25th International Conference on Composite of Structures
19 - 21 July 2022
Faculty of Engineering, University of Porto, Portugal

NONLINEAR VIBRATION OF COMPOSITE BEAMS, PLATES AND SHELLS SUBJECTED TO COMPRESSION AND SHEAR LOADINGS BY UNIFIED FINITE ELEMENTS AND COMPARISON WITH VCT EXPERIMENTS

E. Carrera, A. Pagani, R. Augello, R. Azzara
MUL[2], Department of Mechanical and Aerospace Engineering
Politecnico di Torino

ABSTRACT

This work discusses some advances in the nonlinear vibration analysis of beam, plate and shell elements. Based on the Carrera Unified Formulation (CUF), trivial linearized and full nonlinear governing equations are developed in the framework of a hierarchical finite element formulation to study the effect of pre-stress states on the vibration of composite structures. Thanks to CUF and by making use eventually of full Green-Lagrange strain tensor, the proposed methodology is able to characterize simple to complex nonlinear phenomena, including those related to deep post-buckling regimes. Particular attention is given to the characterization of the natural frequencies of thin to thick laminated structure subjected to progressively increasing compression and shear loads. It is demonstrated that whenever stable pre-buckling exists, trivial linearized equations and low kinematics models can be adopted with no loss of generality. In contrast, in the case of unstable pre-buckling regimes and whenever the interlaminar stress state is complex three-dimensional, high order kinematics and full displacement-strain relations must be used for describing vibration. Several problem are discussed, including cylindrical laminated shell under compression and plates in shear. It is demonstrated that the proposed formulation is effective for all the problem considered and, among the others, can be used to validate non-destructive buckling tests such as Vibration Correlation Technique (VCT).