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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 SIMULATION OF VERY LARGE INFLATABLE TENSEGRITY REFLECTORS

Abstract

Restricted by launch vehicle dimensions, deployable structures became necessary due to their low stowage and area density. For the success of future space missions involving large space structure, the development of new deployable structures and the improvement of current designs are of great importance. Applications can be easily envisioned through truss structures, masts, crew quarters, transport tunnels, large solar arrays, solar concentrators, solar sails or antennas. Scientific, discovery and telecommunication missions showed an especially high interest and demand for large reflective antennas recently. The design idea presented in this paper will focus on the development of a deployable antenna or reflector of up to 50 meters in diameter. Common reflectors today are normally metal mesh or solid surface assemblies that are usually umbrella deployed. This deployment and surface type limits the size and frequency range of the current designs. To achieve large diameters advanced structural concepts need to be applied to the surface and support structure. A novel concept is proposed to use a tensegrity sub structures for a thin foldable reflector dish. Tensegrity structures basically consist of strut elements for compression and cable elements for tensional loads. Tensegrity structures can be optimized for specific load paths and deployment sequences. Due to the fact that the stowed volume of a tensegrity structure is mainly governed by the size of the compression struts which can be disjoined. Therefore, the use of inflatable rigidisable tubes as compression struts is considered. The literature review showed that inflatable structures are most promising for the development of deployable reflectors larger than twenty meters in diameter. Good compression performance and reliability can be achieved by employing rigidisable inflatable tubes. This paper will discuss the use of inflatable rigid elements and their counteraction with the rest of the tensegrity structure. Simulations have been developed to capture the behaviour of the inflating tube while getting perturbated by the attached tensegrity tension cables. The performance of the simulation has been evaluated by comparing the deployment time and the accuracy of the deployed tube with various different inertial states of entanglement between the stowed tube and the tensegrity cables. These simulations showed that the use of inflatable rigidisable struts in tensegrity assemblies can greatly decrease the system mass and stowed volume, especially for very large reflectors compared to conventional approaches. Future work of validating the simulation through experiments is also being proposed.