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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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DESIGN AND EVALUATION OF INFLATABLE STRUCTURAL CONCEPTS FOR AERODYNAMIC DRAG AUGMENTATION.

Abstract

Inflatable and rigidizable gossamer structures are based on the heritage cultivated through the ECHO and Explorer projects in the 60s, however at present they are steadily gaining popularity in the space industry due to many potential benefits when compared to conventional technologies. These include a reduction in the total system mass, higher packing efficiency and fewer components.

Deployment is achieved by applying an internal pressure to the stowed membrane. The structure must then be rigidized to prevent structural collapse due to outgassing. Metal- polymer laminates make good inflatable membranes because they have the toughness and structural properties of a metal foil when deployed, and are resistant to the formation of pinholes. Rigidization occurs in these laminates when the pressure is great enough to remove any wrinkles in the material.

Inflatable structural booms and spherical envelopes can both be highly effective in the design of drag deorbiting systems, although this has not yet been demonstrated in space. The research presented in this paper is undertaken as part of the InflateSail mission, which is part of the European commission funded Deploytech project and other projects within the Surrey Space Centre.

Structural booms are investigated using FEA and experimental methods. Manufacturing methods for producing cylindrical booms of different metal laminates are investigated. As are different folding types such as telescopic, origami and z-folding. The experiments consider the deployment methods of the different configurations and the structural properties of the resultant structural booms. The FEA package ABAQUS is used to model the deployment and structural characteristics of origami folded booms following being compacted axially. The aim of the research on booms is to provide an optimized structural design for the InflateSail mission.

Several spherical envelope designs are experimentally tested to quantify the structural performance and inflation/rigidization requirements. Although the exterior construction of the envelopes is identical, the models vary internally with the addition of sealed compartments or support members. The designs are further analysed in an FEA package, using the experimental results for validation.

Novel and established folding and packaging techniques are investigated for the spheres and tailored to optimise the packing efficiency for each design, without exceeding the maximum volume of a single 1U CubeSat module.