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STRESSES IN STUPAS OF DIFFERENT SHAPES

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Stupa, the most notable feature of almost every Buddhist temple in Sri Lanka, is found in many sizes and shapes. Jetavana stupa, considered the tallest brick structure in the world, is said to have been 122 metres (400 feet) tall and it has a dome in the shape of a paddy-heap.

Sri Lankan stupas have domes of many shapes. Traditional domes are bell shaped (*ghantakara*), bubble shaped (*bubbulakara*), pot shaped (*ghatakara*), paddy-heap shaped (*dhanyakara*), lotus shaped (*padmakara*), and nelli-fruit shaped (*amalakara*). Of these bell shape is the most common and the largest stupas are of paddy-heap shape. Some stupas have changed in size and shape during re-constructions and restorations.

Of these shapes some are more stable than others, and the ancient stupa builders would have arrived at the most stable shape for the required height by trial-and-error processes, rather than by mathematical analyses. However recent restoration and conservation work of ancient stupas has necessitated studies of stress analysis, as some ill-prepared restorations had resulted in disastrous consequences.

This paper presents some results of a study of stresses in the domes of the four most common shapes of stupas, taking as examples Mahiyangana stupa (bell shape), Mirisaveti stupa (bubble shape), Jetavana stupa (paddy-heap shape), and Tissamaharama stupa (pot shape). The stresses in their domes due to self weight loading were computed by finite element analyses using the SAP90 general purpose package, and treating the problems as axisymmetric ones. Vertical, radial, circumferential, and shear stress contours, as well as displacements were obtained for each stupa, and some comparisons were made after normalizations.

The results show that most parts of the domes are in compression with the maximum compressive stresses well below the compressive strength of ancient bricks. Tensile zones are present in some of the domes, with the pot shaped dome having the largest tensile zone and the maximum tensile stress. The latter is also well below the tensile strength of ancient bricks.