ABSTRACT

The North and the North east of India lies on the highest seismic zone. Hence many historic buildings in this region are subjected to natural calamities and damages due to seismic hazards. Sri Govindji temple in Manipur was subjected to damage due to three successive earthquakes. For more than a century the temple remained abandoned and was exposed to further decay and damages. In 2004, the Manipur government assigned the conservation project to ICOMOS India. The scope of work included the restoration and conservation of the temple using technologies for damaged rehabilitation by utilizing local materials and most importantly by reviving the dying traditional terracotta craftsmanship. The conservation involved detailed documentation of the temple precinct before starting of the assignment, followed by a diagnosis and pathological treatment to the damaged building and lastly proper structural strengthening of the building so that it can withstand future seismic tremors. The temple has successfully withstood several seismic forces thereafter in the last five years without any further damage to the structure.
INTRODUCTION

The ancient tradition of terracotta has flourished in India for over five millennia be it in the making of utensils, ornaments, and toys or built structures. Vernacular terracotta-brick architecture of Bengal and Manipur bears testimony to the varied and ancient traditions of terracotta. Eastern India has experienced a use of this material in myriad forms be it in the construction of temples or other built structures that have withstood the test of time. With the vagaries of nature and decay over ages, these temples are in need of immediate preservation and maintenance. The challenges presented by terracotta are compounded by the fact that there is still widespread ignorance about the nature of different types of architectural ceramic, their patterns over age and culture and the craftsmanship that is needed for restoration.

The Govindji temple, located in the Kangla fort of Manipur was the basic case of study and with hands-on experience that became a part of a bigger module to engage people of various capacities in the process. The temple was built in 1846 AD during the reign of Maharaja Nara Singha [1]. Built on an almost square plan, it stands on a raised jagati (platform). The bhittis (plinths) are raised, straight up to the cornice. This east-facing temple, where the kings used to worship, was built with a composite structure of both brick and teak wood. Unfortunately, this temple was subjected to major structural damage due to three successive earthquakes, the major one being in 1869 AD. It was restored during the reign of Maharaja Chandrakirti and was again used from 1876 AD. Eventually, the deity was removed from the premises and moved to a new temple and subsequently this temple was abandoned. A century of neglect led to natural decay and caused major structural cracks and the collapse of the roof. In 2004, the Manipur government assigned the conservation of this temple to the India ICOMOS for complete restoration to reinstate its earlier glory.
For many years Manipur was under the domination of Assam. As a result, the entire Kangla Fort was seized by its enemy. Nothing was done where restoration of the Shri Govindji Temple was concerned. No organization took the initiative at that time to conserve this abandoned temple.

- When Manipur got back the fort from Assam, then the significance of restoration became a vital issue. The local people themselves took the initiative in responding and agreeing to its restoration. This was the first step of people’s participation towards the restoration of Kangla fort.
- Trained artisans and craftsmen were brought from Bengal to restore this terracotta structure.
- Local people came forward to help the artisans during the restoration process.

**Why Brick architecture was prevalent in this region?**
The entire north east of India has a tropical climate, with highest rainfall, lot of humidity and lush green growth of vegetation. The monuments in this region are exposed to high humidity and dense vegetation growth. The area also yielded large amount of timber and very fertile alluvial soil. The abundance of timber took care of the firing of the brick, thus giving rise to terracotta and brick architecture. Proper firing of bricks and appropriate measures if taken for its maintenance can make bricks match the durability of stone. Besides it has the advantage of being composed of small units therefore giving rise to flexibility and greater constructional possibility in these seismic prone regions.

**Conservation and preservation Problems in the North-east.**
The undulated surrounding of the historic buildings poses a constant threat of water logging and as a result of the excessive rainfall for months; the surrounding becomes muddy which gradually leads to shrinkage of the foundation and sometimes partial collapse. To avoid such problems, proper slopes are provided around the structures for easy drainage and water logging problems. An apron all around the temple is created to keep the surroundings free from vegetation growth and water free zone surrounding the foundation of the temple. Growth of lichen and moss on the exterior walls of the building turns the walls into blackish hue with spotted white and red patches. Cracks occurring due to vegetation growth gradually leads to weakening of the area, which in turn absorbs water during torrential rains resulting to collapse.

**Issues in conservation of brick structures**
Brick structures in tropical climate are constantly exposed to excessive vegetal growth creating mechano-chemical action. Bulging, leaning and out of plumb masonry is common to historic structures. The roots of the vegetation grow deep inside the walls resulting in cracks and dislodge...
masonry.

1. In the seismic zone, considerable damages are done during earth quakes causing settlement problems in the foundation. [2]
2. Saltpetere is another destructive element which makes brick brittle. Salt action also causes decay and decomposition in bricks. The high percentage of salt as well as humidity in these areas leads to dampness and with the evaporation of water contents, salt get crystallized. In solid state these expand within the body of the bricks resulting in flaking. [3]
3. Over fired as well as under fired bricks also damages the masonry and make the wall weak. [4]
4. Action of soluble salts, chlorides, sulphites and nitrates damage the structures.
5. In the Indo-Gangetic-Brahmaputra plain, bricks are made either of fine silt and clay deposit after floods or of decomposed earth brought down from the hills. Although well fired, still course grained materials in its composition have the tendency to absorb more water. Due to this texture, the capillary action works more vigorously causing the dampness to rise to considerable heights in old structures as no waterproofing were done at the foundation level. [5]

Figure 5,6,7: Decay in Brick and Wood Construction

Traditional construction techniques and traditional art forms are almost getting wiped out. In recent times, even in the rural sections, traditional artisans are finding comfort in seeking other vocations as part of their livelihood because of the lack of patronage towards traditional art forms. Due to this reason it was felt that it was an ideal situation and opportunity to allow the public to participate in this project and be taught the age old traditional craft which is slowly dying. Artisans from rural Bengal and the local Manipuri craftsmen participated shoulder to shoulder in conserving the built form as per traditional technique.

The entire temple, along with its cultural resources, needed to be brought into an effective management process, in order to preserve and protect the same for future generations. The potential of the Govindji temple as a World Heritage Site gave the following objectives to conserve it:

- To restore the temple using technologies for damage rehabilitation and traditional science of building construction by utilizing the locally available materials and traditional craftsmen.
- To safeguard and protect the cultural resources offered by the temple within the existing legal framework.
- To preserve, protect, restore and revitalize the building within the Kangla Fort.
- To promote its socio-religious values.
The process for the conservation program involved:

- A comprehensive documentation of the temple structure and restoration requirements. The documentation also involved condition assessment to enable estimates and project identification.
- Detailed drawings of the various parts of the temple to be produced for the conservation purposes.
- Study of the vernacular architecture and the terracotta art tradition of East India.
- Pathological and structural analysis of buildings damaged due to natural hazards.

Like any masonry building material, terracotta installations are subject to water infiltration and freeze-thaw damage, so the temple restoration critically addressed the moisture damage, expected unit spalling and cracking repairs and masonry joint damage [6]. The carved motifs on bricks of the temple art form such as creepers and flowers are unique to the era and it required a different approach of conservation. Not restricted to a mere technical restorative program, the team searched means of engaging present day artisans to reproduce the art in the temple for replacing portions of the motifs that could not withstand any more wear and tear.

The main damages that the main structure faced due to three successive earthquakes and followed by a century of neglect are:-

- The barrel vaulted ceiling had collapsed and the structure exposed to weathering hazard.
- Severe cracks on walls due to earthquake which got worsened by vegetation growth on the cracks and crevices.
- Wooden beams and rafters in a state of decay.
- Corridor flooring destroyed completely.
- Rising dampness on walls and floor
- Cornice damaged to a large extent
- Balusters and parapet are broken and missing
- Stucco plaster on external wall has been damaged.

**Figure 8:** Shri Govindji temple before conservation  **Figure 9:** Rear dilapidated state of the temple

**EXPERIMENTS**

Shri Govindji temple is a declared Heritage site therefore any conservation and restoration work should be as per conservation by-laws. Objection has been raised in recent seminars and workshops on conservation regarding the liberal use of cement in conservation of historic
monuments [7] where as the fact that original materials like lime mortar is not so strong a building material. Some modern building materials have been used to make it strong and effective with the structure, keeping in mind the principles of conservation. In India masonary workers suggest mixing of Silica fumes (5%) in lime mortar for additional strength. It is only an experiment. Often in high-rise bridges it is frequently used with cement. That has given additional strength, keeping this in view it can also be applied in old historic buildings too.

Weathering of historic monuments is essentially an interaction between building materials used and environmental factors [8], therefore chemical preservation may be considered as part of integrated approach. Recently in France ICOMOS held a symposium [9], ‘on the conservation of concrete’ where the issue of materials associated with recent heritage buildings were being discussed. Even the use of synthetic resins like silicon and epoxies, to stabilize stone and other surfaces in monuments are being used for further durability of historic monuments. Stainless steel truss too can be used sparingly as security measures against future mishaps as permitted since 1992.

At high risk earthquake zone and cyclone prone areas, structural engineers were advised to provide resistant designs and materials according to National Building Code of 1983 (NBC-1983) [10]. While carrying out structural repairs specially in heritage buildings the safety measures as outlined in earthquake prone areas are observed and in few cases where the structural stability of the building is precarious, modern architectural substitute and remedies [11] are provided in a camouflaged way [12]. For natural hazard prone areas promotion of traditional as well as modern preventive technology [13] should be the response. In the conservation of Shri Govindji temple, we have tried to develop heritage friendly technology keeping in mind the earthquake and other disaster mitigation techniques. The issue of sustainability, durability and other cost effective measures were also taken into account.

Buildings which have domes or vaults on them are prone to collapse due to seismic force if not constructed properly. Shri Govindji temple is a case where the roof fell due to the above mentioned cause. At that time, when it was constructed, seismic forces were not so frequent as it is today. Over the years the area became very seismic prone. Under such a condition the support of dome or vault roof must be a horizontal circular ring of reinforced cement concrete, steel or timber [14]. As such a domical or a vaulted roof is normally a very stable structure, like an upside down basket. Because of this stability of the form most temples in this region were made of this shape. The roof is made light so that the rest of the building can take its load. In this region, in the east of India, most temples have this form as this is the most stable form. Even then the temple roof collapsed with the impact of seismic force.

At the time of conservation, keeping all these issues in mind, the roof was reconstructed with reinforced bamboo instead of timber. Inspired from the weaving pattern of traditional bamboo basket, the entire form of the vault was reconstructed with a grid of bamboo. Very sparingly steel reinforcement has been used at the corner. Bamboo grows in abundance in this area and as it is light weight and has a property of high tensile strength and flexibility, it can withstand the impact of seismic movement. Instead of steel or timber, when reinforced, it can easily get camouflaged as the original structure. In traditional vernacular architecture usage of bamboo was the chief building material in the north-east. Within the limits of architectural conservation technology and permissible experimentation, the reconstruction of the roof was actually by the above mentioned method.
Water table of the area was noted from the brick structures and the capillary action determined. As it was found high, wells were dug in the surrounding area, close to the site, so that the water level goes down in these areas. In cases where the walls had developed wide cracks in the superstructure, neat stitches with tooth edge on both the sides were done and then it was filled with new brick work.

In most cases it has been found that historic buildings earlier in this region were not properly water-proofed at plinth level. Therefore rising dampness due to capillary action caused subsequent damage to the structure [15]. The foundation due to lateral force became gradually weak. Approximately 10’ wide trench was dug up around the temple. A continuous band of
corbelled masonry buttresses were provided along the foundation to strengthen it. An additional plinth protection band of stone was provided around the structure at the ground level to further protect the structure.

**Figure 16,17,18: Trench around the temple**

**RESULTS AND DISCUSSION**

The various precautions taken are:-

- Corbelled buttresses provided to strengthen the foundation against the lateral seismic forces
- The vaulted roof has been reinforced with structural steel and bamboo under lime mortar.
- Traditional artisans and craftsmen trained in terracotta art were brought from various interiors of West Bengal have reconstructed the parts that had completely weathered or had vanished in due course of time.
- Wooden rafters were restored and a few that were missing or totally damaged were replaced.
- Cornices and stucco plasters were restored, and at certain places reconstructed, following the rules laid down by the charters based on authenticity.
- Flooring was repaired inside the sanctum and on the corridor

**Figure 19,20,21: Wooden rafters were conserved**

**Conservation and Pathological measures**

Documentation of the entire site was done, both by drawings and photography, along with detailed notes on the architectural aspects, crack patterns and the condition of the foundation.
At site, the vegetation inside the temple and the immediate surrounding was cleared first. After the growth of vegetation was removed, the superstructure, cracks, damage due to roots, failure of foundation and super load was studied.

Old bricks were dug out from the debris of the monument, sorted out and aired and dried in the sun. Brick bats were kept separately for crushing and making into Surkhi (brick dust). Complete and undamaged bricks were used in conservation work as the same bricks are befitted for visible homogeneity of the structure.

The water used for washing the bricks, masonry and for the mortar has to be salt free. So they had to be tested before conservation work. Saltpetere bricks were removed slowly and carefully without disturbing the structure. Affected areas were treated and those which could be reused were inserted. Water tightening of the exposed portions of the walls was carried out so that no seepage took place from inside. Granite slabs were inserted at the plinth level to prevent water rising due to capillary action.
Certain walls which were slightly out of plumb portions of the walls were jacked back and places where it was not possible, these were removed completely and reset in lime and mortar.

After the analysis of the crack patterns, some cracks were found going up to the foundation, this part of the structure was carefully dismantled, the foundation reset and the super structure remade.

The missing terracotta jalis and ornamentations were reconstructed with the help of master craftsmen.

The eroded hard mortar used in joints needed pointing. Recessed pointing was done and harmonized with the old one.

Places where there was a paucity of bricks, new bricks were manufactured with the year of manufacture stamped and used in recessed manner, ¼ inch, so that the new bricks are clearly seen with the old ones.
In the last 5 years Manipur has faced successive tremors of various magnitudes but the temple has successfully withstood them without any further cracks or damage to the structure.

CONCLUSION

Restoration and reconstruction of structures for the continuity of surviving traditional building science and craft skills associated with the vernacular architecture is essential for the architectural history. Skills should be retained, recorded and passed on to the new generation of craftsmen, architects, and engineers, in education as well as in training. Shri Govindji temple gave the scope of retaining the above mentioned issues. Introduction of contemporary materials along with the traditional materials which maintain a consistency of expression, sustainability, appearance of form and durability even during hazard prone circumstances should be encouraged and respected.

India with its uninterrupted history of terracotta as well as other unique masonry and craftsmanship has a legacy of built heritage. A different methodology is followed in India, wherein we are able to utilize, even today, historical methods of construction. Unlike many other countries in the world, the art of building masonry and craftsmanship is passed on from generation to generation, here. As a result, the old building technologies are prevalent and expert craftsmen are still available. It would be wrong to conclude that reconstruction is being performed; rather, traditional technologies are still being reinforced in these places where pathologically the building requires attention. Today, the Govindji Temple has a mixture of unique cultural characteristics, ranging from archaeological to architectural and sacred.

Figure 39: Reconstruction achieved

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