Sensitivity analysis of variable stiffness composite plates by CUF-based layerwise models

SENSITIVITY ANALYSIS OF VARIABLE STIFFNESS COMPOSITE PLATES BY CUF-BASED LAYERWISE MODELS

A.R. Sanchez-Majano[1], A. Pagani[2] and E. Carrera[3]

[1] Politecnico di Torino,Corso Ducca degli Abruzzi, 24, Torino. alberto.racionero@polito.it
[2] Politecnico di Torino,Corso Ducca degli Abruzzi, 24, Torino. alfonso.pagani@polito.it
[3] Politecnico di Torino,Corso Ducca degli Abruzzi, 24, Torino. erasmo.carrera@polito.it

Key Words: *Composites, Variable Angle Tow, Sensitivity, Optimization.*

Composite materials are increasingly used in many engineering fields thanks to their lightness and high mechanical properrties. Currently, many research activities are focused on the optimization of structures using conventional composite materials, i.e. Constant Stiffness Composite Materials (CSCM). High-performance structures, such as in the aerospace field, could be enhanced by the use of different lamination schemes, e.g. the so-called Variable Angle Tow (VAT). The main idea of VAT composites is to have an increased freeedom in the tailoring of the material properties since the fibers are no longer restricted to be straight and can actually have a curvilinear pattern within each layer.

This work presents a refined beam model based on the Carrera Unified Formulation for linear buckling analyses of VAT structures. These models made use of refined kinematic description for 1D and 2D theories of structures to approximate 3D elasticity equations of metallic and anisotropic structures [1]. Lagrange polynomials have been employed in this work to describe the cross-section variables, obtaining a layer-wise approach. Layer-wise approach confirmed the highest accuracy in comparison with equivalent-single-layer models, also for VAT as demostrated by Demasi et al. [2]. Manufacturing processes to obtain VAT structures lead to misalingments of the fibers, which ultimately affect the global properties of the structure. Such misalingments fields are generated by means of stochastic field theory exploiting the correlation matrix decomposition (CMD) method (like those presented in Broek et al. [3]) where relative distances between structural nodes are considered. Therefore, sensitivity analyses are performed in order to calculate statistical properties for the first five buckling modes.

REFERENCES

1. Carrera, E., Cinefra, M. Petrolo, M., Zappino, E. Finite Element Analysis of Structures Through Unified Formulation.Year: 2014, Ed: Wiley. ISBN: 978-1-119-94121-7.
2. Demasi, L., Biagini, G., Vanucci, F., Santarpia, E. Cavallaro, R. *Equivalent Single Layer, Zig-Zag and Layer-wise theories for variable angle tow composites based on the generalized unified formulation.* Composites Structures 2018; 138
3. Broek, S.v.d., Minera, S., Pirrera, A., Weaver, P.M., Jansen, E.L., Rolfes, R. *Enhanced Deterministic Performance of Panels Using Stochastic Variations of Geometric and Material Parameters.* Proceeding of the AIAA Science and Technology Forum and Exposition, San Diego, CA, 2019.