MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

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DYNAMIC BEHAVIOR ANALYSIS OF INFLATABLE BOOMS IN ZIGZAG AND MODIFIED ZIGZAG FOLDING PATTERNS

Abstract

Dynamic behavior of inflatable booms in zigzag and modified zigzag folding patterns with several folding lines is experimentally and theoretically investigated in this research. As for experimental approach, deployment behavior is investigated by focusing on the relation between the deployment behavior and air pressure/flow rate, and also on the shape of folding lines. The stable deployment of modified zigzag folding pattern is also demonstrated through the deployment experiment. As for theoretical approach, the folding and deployment analysis of inflatable booms are simulated using finite element methods. Locating rigid shells around the inflatable tube elements and controlling their movement, zigzag and modified zigzag folding patterns are analytically simulated. Then the FPM (Finite Point-set Method) is used for deployment analyses due to realize the sequential deployment and to find out the relation between deployment behavior and air flow around the folding line. Corresponding to future several square kilometers' space structure systems, it would be most effective to combine both erectable and deployable structure concepts, which are two major basic structural concepts of space structures proposed between the 1960's and the 1980's, using available adaptive and/or gossamer structure elements. It is also thought that membrane structures with inflatable structures combined with cable networks are much effective for future large space structure systems. Considering hierarchical modular patterns and installing automatic construction schemes for these structures, it might be achieved innovatively to construct several square kilometers' scale space structure systems. Through these viewpoints, the dynamic behavior of inflatable booms is investigated both experimentally and theoretically aiming to get their stable deployment. The modified zigzag folding pattern is developed aiming to improve the unstable deployment behavior of zigzag folding pattern. The main idea of modified zigzag folding pattern is to create the common cavity between upstream and downstream side of injected air. The zigzag folding and modified zigzag folding pattern is naturally fit to the membrane folded spiral folding pattern which is used by the membrane structure with inflatable tube combined cable networks. Through the experimental results, the air pressure and flow rate of modified zigzag folding pattern show the smooth curve during the deployment, but that of zigzag folding pattern shows undulant curves. Through the analytical results, the reasons of unstable deployment of zigzag folding and that of stable deployment of modified zigzag folding pattern are shown through the folding and deployment analysis using finite element method and FPM.