the most powerful method for estimating the strength durability of living structures. It also studies very carefully about the depth of cracking , formation of micro cracks etc.

C. Recommended Method - Combined Test Method

These are the combination of two methods involving ultrasonic pulse velocity and rebound hammer test. Both the tests give a very good result regarding the strength of a structure. We strongly recommend the use of the combined test method for analysis as it can give us the best in detail examination.

D. Proposed Crack Repair Techniques After Visual Examination

Some of the various techniques used for repairing cracks are:

- Sealing
- Stitching

1) Method of Sealing

The effected surface is drilled to a sufficient depth near the cracks at several points. The dirt and other particles in the holes are flushed by injecting water with pressure through them. The surface is kept undisturbed till it gets dried an epoxy bonding sealant compound is prepared .The epoxy compound is injected into the holes by any injecting machine till it comes out from other nearby holes. The surface of the structure is cleaned after completion of injection and the epoxy compound is left to dry for some time.

2) Method of Stitching

Stitching is a permanent structural repair for cracked surfaces. It is simple and effective as it involves rods that are grouted across cracks in walls. It is done in order to reconnect and strengthen masonry. A crack stitching repair provides excellent resilience against further cracking with minimal costs and little disruption.

Crack stitching bars reinforced stainless steel rods that are chemically bounded into bed joints. These rods stitch together the cracks which are found within a property, they in turn help in redistributing the tensile forces and stabilising the structural integrity. The bed joints are cut out with specialist dust

extraction cutting equipment and then the crack stitching bar is grouted in place to prevent any further movement. To finish, our crack stitching bars are hidden on completion , so that the property can retain its original characters.

We also recommend the use of double water proof coating before the plaster is being laid in order to attain strength which can withstand any leakage effectively.

E. Health Monitoring of Structures After Treatment

Sensors play a very vital role in structural health monitoring .They act as the basis for all the fundamental operations which help in monitoring the health of structures. Structural health monitoring is considered as one of the primary applications and helps in maintenance of sustainable infrastructure system. These sensors detect real time damage caused in structures like cracks, joints and etc. It also facilitates damage detection diagnosis. Smart sensors have the ability to repair random errors.

V. CONCLUSION

The detailed study carried out at the Deeniya Nizamia Maghbar E Khali gives us a clear view of the deterioration which has been neglected. As per the information obtained from the study we can conclude that sealing and stitching are the two ideal treatments for these deformities. We also recommend the installation of smart sensors to gain time to time information.

Rehabilitation of Site Illustrated on Timble Sketch-Up

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