QUALITATIVE AND QUANTITATIVE MEASURES USED FOR DURABILITY OF STUPAS: WITH SPECIAL REFERENCE TO THE *MAHATHUPA*

W. I. Malsiri.[1]
D. S. Sampath.[2]

Introduction

The Stūpa is the one of the outstanding structural feature appeared in Sri Lankan Buddhist Monastic architecture and Stūpa has a long standing history of development over many centuries. Ancient technicians used advanced technologies for the durability of Stūpas, but evidences are rarely available in primary literary sources. This paper discusses quantitative and qualitative measures that were used during the construction of *Mahathupa*as per chronicle references and assess its grandeur with modern Engineering technologies.

Methodology

Data obtained from primary literary sources were compared with Archaeological data revealed through present researches. These literary and Archaeological data again compared with modern Engineering technology.

Data Analysis

The following dimensions and sequential strategies of Stūpa construction were pivotally considered by referencing primary literary sources for the analyses.

1. Dimensions for the Stūpa

According to *Mahavamsa*, previously decided dimensions were not used by ancient technocrats during the *Mahathupa* construction. They reduced the dimension of the *Mahathupa* under direction of the monks (MV

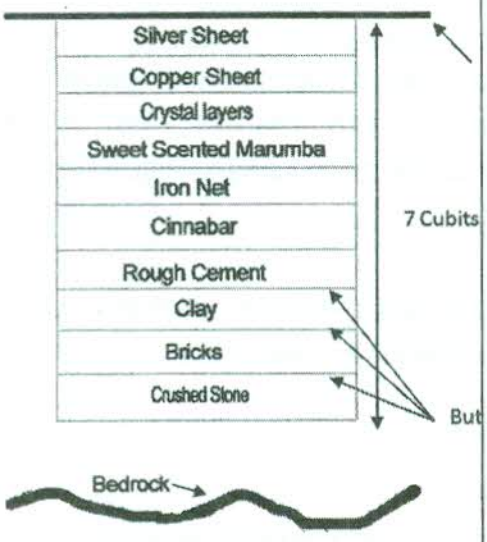
[1] Postgraduate candidate, Department of Archaeology, University of Peradeniya.
[2] Research Assistant, Department of Civil Engineering, University of Peradeniya.

29:52-56). The reasons for this revision were to complete the work during the King's reign and to make it easy for renovations by future interventions.

2. Foundation

After a 7 cubits of excavation of proposed land, crushed rocks were carried in to fill the space and compacted by elephants, whose legs were covered with leather. Afterwards, butter clay (*Nawaneetha*), bricks, clay, rough cement, cinnabar, iron net, *sweet-scented marumba* and crystal layers were laid respectively and everywhere throughout the layers butter clay served as cement. An eight inch copper sheet smeared with resin dissolved in mercury and a seven inch silver sheet smeared ochre dissolved in sesame oil was laid respectively (MV 29:02-12, TW 244). Figures 1 and 2 are shown foundation of *Mahathupa* before and after sink down.

Figure 1: Foundation before sinking



down (not to scale)

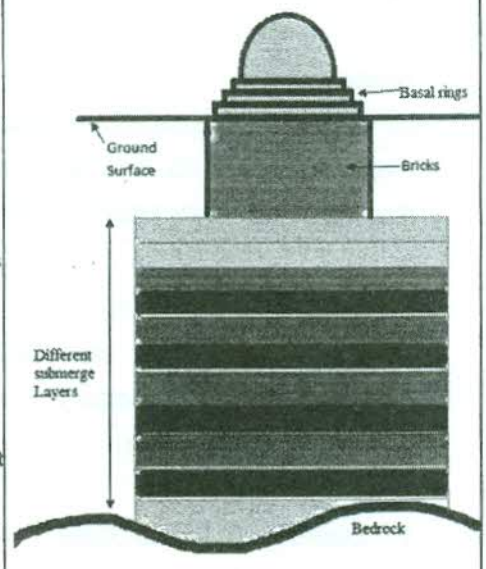


Figure 2: Foundation after sinking down (not to scale)

3. Sink down of basal rings

According to the chronicles, the Stūpa sank nine times after constructing up to three basal rings. Ninety millions of bricks were utilized for above construction. As per chronicles, it is stated that the sinking happened to prevent future sinking and protect the Stūpa (VK 431-432).

4. Qualitative and quantitative raw materials

When King selected brick producers, priority was given to the person who used lesser production rate per a day. *Mahavamsa* and *Thupawamsa* clearly mention that, if someone use higher brick production rate, the *Mahathupa* will contain raw soil with less strength and later grasses and tress might be grown over the Stūpa (VK 426, TW 253).

5. Creation of relic chamber

Lamps were lighted inside the cist, after the enshrinement of gold, silver and precious gem possessions. Afterwards the relic chamber was closed by capstone and sealed completely (MV 31:118-124, VK 465, TW 291).

6. Mortar

Always Butter-clay was used as the mortar. Butter clay was very fine material like butter. So that it is called as *Nawanitha* (VK 411).

7. Plastering and lime washing of Stūpa

The first plastering and lime washing of *Mahathupa* was done by King Saddhathissa. Again King Bhathikabhaya lime washed the *Mahathupa* in the 1st century AD. He has used hundred wagon loads of pearls kneaded together with oil to make a plaster (MV 34:46, VK 507).

8. Site supervision

The King appointed a committee headed by a *thera* to supervise the Stūpa construction. One monk came and gave some bricks for the *Mahathupa* construction, but technocrats identified those unauthorized materials (MV 30:29-32).

Discussion

Above described methods and facts are the technological measures of a well standardized construction and they influence the durability of the Stūpa. Conservation experiences coherence that the size of the Stūpa is made an affects for the conservation process of massive Stūpas. For an example, Jethavana Stūpa; the largest brick monument in the Buddhist world has been conserved for more than 30 years. Abhayagiriya has taken more than 17 years for its recent conservation. Tremendous financial resources should be invested in conservation processes relative to the time. So that the reduction of dimensions of *Mahathupa* was one of the practical quantitative measure.

Although sinking of three terraces of *Mahathupa* has been mentioned as a miraculous activity of *Arahaths*, there is a hidden meaning of that story. This was done to bear its self-weight and prevent the future sinking. Also foundation of *Mahathupa* is very similar to modern reinforced concrete foundation (Ranaweera). Compaction method used in this foundation is also similar to modern layer compaction technology, which is used for earth dam constructions and highway constructions. Anyhow, due to high qualitative foundation, there are no evidences of sinking down of the *Mahathupa* after its construction until present.

The quality of the burnt bricks depends on raw materials. When bricks are not high quality, compressive strength of bricks will below, and it affects the stability of the structure. Also water absorbs into the bricks and decay rapidly. Also, raw materials are not good quality grasses will grow over the surface of the Stūpa. By referencing chronicles, it is revealed that they have pivotally considered the quantity and quality of the material than the rate of material supply. They also paid attention to technologies adhered to.

Sealing of the relic chamber after lighting lamps inside can be identified as a method adhered for the preservation of enshrinements. The amount of Oxygen is constant after sealing the chamber and remaining oxygen inside the chamber is utilized for lighted lamp. As a result the

corrosion of the metal items will not take place due to oxygen free environment. There are numerous Archaeological evidences for lamps enshrinements inside relic chambers such as at Mihintale, Dedigama and Mahiyangana Stūpas (Paranavitana, 2001:85) (Godakumbura, 1969:35).

By using fine and soft clay as mortar, bond between bricks become strong and fill the gaps in between bricks properly. The quality of the plaster also is one of the significant facts that should be considered for the durability of the Stūpa. If outer plaster is damaged or removed, water proofing will not happen and it will cause to cracking the surface and collapsing. Also, this will create a conductive environment for grass growth on the surface of the Stūpa.As an example, removing of outer plaster of Jetavana Stūpa caused to growth of large trees, and parts of the Stūpa decayed and collapsed (Mandawala 2009:210).

Lime washing was an annual meritorious activity over the past. This is an indirect method used to protect the Stūpa annually. Because of lime washing, water absorption is reduced and grass growth is prevented. Also, it impressed religious faith. Therefore lime washing is not only a conservation method, but also a religious activity which protects the Stūpa.

Mahavamsa description of builders who worked on *Mahathupa* showed their great technological skills and management skills. The site was well supervised and quality control was a major priority for the builders.

Conclusion

It is shown that measures have been taken during construction of the *Mahathupa* are qualitative and quantitative and they contributed to the durability of Stūpa.There are similarities in those methods and modern Engineering technological methods. Therefore it is necessary and vital to make decisions during present Stūpa constructions, by considering durability as well as easy maintenance of Stūpas by future generations.

References

Rev. Buddhadaththa, Polwaththe. (1959) The Mahavamso, Colombo: M. D. Gunasena printers.

Geiger, Wilhelm. (1929) Culavamsa, New Dilhi: Asian Education Service.

Moratuwagama, M. M.(1996) Sinhala Thupawamsa, Colombo: Rathna Publisher.

Amaravansha, Akuratiye and HemachandraDisanayake (2001) Vamsatthappakasini, Kelaniya:Vidyalankara Publication.

Ranaweera, M.P. (2004) Ancient Stūpas *in Sri Lanka – Largest brick structures in the world.* London: CHS Newsletter No. 70.

Paranavitana S. (2001) 'Pura Vidu Parikshana', Boralesgamuwa: Visidunu Publisher.

Godakumbura C. (1969) TheKotawehera of Dedigama, Ceylon: Department of Archeology.

Mandhawala P. B. (2007) Jetavanasthupayesanrakshanamuladharma ha prathipaththi, Jetavana Stūpa puranaya, Colombo: Central Cultural Fund.