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

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ADVANCED SIMULATION ANT TESTING OF COMPOSITE TRAC LONGERONS

Abstract

The simulation of deployable composite longerons is not trivial. An appropriate mathematical model should account for large rotations/displacements and an accurate (eventually layerwise) description of strains and stresses in the far nonlinear regime. This is not the case of many models making use of first-order shear deformation plate theories and von Karman approximations, which are known to be effective only in the case of moderate rotations. In this context, the present work proposes a novel modelling technique for the nonlinear analysis of thin-walled composite longerons based on the well-established Carrera Unified Formulation (CUF). In essence, refined beam models are obtained as degenerated cases from 3D elasticity by using a recursive index notation. Then, by using CUF, the governing equations are expressed in terms of a few fundamental nuclei, which are invariant of the theory approximation order. Thus, low- to layerwise high-order models of deployable longerons can be formulated with ease. The nonlinear governing equations are written in a total Lagrangian scenario and solved by using a Newton-Raphson method based on a modified arc-length path following equation constraint. Particular attention is focussed on the simulation of composite TRAC longerons. The numerical results are compared against available literature, commercial software tools, and experiments carried out at the Space Structures Laboratory at Caltech. The proposed method is demonstrated to be effective, computationally efficient, and to provide accurate interlaminar stress fields from moderate to large nonlinear equilibrium states. This is of particular importance for failure characterization and for the prediction of delamination onset, which may be due to stress singularities arising close to free edges and the bonded interfaces.