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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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DEPLOYMENT ANALYSES OF MEMBRANE STRUCTURE SYSTEMS WITH INFLATABLE TUBES FOR FUTURE SPACE APPLICATIONS

Abstract

Effective structure concepts should be necessary and required corresponding to future large scale space structures, for example about several kilometers' like space solar power satellites or space colonies. The international space station was constructed by erectable structure concept using robotic manipulator arms and the size is within about one hundred meters square. This is one of the largest space structures up to now, but it has taken a great amount of time and budget to get its final configuration because its construction concept was based on manned erectable structure concept. On the other hand, recent progress of large scale antenna structures or solar sails using membranes shows the effectiveness of deployable structure concept, but their sizes is about over ten meters square. Corresponding to several kilometers' space structure systems in future, combined use of erectable and deployable structure concepts may be effective.

In this paper, aiming to establish more effective construction scenario for future large scale space structure systems, deployment analyses of conceptual model for membrane structure modules with inflatable tubes are investigated. The shape of conceptual models is hexagon, and it is packed in the spiral folding. The inflatable tubes are set in circumferential direction and/or radial direction. When they are located in circumferential direction, they are folded in zigzag manner; located in radial direction, they are folded in roll-up manner due to the characteristics of the spiral folding pattern. Two kinds of conceptual models are deployed in experimental analysis. One is a single model, and the other is a hierarchical modular model. The latter is made of six single models, and it is formed based on hierarchical modular pattern. From a viewpoint of hierarchical modular structures, the single model corresponds to the first generation of the hierarchical modular pattern, and the hierarchical modular model corresponds to the second generation. Numerical analysis of deployment behavior is also carried out. At first deployment behavior of inflatable tubes which are folded in three different patterns is analyzed using the finite element method. Inflation gas is modeled through the finite point method. The combine structures of inflatable tubes and membranes are also analyzed. Through both deployment experimental analysis and numerical analysis, effective use of deployable membrane structures for future large space applications has been clarified.