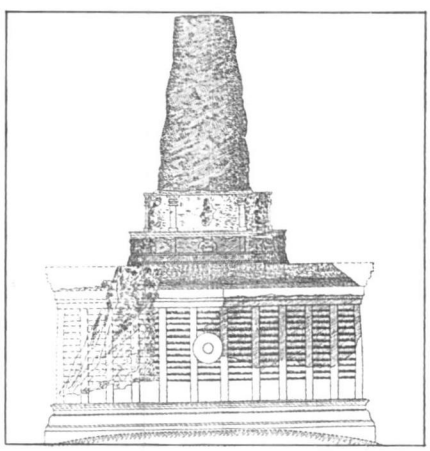
CONSERVATION OF

ABHAYAGIRI STUPA

AT ANURADHAPURA

ARCHT. LALITH MUTUKUMARANA
DIRECTOR – CONSERVATION, ABHAYAGIRI PROJECT

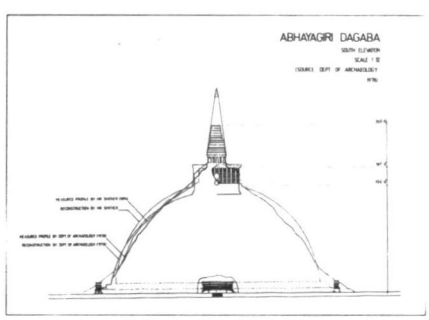
Conservation Handled by
Surath Wickramasinghe Associates for the
Cultural Triangle

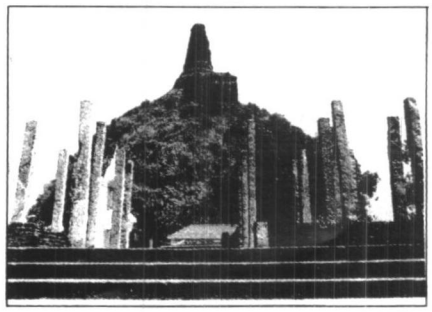


1.0 INTRODUCTION

The **Abhayagiri Stupa** – the second largest brick structure in the world being only second to the **Jetawana Stupa,** (also located at Anuradhapura, Sri Lanka, a few kilometres away from Abhayagiri Stupa) to-day appears as a huge mound overgrown with vegetation. (See Photograph I).

After the shifting of the capital to Polonnaruwa in the 12th Century A.D., with the invasion of Cholas from South India, the monuments of Anuradhapura were more or less abandoned to decay and destruction, at the hands of the invaders. Although few attempts have been made in the Nineteenth Century to conserve selected parts of this great monument, no concerted effort has been made since 12th Century, to systematically and comprehensively conserve the entire Stupa and it's precincts. This enormous task has now been undertaken by the **Central Cultural Fund** under the **Cultural Triangle Programme.**





The items of work connected with the Stupa undertaken for the year 1996 and years following are:

(1) Correction of erroneously constructed **Basal Terraces (Pesavas).**

(2) Construction of the **Frontispieces (Vahalkadas).**

(3) Conservation of **Outer Lower Terrace (Veli Maluwa).**

(4) Conservation of the **Stone-Paved Terrace (Sala Patala Maluwa).**

(5) Conservation of the Stupa.

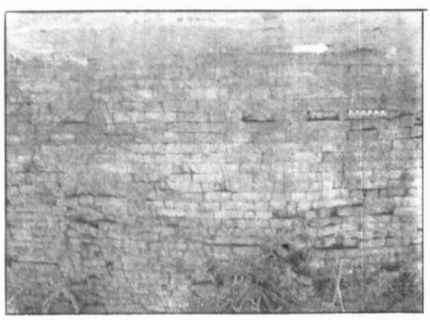
3.0 EXISTING CONDITION OF STUPA

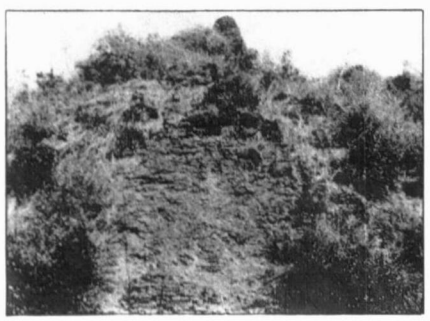
The Abhayagiri Stupa today is home to a wide variety of dry zone Fauna and Flora. The vegetation types range from hard wood trees such as **Diospyros Ebenum (Ebony), Azadirachta Indika (Margosa) to Thorny Bushes** like **Pithecellobium Duice (Andara)**, **Opuntia Dillenii (Pathok)** and **ground covers** like **Desmodium Triflorum (Udupiyaliya)** and **Mimosa Pudica (Nidi Kumba)**. The structure is infested with **Monkeys** and **Serpents** too. A detailed systematic study of Fauna and Flora is underway.

An experimental stretch of the **Stupa, Dome**, approximately 15m wide vertical band up to the cube (Hataras Kotuwa) has revealed the following facts about the existing conditions of the Stupa.

I The hard wood tress like **Ebony** and **Margosa** have developed strong roots that have penetrated several brick courses to the interior of the structure. The growth of these roots have caused outward swelling of the brick courses thereby loosening the bond, and subjecting the structure to gradual erosion. On the other hand the surface network of roots have also helped to stabilise the bricks against erosion. These opposing effects of vegetation on the brick structure coupled with weather erosion and animal destruction has resulted in a ruined state potched with protrusions and depressions throughout its surface, as shown in photograph 04 one interesting feature observed in the nature of plant growth on the stupa is somewhat dwarf growth of normally tall tress due to constricted growth, as followed in the Bonsai technique.

II. The ancient outer plaster in seen exposed at several places, where the brick bond and the bricks are in an excellent state of preservation.





III. The Stupa appears as a solid brick structure perhaps with a hollow **Relic Chamber** somewhere at the centre, as the chronicles record. The bricks of several dimensions have been used in the Stupa.

The following types were recorded from the cleared areas:

(a) 500 mm long x 250 mm wide x 85 mm high

(b) 500 mm long x 260 mm wide x 80 mm high

(c) 530 mm long x 270 mm wide x 90 mm high

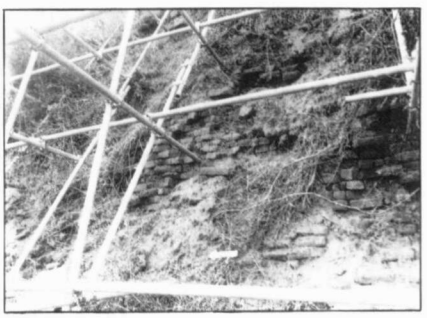
(d) 460 mm long x 210 mm wide x 70 mm high

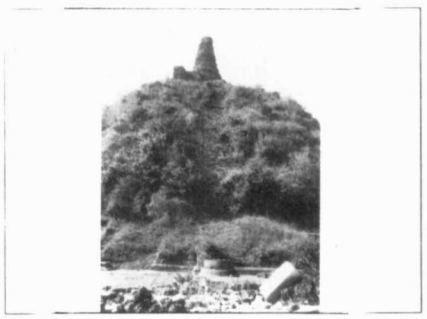
(e) 450 mm long x 250 mm wide x 60 mm high

(f) 450 mm long x 250 mm wide x 75 mm high

The use of some brick bats is evident in the interior, though mostly it is a structure using solid wholesome bricks.

IV. The outer surface comprises stretcher courses finely bonded together with minimum mortar joints which are of the order of 1/16" and less. Some layers appear almost sitting one on top of the other. The interior is finely bonded with headers and stretchers.





The average compression strength = 10.00 Newtons/MM^2 of ancient bricks at Abhayagiri

V. A portion of the Cube has collapsed on the Dome causing a portion of the Dome also to slide with the debris.

The remaining portion of the **Cube (Hataras Kotuwa)** and the **Spire (Koth Karalla)** appear to be stable as it stands today. The conservation programme includes examination of the structural stability of the entire brick structure.

4.0 STUPA DOME-CONSERVATION PRINCIPLE

I. Minimum intervention to existing status i.e., conserving brick masonry as found without adding new brickwork.

II. Any areas found to be structurally unstable to be analyzed and a suitable structural solution that would uphold Principle I to be adopted.

5.0 EXPERIMENTATION

Several experiments were conducted to arrive at a suitable conservation technique using above conservation principle first on **Jetawana Stupa Dome**, and next on **Abhayagiri Stupa** itself.

The best results of the tests conducted at the site and in the laboratory of the National Building Research Organisation are given below:

Test Mixture (1)

i.	Ant-Hill Clay	–	120	g
ii.	Slaked Lime	–	40	g
iii.	Rice Husk Ash	–	10	g
iv.	Sand Powder	–	30	g
v.	Water	–	65	ml

Strength developed after 24 days – **# 1.85N/MM²**

This mixture showed minimum shrinkage with controlled water content.

Text Mixture (2)

i.	Ant-Hill Clay	–	60	g
ii.	Slaked Lime	–	30	g
iii.	Clay Tile Powder	–	60	g
iv.	Rice Husk Ash	–	30	g
v.	Water	–	65	ml

Strength developed after 24 days – **# 3.1 N/MM²**

This mixture too showed neglible shrinkage and cracking under controlled water content.

Text Mixture (3)

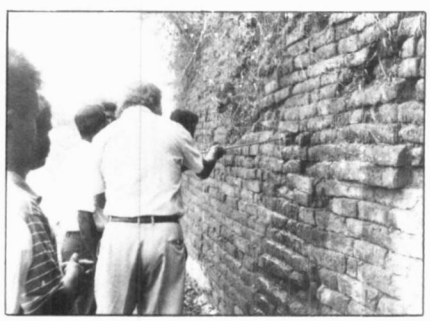
i.	Ant-Hill Clay	–	240	g
ii.	Slaked Lime	–	30	g
iii.	**Cement**	–	**60**	**g**
iv.	Clay Tile Powder	–	60	g
v.	Water	–	45	g

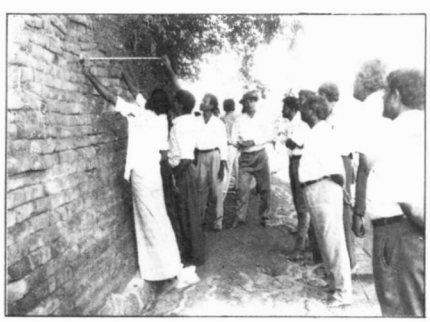
strength developed after 24 days – **# 5N/MM²**

This mixture showed best results of all the samples tested and had very good resistance to water absorption, shrinkage and cracking. But the mixture contained **cement**, and the use of cement is considered inappropriate to conserve a monument which had not used cement in the original construction.

6.0 CONSERVATION TECHNIQUE

The ancient Stupa it appears had used Butter Clay with perhaps some organic adhesives for bonding the bricks. These additives are now untraceable as they have been reduced to carbon over the years. No cement had been used. **Thus the text mixture No. 2 without cement has been selected for use on a further experimental band on the Stupa. As the injection of a mortar is intended to stabilize the surface layers, a strength of 3/N/MM² is considered adequate and satisfactory for the purpose.**





The following technique has now been decided for use in the brick conservation of Stupa.

Step i. Leaving one or two verticle bands of vegetation on the Dome, to show the status quo in 1996 prior to conservation; clearing the balance vegetation completely **in stages** after taking note of Fauna and Flora.

Step ii. Cleaning the exposed brick surface carefully of debris and soil by finely brushing down to expose the brick courses.

Step iii. Cleaning the brick courses by directing a pressurized water jet (Pesticide Sprayer is used here) at the mortar joints to clear decayed and loose mortar to a depth of about 1 foot (care being exercised not to break loose strongly bonded brick work).

Step iv. Using improvised Injector Gun (specially designed for this purpose modifying a Grease Gun) injecting a mortar slurry of Lime, Ant-Hill Clay, Tile Powder, Paddy Husk Ash and Water (special care being exercised not to spill the slurry over the brick face).

Step v. Fine pointing the mortar joints with a pointing trowel using the above mixture. (see Photographs 11).

Figure 03 shows how the Stupa would look after conservation, using the above technique. The idea of leaving one or two bands of vegetation needs careful examination, as such a band of vegetation could promote the spread of vegetation to the

conserved areas. In any case while the brick conservation in this manner, preserving the historic form as found, is archaeologically the best, the so conserved monument will almost certainly require very careful regular maintenance than a restored monument.

The final experiment on the conservation of brick structure of the Stupa Dome carried out on 9th August 1996 using Ant-Hill Clay, Lime, Paddy Husk Ash, Tile Powder and Water in the proportions given above has shown excellent results. After 28 days the masonry bond appeared strong and free of cracks. Minimal shrinkage was observed. and the colour of the mortar too matched the ancient brick surface. The conserved brick surface has stayed strong and solid after several wash down by rain and manual wetting. The behaviour of the conserved patch is being carefully monitored on a day to day basis with constant wetting daily. In the meantime a larger portion is now being prepared for conservation using the above technique.

The experience of brick conservation in the above technique revealed the necessity for the application of the following varied methodology in the varying situations.

Situation (1) – (see Photograph 02)

Where the brick masonry was uniform and not eroded, the mortar mixture was injected into the cleaned crevices and the gaps closed finally by fine-pointing using the same mortar.

Situation (2) – (see Photograph 04)

Where the brick structure was not uniform, eroded, showing loose bricks and cantilevered portions, the following steps were adopted.

Step I – carefully removing the loose bricks, and rebuilding with the new mortar using the same old bricks in the same place, after cleaning the joints.

Step II – carefully collecting the bricks fallen off from underneath the cantilevered portions and rebuilding under the cantilever using the old bricks and the new mortar.

Step III – Injecting mortar into the cleaned crevices of the old brick masonry.

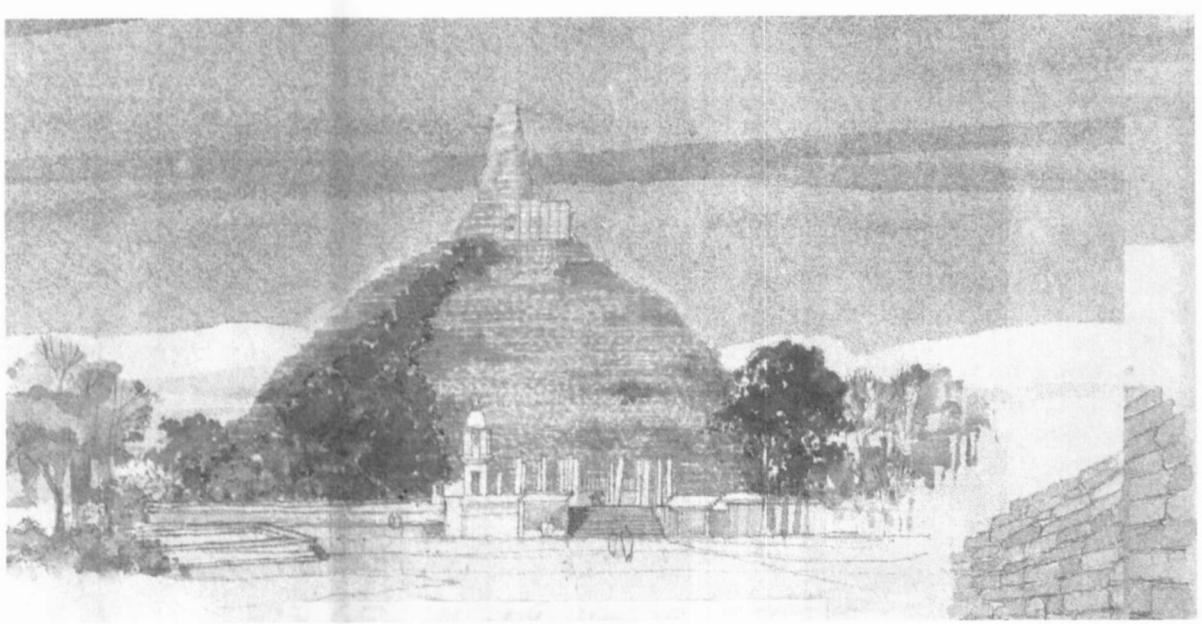
Situation (3) – (see Photograph 12)

Where a strong root structure prevented the complete uprooting of the trees the stems were cut level with the brick surface and a root killing chemical injected into the roots. Whatever roots that could be removed without damaging the brick masonry were pulled out first. The above conservation process was then repeated.

This conservation process will almost certainly need to be repeated from time to fill the crevices left over by the rotting roots, and the slight shrinkage of mortar which is to be expected with ageing.

7.0 CONCLUSION

The conservation of a brick structure using the above technique is unique in that, such a conservation has not been tried out earlier in any of the known brick monuments. Of the most recent conservation attempts, it is a re-build at **Mirisavetiya Stupa**, and conservation with several new outer layers almost amounting to a restoration at **Jetawana Stupa**. Although brick conservation using the above technique is a cumbersome and an intricate process, the resulting monument with the historic character written on it is well worth the pains.



Perspective showing stupa after conservation.