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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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EXPERIMENTAL VALIDATION OF A TENSIONING SCHEME FOR MEMBRANES USED IN SAR ANTENNAE

Abstract

Synthetic Aperture Radar (SAR) antennae are large structures whose flatness is critical to obtain reliable results. SAR antennae are usually made of large aluminum plates. The folding options are limited and therefore, a large launcher is required to accommodate these large plates, and the mass is also substantially high. Using membranes opens the possibility of packaging the membrane more tightly and using a smaller, less costly, launcher. Mass savings can also be obtained if the membrane is maintained flat in a lightweight frame. The flatness of the membrane depends on the flatness and stability of the frame, but also on the tensioning scheme used.

The Canadian Space Agency has concentrated itself on the tensioning of membranes through cables running along the membrane in a parabolic fashion and being attached to the frame at discrete points. A mathematical system of equations has been developed to calculate the exact shape needed to produce the required in-plane uniform tension field, as well as to calculate interface triangular plates to attach the cables to the frame. These triangular plates ensure the moments and forces are balanced at the attachment points and, as a result, wrinkles are eliminated.

Preliminary testing had shown that a very good flatness was obtained with this tensioning scheme for a relatively low in-plane tension, which in turn, translated into a relatively low loading on the frame, allowing a lighter frame. The preliminary tests were done on a 50 cm by 80 cm membrane, but the question remained opened as to how it would translate on a 4 m by 10 m membrane. In order to validate the mathematical system of equations and ensure that the quality of the obtained flatness was effectively due to the design of the tensioning scheme, an experimental comparison was done. It is difficult to measure the in-plane tension in the membrane or the flatness on a transparent sheet of polymer, but the tension in the cables can be measured.

In this study, the tension imposed on the frame has been measured for different thicknesses of membranes and this has been compared to the prediction of the mathematical system of equations. The correlation is in the same order of magnitude, which validates the use of that theoretical tool in the design of large scale membrane antennae. The next step will be a validation on a 2 m by 3 m membrane.