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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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EQUIVALENT STIFFNESS OF LARGE DEPLOYABLE MEMBRANE WITH RANDOM INITIAL DEFORMATION

Abstract

Large deployable space membrane structures are developing in recent years as Gossamer spacecraft for solar sail and sun shield, and etc. To design the deployable membrane structures, the mechanical properties of the structures are significant to examine the deployment configuration, vibrational and dynamic properties of the membrane structures. However, the initial deformation on the membrane due to the folding line and wrinkle with plastic deformation is not negligible for evaluating the mechanical properties because it is very large with respect to the membrane thickness. This paper investigates the effects of relatively large initial deformation on the vibration properties of large membrane numerically and experimentally under the assumption that the initial deformations are random that has a band range of wavelength as the deformation observed in the solar sail "IKAROS". At first the double corrugated deformation model is theoretically examined under the sinusoidal initial deformations for vibration properties. Then, FEM analyses are performed for the corrugated membrane to examine the effects of amplitude of initial deformation and wavelength on the properties of modal vibration using the FEM model for membrane model consists of 20m x 20m square membrane with thickness, t=0.1mm, and with simply supported or free boundary condition. In the numerical analyses, the normal random distribution is assumed. The effects of random initial deformation of deployable membrane on vibration properties are obtained. Finally, it is found that the vibration properties of large deployable membranes are quite sensitive for the relatively large initial deformation.