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Impact on restoration of heritage structures with an emphasis on materials

Ar. Samruddhi Arte and *Ar.Rasika Uchgaonkar

assistant professor, assistant professor

samruddhi.arte@gmail.com,uchgaonkar.rasika@gmail.com

Abstract

The existence of various ruins and heritage building elements, which serve as priceless witnesses to India's past, speaks for itself. The preservation of historical evidence and the strengthening of the essence of the country's rich past necessitate the restoration of these structures. Historical structures are the most important ruins for describing a society's past. These structures reflect the lengthy, intricate, and rich history of our nation. They serve as a physical reminder of our past and a monument to our forefathers' mastery of architecture. Because of this, allowing these structures to deteriorate is ultimately ignoring all of that history and the lessons it has to offer us. Buildings that have been subjected to the severe impacts of time and natural calamities are often subjected to very serious difficulties, including the possibility of collapse and extinction. A large number of historical buildings all over the world need to be restored. Historical building restoration safeguards our nation's past in addition to safeguarding valuable assets for the future. Due to the necessity for their great seismic resistance, their constructions must be strengthened. Long- term economic progress in the region depends on preventing the demolition of historic buildings. The paper discusses the relevance of heritage building restoration in modern society and the materials that are utilized to preserve these structures for future generations.

Keywords— Historical, Restoration, Structure, Heritage

Introduction

The presence of numerous ruins and remnants of heritage structures that are invaluable witnesses to India's past speaks for itself. The preservation of historical evidence and the strengthening of the essence of the country's rich past necessitate the restoration of these structures. Historical structures are the most important ruins for describing a society's past. Buildings that have been subjected to the severe impacts of time and natural calamities are often subjected to very serious difficulties, including the possibility of collapse and extinction. The majority of historical buildings are pressure-stressed and exhibit the features of masonry constructions. As a result, building structural components include bearing walls, columns, buttresses, vaults, and domes.

II. Relevance

A large number of historical buildings all over the world need to be restored. There is a need to strengthen their structures due to the demand for their high seismic resistance, as well as for other reasons. Because historical buildings are particularly complex and necessitate the detailed preservation of their original historical forms (architectural, artistic, structural, etc.) as well as their building materials, historic building restoration and strengthening are extremely complex and demanding. It specifically refers to the restoration and reinforcement of load-bearing structures in historic buildings, which presents a significant challenge for structural engineers.

Historical buildings are primarily constructed of stone and brick, i.e., their structures are primarily masonry. Due to the mechanical properties of such materials and load-bearing structures of masonry elements, restoration and strengthening of historical buildings can only be performed by experienced and creative structural engineers, while taking into account the many restrictions required by architectural, conservational, and other objective requirements. Throughout the years, numerous historical buildings have been constructed in a variety of forms, construction styles, building materials, supporting systems, and purposes. Some historical structures have been subjected to severe actions over the years,

significantly altering their original purpose, load-bearing structure, and appearance. In several cases, new building construction or interventions near historic structures had a significant impact on the safety and sustainability of those structures. uctures.

III. Restoration of Structures

Restoration is described as the act or process of faithfully reflecting the form, characteristics, and character of a property as they were at a certain point in time by removing features from its past and rebuilding missing features from the restoration phase The restoration of historical buildings entails the renovation of their various original solutions in terms of shape and size, architectural style, construction, bearing structures, materials, functionality, and aesthetics, among other things.

IV. Basic Critria for Restoration

Restoration strives for authenticity by precisely resembling materials and procedures. Modern works, such as upgrading old utilities or introducing climate controls, detection systems, and so on, are done discreetly in order to preserve the historic character. The following criteria could be used to determine whether restoration work is acceptable:

1. The impact of restoration work on the building's overall heritage value.

2. The weight of evidence for need for the work.

3. Whether the work respects the previous forms of the building.

4. The implications of the work in terms of ongoing maintenance requirements.

The following are the fundamental principles to consider, particularly when it comes to structural restoration:

1. Having sufficient respect for the original materials.
2. Respecting the valid contributions of all periods on the building.
3. Missing parts must be replaced in a way that blends in with the overall design.
4. Additions should not detract from the building, its site, or its relationship to the surrounding environment.
5. Use of traditional techniques and materials.
6. Modern procedures and materials are permitted if older alternatives are impractical.

There are two types of restoration techniques: reversible and irreversible. Reversible actions may be preferable because they can be replaced without causing damage to the original fabric, such as if additional restoration is required or better techniques or materials are developed in the future. Reversible techniques are commonly used in the following ways:

- 1. External buttresses.
- 2. Ties at arch springing's.
- 3. Rings at the base of domes.
- 4. Pre stressed un bonded stitches.
- 5. Anastylosis of stone or marble monuments with dry joints.
- 6. External ties.
- 7. Improvement of the strength, stiffness, and ductility of existing diaphragms.

However, using reversible methods for interventions may not be possible, and some interventions cannot be easily undone without causing damage to the existing structure. Irreversible techniques are commonly used in the following ways:

- 1. Grouting's.
- 2. Bonding-in of new bricks across cracks after grouting and cutting out to each side.
- 3. Deep rejoints.
- 4. Rebuilding of part of the facings of walls.
- 5. Stitching of walls with prestressed rebar.
- 6. Reinforcement of masonry with steel bars.
- 7. Connection of marble or stone parts with bonded dowels.
- 8. Skins of reinforced concrete on masonry.
- 9. Strengthening of foundations.

The suitability and durability of the replacement materials must be carefully evaluated. They should be chemically, mineralogically, physically, and mechanically compatible with the existing structure, as well as aesthetically pleasing. Strength, stiffness, bonding, thermal expansion, and permeability are also factors to consider, as are problems such as efflorescence. Non-metallic materials that are commonly used for irreversible interventions include the following:

- 1. Stone and marble.
- 2. Brick.
- 3. Concrete.

4. Mortar and grouts (Portland cement, lime-cement, pozzolanic, epoxy resin).Steel, as well as fiber composite cables, are frequently utilized where high tensile strength or pre stressing pressures are required.Air pollution, acid rain, UV radiation, and other factors can cause paintwork and renderings to decay. Historic paint study of old paint layers can detect the original coloration and enable the

reproduction of a chemical recipe. Because some paints were initially made with dangerous elements such as arsenic and lead, newer alternatives are frequently required.

V. Case Study

The restoration of Subramanya Swamy choultry has been studied in order to examine how restoration work is often conducted in India. The Choultry was built in 1934 alongside the Subramanya Swamy Temple by the philanthropist Sajjan Rao, after whom the circle is also named. Over the years, the Choultry has served as a significant landmark, catering to various community needs. Currently, it is managed by a trust that oversees not only the Choultry but also the temple and several other institutions. The trust plays a crucial role in maintaining the heritage and ensuring the smooth functioning of these establishments, thereby continuing the legacy of Sajjan Rao's philanthropic contributions to society.

A. Choultry Meaning

Choultry is a resting place, an inn or caravansary for travelers, pilgrims or visitors to a site, typically linked to Buddhist, Jain and Hindu temples. A choultry provides seating space, rooms, water and sometimes food financed by a charitable institution. Its services are either at no cost, or nominal rates, or it is up to the visitor to leave whatever they wish as a donation. They were also used by officials traveling on public business.

B. Architecture

The building while being dedicated for community service, has very interesting architectural elements largely retained in original form. There have been certain modifications in the interiors, where the reception hall, which was originally a double height space has now been covered so as to create a dining area on top. Besides, minor modifications in the rear block, adding a staircase, gas units, etc. have been added. Also on the first floor, hand wash area are the new constructions added to the original structure. The significant elements of the building which have retained in various ways in which the choultry is proposed to be altered are:

1. Front elevation, side elevation
2. First floor ceiling with variation in heights
3. Terrace construction
4. Cast iron grills
5. Windows and ornamental chajjas
6. Open to sky spaces inside

C. Material Selection

Selecting appropriate materials for repair requires specialized knowledge and, in many cases, thorough investigation. The use of authentic traditional materials is essential for preserving the historical character of buildings while also supporting traditional industries and craftsmanship. However, in certain situations, alternative materials may be considered, particularly if they enable the conservation of a larger portion of the original structure. Such materials should only be used if they have been tested and proven suitable for historic buildings. Regardless of the material chosen, compatibility with the existing fabric is crucial. Along with aesthetic considerations, the physical properties of the repair material must be evaluated, as some materials can accelerate deterioration rather than preserve the structure. The selection process relies on comprehensive documentation and detailed analysis of the structure. Material mapping plays a significant role in identifying suitable materials for conservation. Additionally, the availability and cost of materials in the market can also influence the final decision.

VI. Materials Used For Restoration After Analysis

Lime mortar Admixtures:

- i. Bel phal- juice of these fruit added in jaggery and keep it for decay and then add in lime.
- ii. Jaggery- use with bel phal.
- iii. Cactus juice- to avoid insect attack
- Binding materials used:
- i. Animal waste
- ii. Bee wax
- iii. Black gram (udad)
- iv. Curd
- v. Green gram (moong)
- vi. Rice stock
- Reinforcement used:
- i. Animal hair
- ii. Rice husk
- iii. Coconut husk
- Water proofing:
- i. Milk products
- Materials used for Cohesion:
- i. Corn oil
- ii. Mustard oil
- iii. Linseed oil
- Stucco
- i. Lime prepared by burning couches (Shankha) or oysters (Shipi) is called Sudha. Fine sand, decoction of moog is also used.

VII. Different Materials That Can Be Used For Restoration

A. Cast Aluminum

Material: Cast aluminum is a molten aluminum alloy that is cast in permanent (metal) molds or one-time sand molds that must be adjusted for shrinkage during the curing process.

Application:

- Cast aluminum can be used in place of cast iron or other decorative elements. This includes grillwork, roof cresting's, cornices, ornamental spandrels, storefront components, columns, capitals, column bases, and plinth blocks.
- Elements are generally screwed or bolted to a structural frame if they are not self-supporting. Because of galvanic corrosion issues with dissimilar metals, joint details are critical.

B. Cast Stone (Dry Tamped)

Material: Cast stone is a dense stone-like unit formed by dry-tamping a nearly dry cement, lime, and aggregate mixture into a mold.

Application:

- As a replacement for unveined deteriorated stone, such as brownstone or sandstone, or terra cotta in imitation of stone, cast stone is often the most visually similar material.
- It's used for both surface wall stones and ornamental features like window and door surrounds, voussoirs, brackets, and hoods. Rubber-like molds of good stones can be taken on-site or made up at the factory from shop drawings.

C. Glass Fiber Reinforced Concrete (GFRC)

Material: Glass fiber reinforced concretes are lightweight concrete compounds that have been reinforced with glass fibers and have been modified with additives.

Application:

- Cornices, projecting window and door trimmings, brackets, finials, and wall murals are made of glass fibre reinforced concrete instead of stone, terra cotta, metal, or wood. It can be produced as a molded product in long sections of repetitive designs or as sculptural elements.
- Due to its low shrinkage, it can be manufactured using molds taken directly from the building. It has a separate noncorrosive anchorage system installed. It is vapor permeable due to its cementitious composition.

D. Precast Concrete

Material:

- Precast concrete is a wet mixture of cement and aggregate that is poured into Molds to form masonry units. Molds can be made from the building's existing good surfaces.
- Precast concrete is commonly used in place of masonry materials like stone or terra cotta. It can be used for both flat wall surfaces and textured or ornamental elements.
- Wall stones, window and door surrounds, stair treads, paving pieces, parapets, urns, balusters, and other decorative elements are all included. The surface is more dependent on the textured mold than the hand tamping method of fabrication, which distinguishes it from cast stone.

E. Fiber Reinforced Polymers (FRP, FIBERGLASS)

Material: Fiberglass is the most well-known FRP product, and it is typically manufactured as a thin rigid laminate shell formed by pouring a polyester or epoxy resin gel coat into a mold.

Application:

- Fiberglass, a non-load-bearing material attached to a separate structural frame, is frequently used as a replacement where a lightweight element is required or where an inaccessible location makes regular maintenance of historic materials difficult.
- Because of its superior molding capabilities and adaptability in replicating stone, wood, metal and terra cotta, it is an appealing alternative to ornate or carved building features such as column capitals, bases, spandrel panels, belt courses, balustrades, window hoods and parapets. Its capacity to create vibrant colors is a big advantage.

F. Epoxies (Epoxy Concrete, Polymer Concrete)

- Epoxy is a two-part resinous thermosetting material that is used as a consolidant, adhesive, patching compound, and molding resin. It has the ability to repair damaged material and recreate lost features.
- One of the most versatile new materials is epoxy. It can be used to bind fractured terra cotta fragments, to build up or infill missing ornamental metal components, or to cast missing elements of wooden ornaments.Small cast elements can be attached to existing materials, or new features can be cast entirely.
- The resins are poured into molds, and the molded units are generally small or hollow on the inside due

- to the rapid setting of the material and the need to avoid cracking.
- For larger elements, multiple molds can be combined. Epoxies can be structurally reinforced with special rods. Finials, sculptural details, small column capitals, and medallions are examples of epoxy replacement pieces.

VII. Problems Faced

was the demolition of improvised structures that had been added as extensions to the original heritage building. The dismantling process required careful planning to ensure the integrity of the historic structure was maintained. Adequate structural support was provided under the supervision of structural engineers, architects, and clients to prevent any unintended damage.

Additionally, ensuring labor safety was a key consideration throughout the process. To minimize risks, no heavy machinery or cutting tools were used during the dismantling phase, as vibrations from such equipment could potentially cause cracks in the existing heritage structure. Unlike conventional architectural projects, restoration work presents unique challenges, particularly in balancing dismantling, restoration, and reconstruction. These factors often lead to an increase in the Bill of Quantities (BOQ), directly affecting both the timeline and cost of the project. Moreover, the success of the restoration relied heavily on the availability of skilled labor, which was essential for executing the work with precision and care.

IX. Conclusion

The deterioration of historic structures can result from multiple factors, including aging, lack of maintenance, unchecked growth of vegetation, improper drainage systems, material degradation, and exposure to weathering. Preventive maintenance is the most effective approach to minimizing decay, as regular upkeep can help delay or even eliminate the need for extensive interventions.

A successful repair process begins with a thorough assessment of the structure's existing condition and an analysis of the causes of deterioration. It is equally important to establish a monitoring system for ongoing deteriorative factors to ensure the long-term preservation of the structure. Any intervention should be based on a comprehensive understanding of both the factors that contributed to the damage and those that will influence the building's condition post-restoration.

To maintain the authenticity of historic structures, the removal or alteration of original materials and architectural elements should be avoided whenever possible. Instead, efforts should focus on repair rather than replacement to preserve the integrity of the structure. Historic buildings serve as tangible links to the past, carrying cultural and historical significance across generations. It is the

responsibility of the present generation to safeguard these structures for the future. The challenge lies in addressing modern demands while ensuring minimal disruption to the original fabric, requiring careful and less invasive conservation strategies that respect both the structure and its socio-economic context

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