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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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ACCURATE THERMO-MECHANICAL ANALYSIS OF COMPOSITE TRUSS STRUCTURES FOR SPACE APPLICATIONS

Abstract

The thermal stability is challenging problem in the design of large structures for space application. An accurate evaluation of the thermo-mechanical response of the structures is mandatory considering the extreme thermal conditions in which those structures have to operate. The stress and strain fields due to the thermal loads can produce a failure of the components but, even in those cases in which the deformation is not so severe, large thermal deformation can reduce the performances of telecommunication or optical devices that have strict requirements regarding pointing. Larger are the structure considered; larger is the problem of the thermal stability, this makes the development of large truss space structures, such as those for antennas, a challenge. The use of composite materials can reduce the thermal deformations because these material have a low thermal expansion coefficient, CTE, if compared with those of metallic materials. Moreover, the CTE orthotropy allows the thermo-mechanical properties to be designed adopting ad-hoc laminations. The use of classical structural models may lead to inaccurate results when such complex materials are considered, thus refined models must be introduced. The present paper proposes the use of refined one-dimensional models, derived in the frameworks of the Carrera unified Formulation, for the analysis of complex composite structures. The refined kinematic models adopted allows the complex behavior of the composite materials to be described while, the use of a node-dependent kinematic, NDK, formulation makes it possible to reduce the computational costs where possible. Finally the component-wise approach has been used to investigate complex truss structures. The assessment of the present model is presented, then some applications to real truss structures are reported. The effects of the use of composite materials, including the tailoring of the laminations, have been investigated. The results show the accuracy of the present model if compared with those from classical approaches. The refined kinematic and the high-fidelity geometrical description leads to quasi 3D results with the computational cost of a refined one-dimensional model.