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

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THERMAL STRESSES AND BUCKLING OF VARIABLE STIFFNESS COMPOSITE LAMINATES

Abstract

Nowadays, Variable Angle Tow (VAT) composite structures are widely studied due to their tailorable properties, which ensure the maintenance of high performance in the presence of significant mechanical and thermal loads with the possibility of lighter structures compared to straight-fiber composites. The properties of VATs vary continuously in the curvilinear path of each lamina from one point to another, according to the curvature imposed on the fibers, which determines their suitability for the specific application (1). The thermal buckling phenomenon is a critical aspect for VAT plates involved in space application, and its complete understanding is crucial in designing structure components. The present paper exploits the capability of the well-established Carrera Unified formulation as high-order plate theory in the finite element method framework to investigate new numerical results for complex 3D phenomena of VAT plates (2). The use of a layer-wise approach allows an accurate description of the through-the-thickness model direction. The study is focused on the linearized buckling analysis approached with the eigenvalue problem to investigate the critical buckling thermal load (3). The accuracy of the present numerical results is validated through comparisons with reference assessments. Furthermore, new simulations are conducted considering different combinations of VAT parameters, e.g., the curvature of the fibers along the plane and stacking sequences, and the findings are discussed. Finally, the outcomes are investigated to identify the optimal condition for maximizing the critical buckling temperature.

REFERENCES (1) Accurate Stress Analysis of Variable Angle Tow Shells by High-Order Equivalent-Single-Layer and Layer-Wise Finite Element Models. A. R. Sánchez-Majano, R. Azzara, A. Pagani, E. Carrera. s.l. : Materials, 2021, Materials, Vol. 14(21):6486. (2) Finite Element Analysis of Structures through Unified Formulation. E. Carrera, M. Cinefra, M. Petrolo, E. Zappino. ISBN: 978-1-119-94121-7, s.l. : Wiley Sons, 2014. (3) Thermal buckling of composite plates with spatial varying fiber orientation. A.V. Duran, N.A. Fasanella, V. Sundararaghavan, A.M. Waas. s.l. : Composite Structures, 2015, Vol. Volume 124.