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CONSERVATION AND RESTORATION OF ANCIENT STUPAS IN SRI LANKA

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ABSTRACT: Ancient Stupas in Sri Lanka are solid structures, mostly composed of burnt bricks. Some of them date back to the third century BC, and some attained gigantic proportions, making them the largest brick structures in the world. At the turn of the 19th century AD all of the ancient stupas were in ruins, covered with vegetation. Initially rehabilitation of these stupas were attempted in haphazard ways, but presently modern principles of archaeological heritage management are applied to the conservation and restoration of these historical structures. Mirisaveti stupa (2nd century BC) is a good example for a complete restoration. It had only the cracked dome at the beginning of the 20th century after repairs by the British, and an ill planned restoration in 1987 resulted in a collapse of the stupa. After a thorough study the stupa was restored to its original form in 1995. In the case of Jetavana (3rd century AD) a conservation rather than a full restoration is presently done. The dome, which is covered with vegetation, is cleaned and a new layer of brick is added on top of ancient bricks. The square chamber has to undergo major repairs as some parts of it had suffered serious damage. In the case of Tissamaharama (2nd century BC), equally spaced meridional cracks appeared on the surface of the dome towards its mid height due to hoop tension. In order to halt the spread of these cracks, external pre-stressing was done using circumferential cables fixed to the dome.

KEYWORDS: ancient stupas, brick structures, restoration, conservation, finite element analysis

1. INTRODUCTION

Stupas in Sri Lanka [1, 2] are religious structures venerated by Buddhists, and they house corporal remains of Buddha or mark an important place associated with the religion. Buddhism came to Sri Lanka in the third century BC and since then Sri Lankan Kings have built stupas of various shapes and sizes. Notable ancient stupas in Sri Lanka are: Thuparama-the oldest stupa- built by King Devanampiyatissa in the 3rd century BC, Tissamaharama (Figure 1a) built by King Kavantissa in the 2nd century BC, Miriseveti (Figure 1b) and Ruvanweli (Figure 1c) built by King Dutugemunu in the 2nd century BC, Abhayagiri built by King Walagamba in the 1st century BC and Jetavana (Figure 1d) built by King Mahasen in the 3rd century AD. Jetavana which attained a height of 121.9 m was at one time the third tallest structure in the world surpassed only by the two great pyramids of Giza. Its present height is only 70.7 m but with a volume of 233,000 cubic metres, it is arguably the most voluminous brick structure in the world.

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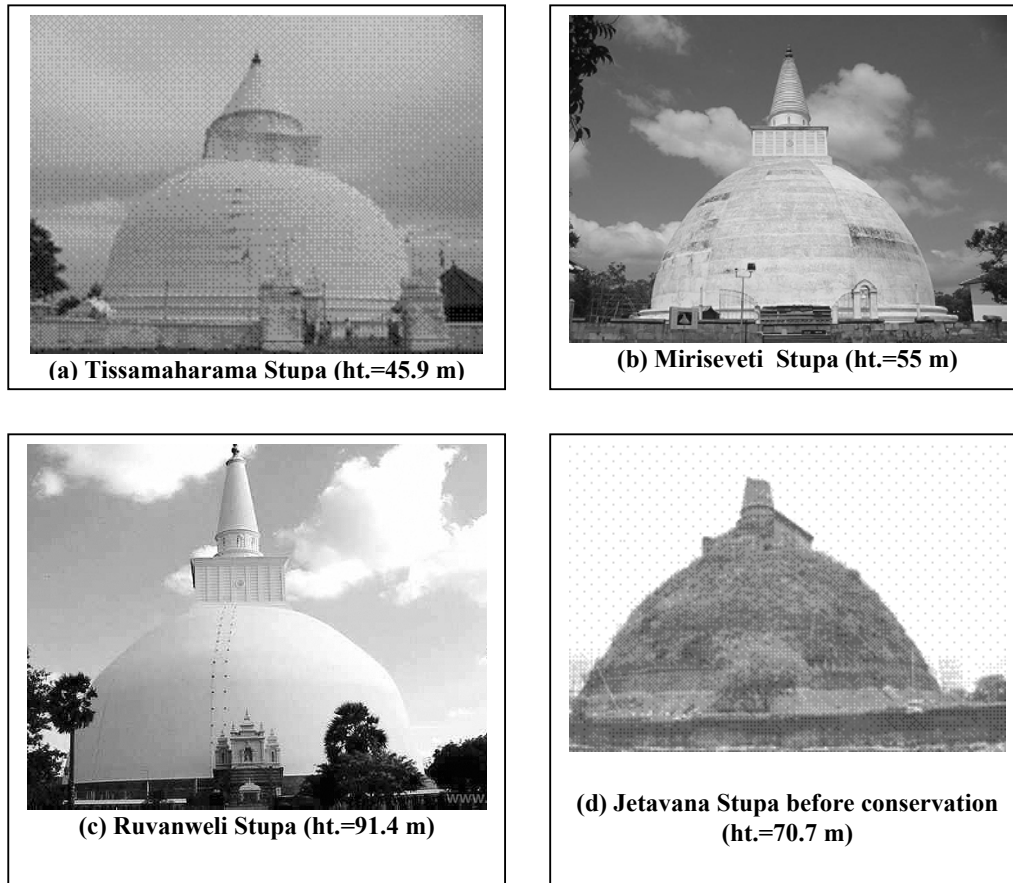


Figure 1. Some ancient stupas in Sri Lanka

Ancient stupas in Sri Lanka are solid structures, built mostly of burnt clay bricks. Over the years, the structural form of the Sri Lankan stupa has changed from the original Indian form to a form of its own shown in Figure 2.

The stupa dome has one, two or three cylindrical terraces or basal rings at the bottom, which sometimes form a plinth. At its top, the dome carries the square chamber, which is a solid structure having a square plan. Then come one or more cylinders, the spire and the pinnacle consisting of a minaret and a crystal. All these components are solids, and except the square chamber, are axisymmetric. Brickwork of the stupa consists of high quality bricks laid with a very thin mortar and the outer surface of the stupa is water proofed using a thick plaster layer [3].

2. CONSERVATION AND RESTORATION OF STUPAS

Due to foreign invasions and the shift of the capitals from one place to another, the ancient stupas were neglected and started to decay. Various Kings of Sri Lanka carried out reconstruction, restoration or conservation of stupas built by their predecessors. In the second century AD, King Prakramabahu restored many of the stupas including the mega stupas, Ruvanveli, Abhayagiri and Jetavana. After the twelfth century there was hardly any work on stupas until the British started

documentation and reconstruction work on them, in the latter half of the nineteenth century. Around the same time Buddhist organisations undertook restoration works of many important stupas.

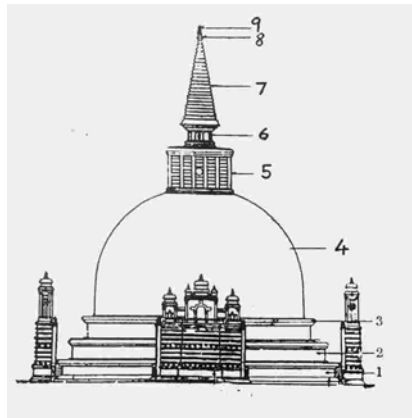


Figure 2. Main components of a Sri Lankan stupa

(1,2,3-Basal rings, 4-Dome, 5-Square chamber, 6-Cylinder, 7-Spire, 8-Minarets, 9-Crystal)

2.1 MIRISEVETI RESTORATION

Miriseveti, built by King Dutugemunu in the second century BC was enlarged by several Kings. It is the first stupa to be reconstructed by the British, and when they started their investigation work in the late nineteenth century, the stupa was in ruins (Figure 3a). Even though the plans were prepared for its full restoration, only the dome was reconstructed (Figure 3b). An ill conceived restoration attempt led to a catastrophic failure in 1987 leaving only a conical mound of the original stupa (Figure 3c). Finally, a full restoration was done based on a design concept [4] where the new brickwork acts as a thick shell without bearing on the remaining ancient brickwork (Figure 3d). To take up radial and hoop tensile stresses (Figure 3e), radial and circumferential reinforced concrete beams were embedded in the new brickwork (Figure 3f). The construction work, started in 1990, was completed in 1992 (Figure 1b).

2.2 JETAVANA CONSERVATION

After the restoration of Miriseveti stupa to its full conjectured height, the thinking changed to conservation rather than full restoration, with the aim of preserving the as found nature of the monument with minimum intervention. Hence in the repairs done at present to Jetavana, the largest stupa in Sri Lanka, rules of archaeological conservation are used. In order to identify weak zones of the stupa, finite element stress analyses were done and they showed (Figure 4a) that the stupa dome has no tension under self weight, but the square chamber and the cylinders have some hoop tension. Hence, in the dome which was covered with vegetation (Figure 1d), provisions to take tension is not necessary, and the surface of the dome is cleaned and a new layer of specially made bricks [3] is added on top of old bricks (Figure 4b). The square chamber, which has tensile regions and had undergone serious damage, requires major reconstructions with new brickwork, and reinforced concrete ring beams and slabs are provided to take up tension (Figure 4c). Partly conserved stupa is shown in Figure 4d.

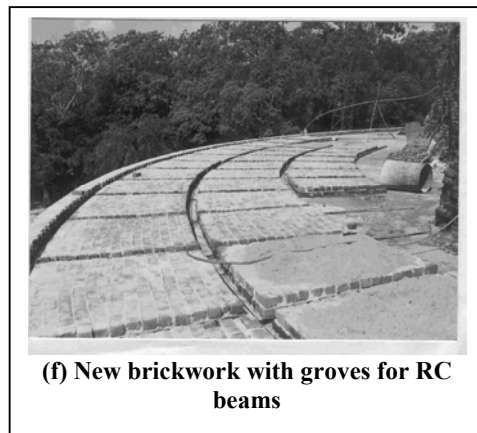
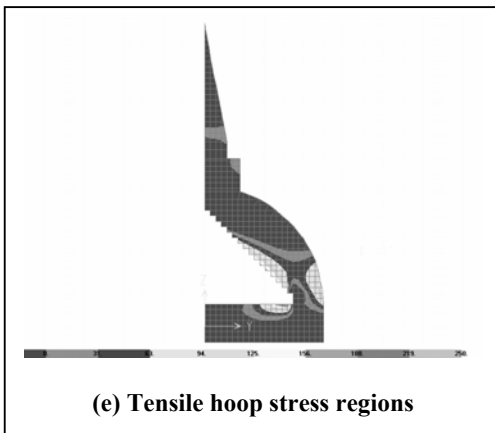
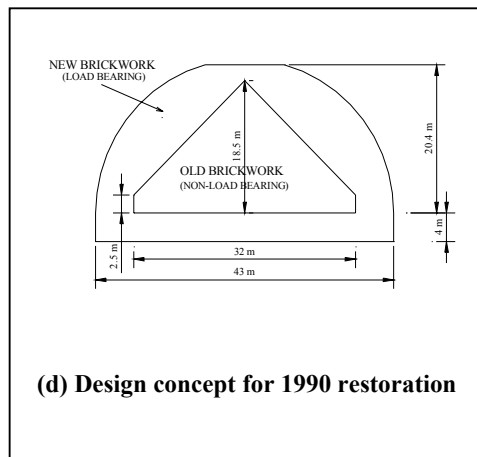
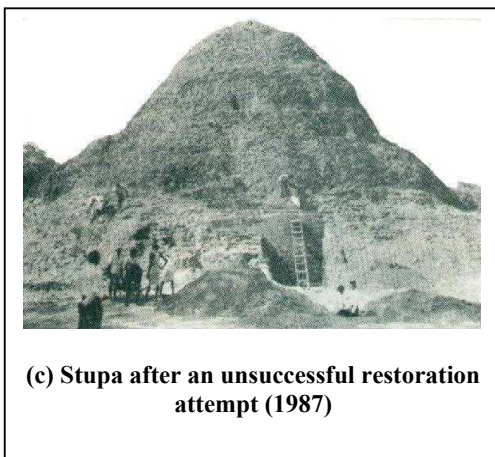
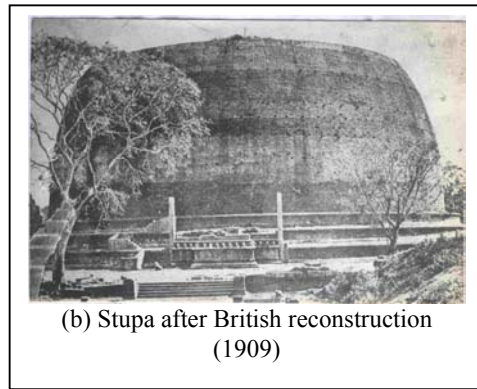
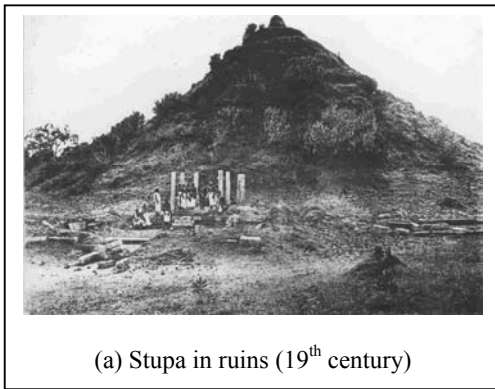


Figure 3. Miriseveti stupa restoration

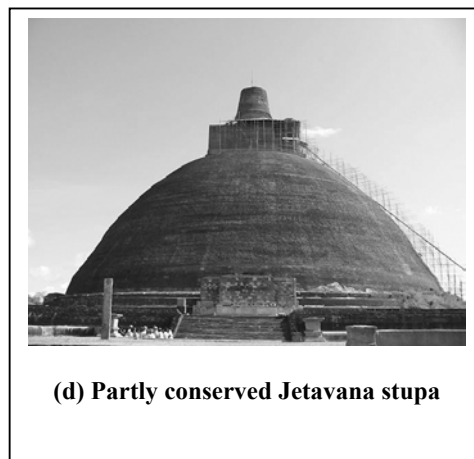
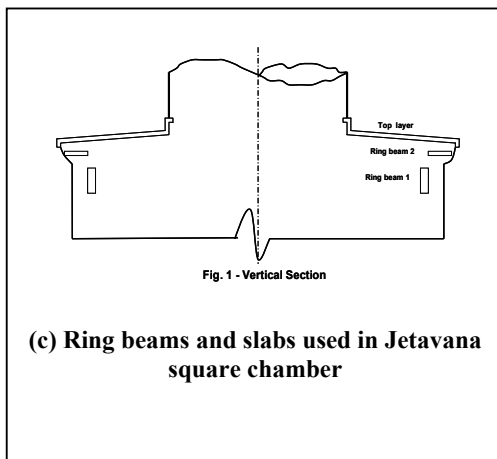
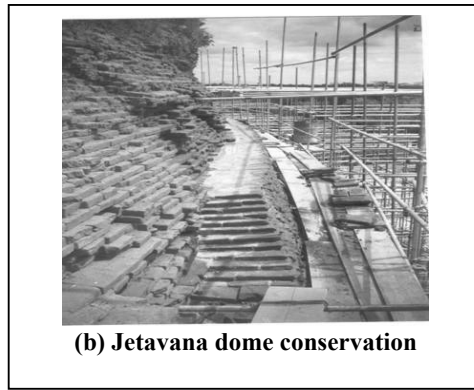
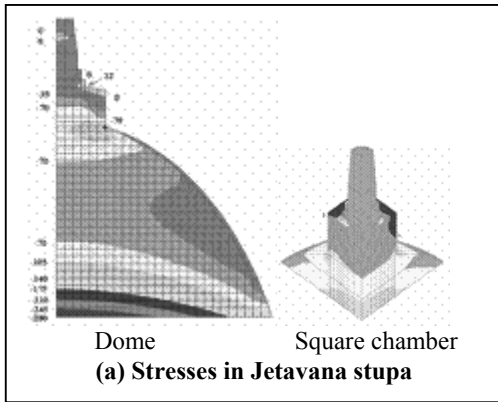


Figure 4. Jetavana stupa conservation

2.3 TISSAMAHARAMA CONSERVATION

Tissamaharama stupa, dating back to the second century BC was restored in the last decade of the 19th century. However a large number of vertical cracks, evenly spaced around the dome, appeared in the 1970s (Figure 5a). A finite element study showed a large region of hoop tension in the dome (Figure 5b), consistent with the cracks. Some of the cracks were so large that it was felt that a collapse was imminent, and it was proposed to construct a series of reinforced concrete rings on the dome, but the placement of some rings did not halt the cracking. Hence it was decided to prestress the dome using stainless steel cables running circumferentially over stainless steel bearing pads fixed using long spikes driven into the dome (Figure 5c). Altogether six cables of diameter 20 mm placed at heights of 5.7 m, 7.4 m, 9.2 m, 10.9 m, 12.6 m, and 14.3 m, above the base were used and each was tensioned to 5 T(Figure 5d). This intervention has stopped the propagation of cracks and the conserved stupa is shown in Figure 1a.

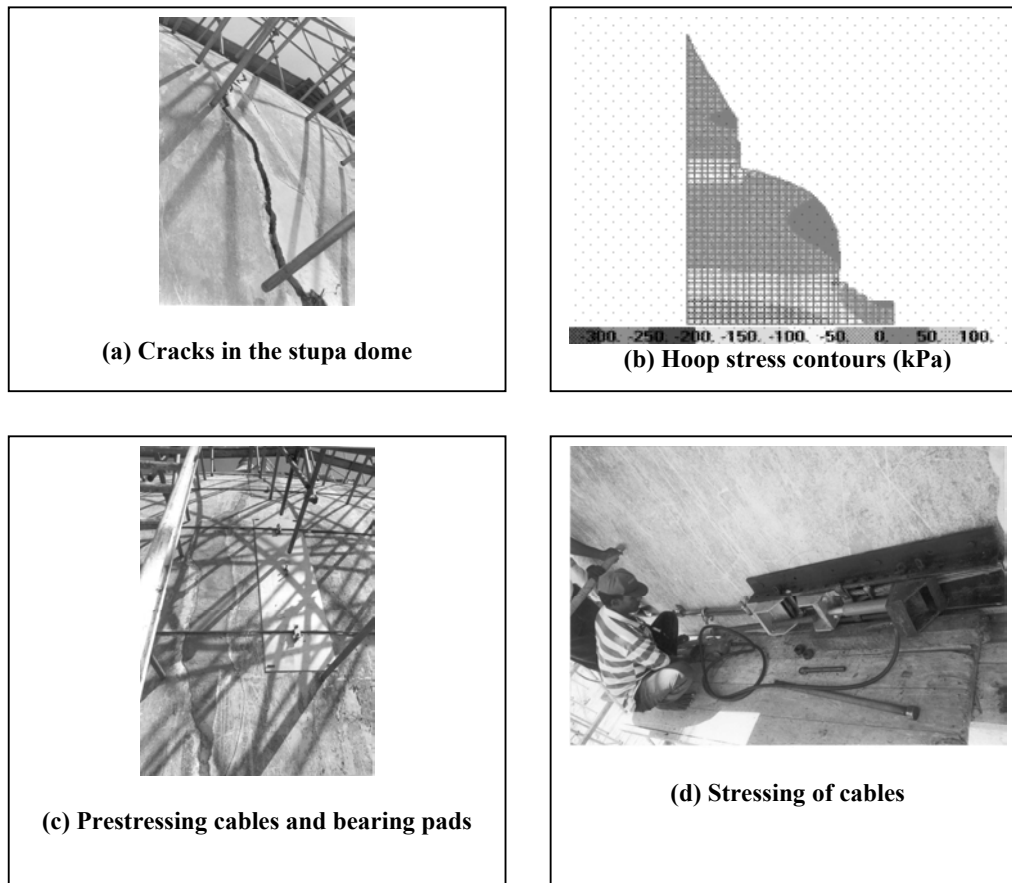


Figure 5. Tissamaharama stupa conservation

3. CONCLUSIONS

Stupas are the finest examples of structural engineering heritage of Sri Lanka. They must be conserved or restored with care and sensitivity. Involvement of archaeologists, historians, engineers and architects is essential in this process.

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