Study of System-Component Interactions in a Thin-Tile Masonry Dome

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Abstract:

Guastavino timbrel domes are concentric thin-tile domes constructed without formwork. In this study, a Guastavino timbrel dome is analyzed to determine the behavior of the system components, which are the supporting arches and the thin-tile dome webbing. The boundary conditions between the components are determined as well as each component's contribution to the system's modal stiffness. Two physical models were constructed at the Peter Kiewit Institute Structures Laboratory at the University of Nebraska. Experimental modal analysis was performed on the physical models and the results were used to validate a finite element model. The validated finite element model was then decomposed into the system components and the boundary conditions were determined. Using the fundamental frequency and mass of each component and the system, the modal stiffness was calculated. The component modal stiffnesses were combined as a series of spring-like configurations to determine the interaction between components. Parametric studies of finite element models were used to confirm the component interactions identified and to study their applicability in different geometries. Analysis of the spring-like configurations and parametric studies show that the boundary between the components was restrained longitudinally and that the components worked together in series to establish the system behavior.

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