

Numerical Analysis of a Hybrid Bending-Active Gridshell

Ioanna ANASTASIADOU*, Marios C. PHOCAS

* Department of Architecture, University of Cyprus
Kallipoleos St. 75, 1678 Nicosia, Cyprus
mcpocas@ucy.ac.cy

Abstract

Elastic gridshells were incepted around 1960s and popularized by the work of Frei Otto and especially through the famous Mannheim Multihalle in the early 1970s. Since then, a number of researchers have dealt with the systems' materiality, constructability and applicability, driven by respective cost and time advantages in their production, transportation, erection and construction. Adaptive architecture has also triggered the interest of many architects and structural engineers, aiming at an optimized static performance and reconfigurable spatial systems that can be transformed and adapt to functional or structural requirements. Adaptive spatial structural systems may emerge by utilizing reversible elastic deformations of bending-active members integrated with secondary actuation and control components to achieve active shape control. In addition, new materials have shown their potential in achieving adaptation and shape transitions, while improving the overall performance and the structure's stability. Along these lines, the current paper examines the design and analysis of a hybrid bending-active gridshell, that consists of an array of elastic strips interconnected through a secondary system of strut elements and cable segments. The proposed gridshell has a span of 9.6 m and a length of 10 m. The three-stage development of the gridshell includes the planar deformation of the bending-active members, the erection of the system and its external loading. The analysis examines three different materials for the bending-active members. The numerical investigation of the system is conducted through a progressive form-finding and load-deformation Finite-Element Analysis (FEA). The analysis provides insight to the efficiency of the proposed hybrid bending-active gridshell in terms of deployability, transformability and operability, highlighting the structural and architectural potentials in achieving lightweight, reconfigurable and adaptive structures.

Keywords

Bending-active gridshells, Hybrid structures, Form-finding, Load-deformation behavior, Finite-Element Analysis.