

MATERIALS AND STRUCTURES SYMPOSIUM (C2)

Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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STATIC AND DYNAMIC ANALYSIS OF SPACE WEBS

Abstract

Future space missions require deployment of large flexible structures, for example space webs, the lightweight cable nets deployable in space, which can serve as platforms for very large structures. The interest in research of space webs is likely to increase in the future with the development of promising applications such as Robotic Geostationary Orbit Restorer (ROGER) of ESA. Unlike high-tensioned nets in civil engineering, space webs may be low-tensioned and extremely flexible, owing to the microgravity on orbit and lack of support components. Because space webs are too slack and flexible to resist any compressive forces, there may be no formed configurations for them, which might cause computational problems. A Finite Element Method (FEM) model might be necessary for analysis of space webs. Early in our research, a fully three-dimensional model was developed using Absolute Nodal Coordinate Formulation (ANCF). We paid attention to the free deployment of square space webs and computed the 3D space webs with 100 grids under different conditions. Then we found the computing time would become unacceptably long when the number of grids increased to 400. Considering cable is compression-free material and its tensile stiffness is also variable, new cable elements must be introduced to the FEM model of space webs. In the new three-dimensional FEM model of space webs, we discrete webs into normal cable elements and introduce incompressible property and variable tensile stiffness. As space web is unstable structure, finding its shape in equilibrium state is particular and interesting. An optimization method here is adopted to solve this problem. In dynamical analysis, special attention is paid to both problems of impact and free oscillation. 2D and 3D flexible nets are computed in numerical examples. The simulations indicate interesting phenomenon probably worth further researching.