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

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STEPWISE DEPLOYMENT OF MEMBRANE SPACE STRUCTURES - ROLLED-UP TOGETHER WITH SUPPORT BOOMS

Abstract

In Japan, a small solar power sail demonstrator, which is called IKAROS was launched as a first actual example of solar sail spacecraft, and it successfully deployed the square membrane in June 2010, and its successful acceleration by photon has been confirmed in the course of determining its precise orbit after the sail deployment. IKAROS is a spin type spacecraft; centrifugal force due to spinning has deployed its membrane, and it also keeps the deployed configuration. But for rather near future space programs, not only for solar sails but also for general gossamer space structures such as large solar cell arrays, high precision patch antennas and so on, non-spinning type light weight membrane space structure systems are desirable, and boom structures are necessary to support large membrane elements, which are not so thin compared with solar sail membranes. In this case, reliable deployable booms are necessary, which are directly applied to space structure systems at the moment within present deployable boom technology.

In this paper, compound membrane structure systems consisted of membrane elements and elastic boom ones are proposed, in which both kinds of elements are connected mutually at several points, rolled-up together around a center body, and stepwisely deployed. Their effectiveness is presented through some deployment experiments of a small laboratory scale conceptual model and its numerical simulations. A model consists of six elastic (carpenter-tape) booms connected to a hexagonal prism center body and a hexagonal membrane connected to booms at several points. These booms are elastically bended at the corners of the center body, and they are rolled-up together with a membrane. They are fixed to the center body using several fixing cables, and released one after the other for deployment, which is defined as the stepwise deployment in this paper. The top of a boom and other two inside points are fixed, and the fixing cables are cut by heaters. The total aspects of its deployment have been recorded by a high speed video camera, and the deployed length and the angle of booms are measured through the video images. Numerical simulations using the multi-particle (spring-mass) approximation method for this model are carried out, and the various parameters such as the number of fixing points, their locations, the number of connecting points between booms and a membrane, and so on, are checked for the safe deployment of this kind of deployable membrane space structures.