MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures 2 - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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BUCKLING DESIGN OF BOOM STRUCTURES BY FEM ANALYSIS

Abstract

Nowadays the interest in nano-satellites and microsatellites is rapidly growing, and with that the design of thinner and stiff booms is becoming an emerging interesting topic. Satellite and deep space probes often needed long structures to keep instruments far from other satellite components or simply to stabilize low orbit spacecrafts via gravity gradient. Boom structures are also important elements in the design of solar sails for interplanetary mission, where lightweight long structures are needed to extend and keep the sail in tension. Because of the role that booms play in the entire concept of a spacecraft, the structural design is very significant. Booms are characterized by one large dimension and a very thin cross section, which changes with the applications, thus influencing both weight and stiffness of the entire structure. The loading limit in the thin-walled profile is characterized only by the buckling stability. Moreover, the booms are pressed down flatly and/or rolled up in order to be stored and transported within a very small volume. To meet all these constraints is not always simple, and experience is required in the design and material selection. In this work, we present a full buckling analysis on two cross-sections for Storable Tubular Extendible Member (STEM) booms designed using carbon-fiber reinforced plastics (CFRP). The cross section shapes were the omega and open-circle ones, which were individuated from manufacturing considerations. The length of the boom was fixed at 5 m. Ultra-thin carbon reinforcements with different weaves were considered in the linear analysis in order to determine the effects of the armatures on the stability. From the linear analysis, the fabric style for the carbon reinforcement was selected and a non-linear buckling analysis was performed at different stacking sequence of layers. In addition to a favorable influence on the buckling behavior of the very thin-walled structure, the choice of the stacking sequence is essentially based on the requirement of minimizing the bending that takes place during single-sided thermal loading.