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ANALYSIS OF LAMINATED STRUCTURES BY COMBINED ESL-LW VARIABLE KINEMATICS PLATE ELEMENTS

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Abstract

The present work deals with the analysis of multilayered composite plates by combined Equivalent-Single-Layer (ESL) and Layer-Wise (LW) varibale-kinematics models. Hierarchical theories are formulated in the framework of the Carrera Unified Formulation (CUF), whose main advantage consists in the possibility of keeping the order of the expansion of the state variables along the thickness of the plate as a parameter of the model. A finite plate element is developed accordingly by using a Mixed Interpolated Tensorial Components (MITC) method in order to contrast the membrane-shear locking phenomenon. Thanks to the refined and hierarchial characteristics of CUF, the devised finite element is able to deal with both ESL and LW descriptions of the fundamental variables. This formulation already showed all its potentiality as a base for finite elements in the mechanical analysis of multilayered plates [1]-[2]. In the present paper, variable-kinematics models, obtained by combining LW and ESL approaches, are formulated

and assessed for various laminations, boundary conditions and loadings. The results are verified by comparison with various closed-form solutions from the literature. The analyses clearly show that this mixed modeling technique allows the analyst to tune the model accuracy depending on the problem characteristics. Thus, efficient and still accurate models able to characterize the strain/stress fields within laminated structures can be implemented with ease.

References

[1] Carrera E.. "Theories and Finite Elements for Multilayered, Anisotropic, Composite Plates and Shells," *Archives of Computational Methods in Engineering*, 9, pp. 87-140, (2002)

[2] M.B. Dehkordi, M. Cinefra, S.M.R. Khalili and E. Carrera., "Mixed LW/ESL models for the analysis of sandwich plates with composite faces," *Composite Structures*, 98, 330-339, (2013).