Structural Assessment of the Seismic Behavior of the Dome of the Taj Mahal

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ABSTRACT

This paper presents the results of a study of the structural assessment of the seismic load behavior of the main dome of the Taj Mahal, in Agra, India. Built by the Moghul emperor Shah Jahan between 1632 – 1648 AD, the structure is one of most famous and renowned buildings in the world - in addition to being the finest and most sophisticated symbol of Moghul architecture in India. As it is located in a moderate seismic zone, there is an urgent need for ensuring the structural safety and preservation of this iconic cultural heritage, for all future generations.

The objective of this study is to develop a simplified approach to enhance our conceptual understanding of the mechanism of load path/transfer in the dome of the Taj Mahal under both gravity and seismic loads, as well as to better understand the influence of the geometry of the dome on its structural behavior.

Based on previous work on the structural assessment of the Taj Mahal, as reported by Dayalan [1], and Mehrotra and Glisic [2], the methodology consists of dividing the dome into a series of circular rings, which are then divided into sixteen radial segments (lunes). Nodes for the finite element model are defined based on the rings and the corresponding segments, while the dome is assumed to be fixed at the base. The finite element model of the dome is then analyzed under the action of gravity and seismic loads using the SAP 2000 software, with the seismic loading assumed to have a PGA of 0.25 g based on results of a study conducted by the Indian National Disaster Management Authority [3].

The results obtained include graphical plots of the distribution of nodal reactions (in the x, y and z directions) at selected levels to represent the lateral load behavior of the dome of the Taj, as well as plots illustrating the paths of load transfer under the action of gravity and seismic loads. Free body diagrams of selected rings are also presented to illustrate the 'hoop' forces in the dome, while simplified internal stresses are computed and compared with known material properties. Graphical plots and diagrams are also used to present observations about the effect of the dome geometry, especially the bulging part of the dome, on the distribution of reactions and the resulting mechanism of load transfer in the structure under both gravity and seismic loading.

REFERENCES

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