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Construction Techniques in Architectural Conservation

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Abstract—*Architectural conservation describes the process through which the material, historical, and, design integrity of humanity's built heritage are prolonged through carefully planned interventions. Archaeological conservation is the profession devoted to the preservation of objects, structures, and sites that constitute the archaeological record. These are primary resources for understanding and interpreting the past.*

Preserving old buildings not only benefits a community's culture and identity but also its business and economy. Simply put "historic" means "old and worth the trouble." It applies to building that's part of a community's tangible past. And though it may surprise cynics, old buildings can offer opportunities for a community's future. The Preservation Architect must consider factors that deal with issues of prolonging the life and preserving the integrity of architectural character, such as form and style, and/or its constituent materials, such as stone, brick, glass, metal, and wood. In this sense, the term refers to the "professional use of a combination of science, art, craft, and technology as a preservation tool".

As a movement, architectural conservation in general, and the preservation of ancient structures specifically, gained momentum during the 18th and 19th centuries. It was a response to Modernism and its corresponding architectural perspective,

Which eschewed sentimental attachment to old buildings and structures in favour of technological and architectural progress and change?

Scope of the study is to understand the conservation techniques in buildings depending on their structure by understanding the types of defect and by learning how to rectify those defects. Its main aim is to study and analyse the construction techniques used in conservation through learning construction techniques used in conservation and restoration by analysing the defects in buildings / monuments and identifying the methods of rectifications and repair.

1. INTRODUCTION

Architectural conservation or any method of conserving an existing structure not only deals with the techniques but includes preserving the integrity of architectural character, such as form and style, and/or its constituent materials, such as stone, brick, glass, metal, and wood. In this sense, the term refers to the "professional use of a combination of science, art, craft, and technology as a preservation tool" [1]. Which in turn results into the longer life span of any building or structure?

Architectural conservation also refers to identification, preservation of cultural built environment along with policy regulation considering harmony of surrounding. This process also informs policies and plan development on the basis of historicity of a place for protection of its cultural resources. ASI, INTACH are some organizations contributing for the same and the practitioners are known as conservationist or conservation Architect.

Architecture conservation got a boom during 18^{th} – 19^{th} century responding to modernism and its architectural perspective. Various methods of conservation were adopted so as to encourage the preservation and maintenance of existing structures through maintaining the existing buildings and preserving them from further damage and deterioration. John Ruskin and artist William Morris were two pioneers of conservation and preservation during early 19^{th} century[1].

Restoration is a process of building improvement and preservation sometimes also reconstruction by the use of previously existed building material, design and technique. This helps in maintaining the socio-cultural characteristic of any building without losing its originality and features.

2. VARIOUS METHODS

The Department of the Interior of the United States defined the following treatment approaches to architectural conservation:

2.1. Preservation

Places a high premium on the retention of all historic fabric through conservation, maintenance and repair. It reflects a building's continuum over time, through successive occupancies, and the respectful changes and alterations that are made." [3].

2.2. Rehabilitation

Emphasizes the retention and repair of historic materials, but more latitude is provided for replacement because it is

assumed the property is more deteriorated prior to work. (Both Preservation and Rehabilitation standards focus attention on the preservation of those materials, feature, finishes, spaces, and spatial relationships that, together, give a property its historic character." See also adaptive reuse.

2.3. Restoration

Focuses on the retention of materials from the most significant time in a property's history, while permitting the removal of materials from other periods."

2.4. Reconstruction

Establishes limited opportunities to re-create a non-surviving site, landscape, building, structure, or object in all new materials.

3. ETHICS OF CONSERVATION

The state of the structure, before any mediation and all strategies and materials utilized during the procedure must be completely reported. The intercession ought to be least and reversible however much as could reasonably be expected. The mediation must be administered by regard for the stylish, chronicled and physical honesty of noteworthy structure. The intercession ought to enable greatest measure of existing materials to be held [4].

The utilization of neighbourhood materials and customary advancements should perpetually be liked. Present day substitutes ought to be viewed as simply after their utilization is demonstrated effective and wise. The intercession ought to be agreeable in shading, tone, surface, structure and scale, if increases are important, however ought to be less perceptible than unique materials, while simultaneously, being recognizable. The work ought to be attempted by experienced and prepared conservators/engineers.

4. CONSERVATION PRINCIPLE

Conservation process works on various principle which primarily includes conserving a structure with minimum intervention as it's found on the basis of like for like repairs. Repair process should be reversible and interventions or changes done shall be under Sympathetic principle.

5. APPROACH FOR CONSERVATION

The attributes of the heritage Structures and how they are not quite the same as their contemporary counterpart can be defined taking in consideration the Architectural style, construction techniques, material and variety of structure such as robust structures and outlasting materials, thick masonry walls, arches, columns, arcades, colonnades, domes, brackets, vaults, jack arch constructions etc[4].

Process for preparing conservation plans includes establishing the form of construction by Identifying various types of construction system, materials and techniques used in the structure, Identifying various types of defects in the structure and preparing legend for all kinds of defects. It further includes documenting conditions through Marking the defects in the drawings such as floors, ceiling, internal wall surfaces, external wall surfaces, terrace, decorative features and sections.

Soon after documenting the condition causes of decay are evaluated by assessing the overall effect on the building level. This process then follows by Identifying conservation items of work for each type of work separately and Quantifying each kind of problems in area, volume, length or numbers. Conservation estimates and strategy for conservation are framed after that. Execution of the project is the last stage for this approach[4].

6. PROCESS OF DATA COLLECTION

It is essential to maintain the authenticity of any heritage building it is necessary to collect all available information of the structure. Building itself is an authentic record of its architecture, which needs to be recorded. Data can be recorded through Archival research, Measured Drawings and various techniques of documentation such as visual survey, Photography and Plaster survey.

Building material study, site study, condition assessment by identifying defects, recording site condition on drawing and photographic documentation. The process of documenting is then followed by assessment and analysis of conservation needs. Assessment and analysis is done by identification of the current use of the site and consideration of any need for an appropriate change of use.

Any constraints imposed by statutory consent require actions and needed to conserve or restore the setting of the site.

7. UNDERSTANDING DEFECTS

Preparing inventory of defects where various causes and types are recorded. There are various problems associated with such defects. These defects include

Problems like structural deterioration, Biological and botanical problem, problems of surface, dampness problem, missing members and manmade problems[5].

Whereas defects and deterioration involves structural deterioration, Structural defects, cracks, missing masonry, dislocation of structural walls and arches, Structural cracks and loose masonry, Fracture in architectural members.

The causes of these defects can vary widely most of them are Unequal settlement, Foundation settlement, Natural hazards, Vibrating activities mining, airports, heavy traffic, etc. near the building, Failure of structural members, Inappropriate addition and alteration[5].

7.1. Types of Defects

Defects caused by water include Water seepage, Capillary water rise, and Biological growth. It also causes rising dampness Rising damp actually describes the movement of moisture upward through permeable building materials by capillary action.

The most common source of moisture in the base of the walls of buildings is from defective ground and surface drainage through capillary action. Bricks stones, lime and mud mortars are composed of carbonates, silicates, aluminates or oxides has hydrophilic surfaces which attracts water molecules. Porous building material[6].

Water is drawn into them through suction. Suction force depends upon the nature of the surface and the Diameter of the pores. Smaller the diameter the stronger the force. Movement of water in liquid phase inside a porous material takes place by suction -wet to dry and diffusion occurs when water moves from higher content to lower water content [6].

8. CONSERVATION TECHNIQUES

Dismantling decayed lime concrete layer very carefully without disturbing the underneath layer. Dismantling top layer to provide appropriate slope. Marking appropriate slopes towards outlets. Preparing lime concrete by mixing 50 % brick 20mm nominal size brick aggregate and 50% lime mortar 1:2(1 lime putty : 2 Surkhi).

Cleaning the surface to remove loose particles. Curing the surface with lime water. Laying lime concrete as per provided slopes. Ramming till the shrinkage cracks appears. Finishing with gur and belgiri. Construct gola along the edges using lime concrete. Providing finishes layer with lime mortar. Curing till the carbonation process completes. Protecting the lime concrete from sun to avoid quick drying.

8.1. Lime concreting

It includes Ramming, Beating, and Finishing with belgiri and Jaggery and Sound check. The laid concrete is compacted for 2-3 weeks depending upon the climatic condition to fill the gaps raised in between the ingredients as well as to treat the shrinkage of the lime works. After 3-4 days of the compaction the lime concrete become hard, then small wooden rammer (thapies) are used for continuous compaction of the surface.

It is continuously compacted till the thapies starts getting back from the hard surface of the newly laid and sounds changes as compacted set materials.

During the compaction, the lime concrete surface is cured with water mixed with milk of lime, pulp of belgiri and jiggery water to improve the water proofing properties of the lime concrete.[5]

Initially, for 3-4 days the compaction sound is like compacting watery stuff as lime leaves water. After 3-4 days, the lime concrete becomes little hard and sounds changes like brick. After 15-20 days, the compaction sounds completely change and sounds similarly as first class bricks sound when strike together for the quality check.

8.2. Curing

The lime concrete is cured for a month for complete Carbonation. It is covered with a damp jute cloths, especially in case of flat horizontal surfaces which are open to sky and dry very fast.

8.3. Grouting

Manually operated pressure grout machine was used to inject the lime slurry inside the weak areas with controlled pressure without harming the structure. Before grouting, water was injected to wet the inner cores. Pressure grouting should be started from the visible hole and gaps over the surfaces. When grout mix injected, all the leakage points were observed to understand the holes and gapes in the masonry.

The leakage points are then closed using lime based mortar before grouting so that inner cores can hold the lime grout inside the masonry for consolidation of the weak materials. Grouting in historic building is a very slow process. Grout mix is injected very slowly inside the core at appropriate intervals to allow grout to be soaked by the weak areas required for the consolidation. Grout mix is injected till the time of saturation for complete consolidation of weak areas. During grouting of the lime slurry mix, strict supervision is required to observe the points of leakages , structural movements if any and to control the grout inject which varies as per site conditions. [5]

9. CASE STUDY

Jaisalmer fort conservation:

Jaisalmer Fort a UNESCO world heritage monument is on a hill about 30m above the

Surrounding plain, received piped water only in 1991, since then, there have been several collapses of the bastion walls. The conservation team found that a layer of mudstone in the hill was the main culprit. This is a soil that is very sensitive to water ingress, and virtually dissolves in the presence of water. This led to the collapse in parts of the fort, also new hotels within the fort and am imperfect sewage and rainwater drainage system enhanced the problem within the compound [1].

The team suggested and successfully implemented a method called Inclinometer testing to find out whether there are sub-surface movement in the soil. This is done by drilling vertical boreholes into the hill slopes at critical locations, mainly the corners of the triangular-shaped fort. Flexible plastic tubing is installed in these boreholes.

A very sensitive probe is sent down the boreholes every 6 months or so and exact profile of the boreholes is mapped. A

comparison of the profiles of a borehole over time will give a clear picture of the direction, location and magnitude of any subsoil movement.

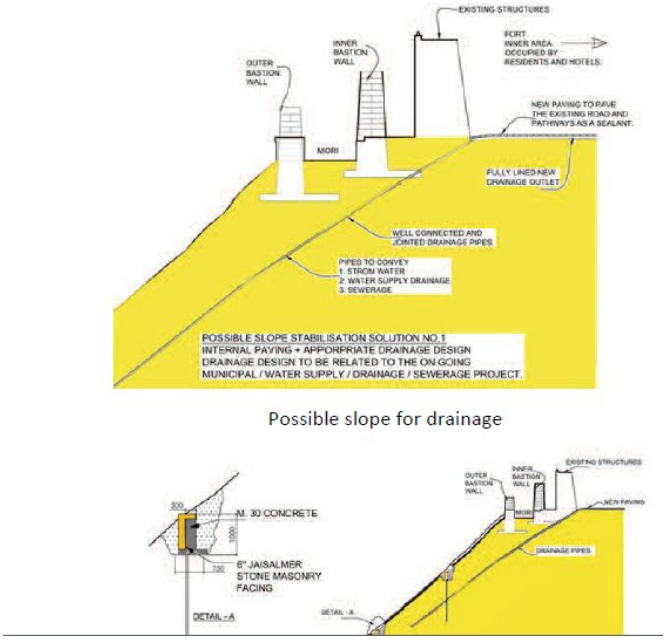

Figure 1 Possible slope for drainage

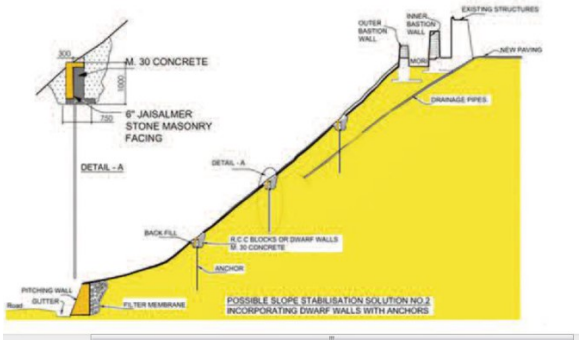

Figure 2 Possible slope for dwarf walls

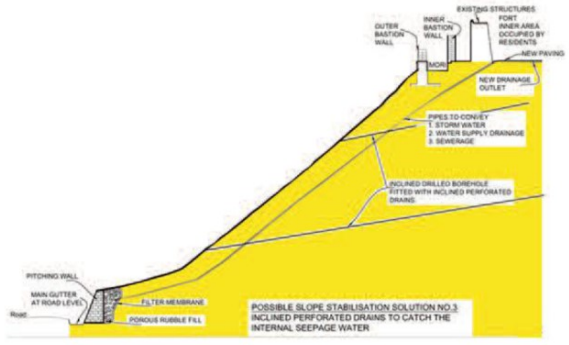

Figure 3: **Possible slope for dwarf walls**

Restoration and Re-use of the - Mori

The Mori is a circuitous passage running between the living areas and the outer bastions of the fort. Originally used by guards to protect the Fort, this had become an open garbage dump. INTACH has completely cleaned the Mori, which enables tourists and residents to walk around the fort and enjoy beautiful views of the city. The first task was to clear the entire passage of accumulated debris [5].

The 850 year old Jaisalmer Fort was in a state of decay, with many of its beautiful palaces on the verge of collapse. The arrival of tourists put a spotlight on these heritage buildings leading to a major conservation initiative by INTACH [5].

10. CONCLUSION

An essential requirement for you as a conservation practitioner involves an ability to synthesise a whole raft of information and, from analysis of it, make recommendations about intervention works. These works might involve, repair and maintenance or, where called for, changes of use, rehabilitation, refurbishment, etc.

The historic record that the asset holds and offers must not be compromised by such work of intervention. It is, therefore, incumbent upon you to clearly understand the implications of any proposed intervention work; this based on detailed knowledge through research and investigation about what it is that makes the asset significant and what, in terms of its deteriology, is a threat to that significance [7].

"The object of conservation is to prolong the life of cultural heritage and, if possible, to clarify the artistic and historical messages therein without loss of authenticity and meaning. Conservation is a cultural, artistic, technical and craft activity based on humanistic and scientific studies and systematic research. Conservation must respect the cultural context" [7].

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