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REFINED 2D FINITE ELEMENTS FOR COMPOSITE PLATES AND SHELLS ACCOUNTING FOR HYGROTHERMAL EFFECTS

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Abstract. *This paper presents numerical results related to the linear static analysis of composite plates and shells under hygrothermal loads. Particular attention is paid to the study of thick multilayered laminates via higher-order theories. 2D finite elements are employed, and refined structural models are adopted. The Carrera Unified Formulation (CUF) is used to build the refined models. In particular, Equivalent Single Layer (ESL) and Layer-Wise (LW) models are employed. The ESL is based on Mac-Laurin polynomial expansions of the unknown variables along the thickness of the structure. The LW makes use of Legendre polynomials. In both cases, the expansion order of the expansion can be set arbitrarily; that is, the expansion order is an input of the analysis and can be chosen via a convergence analysis. As well-known from CUF works, such a feature stems from the use of the fundamental nuclei of the governing equations and finite element matrices. Such nuclei are independent of the order and the type of expansion adopted. The hierarchical capability of CUF allows 3D stress fields to be detected using 2D or 1D models based on higher-order expansions. Moreover, significant fewer degrees of freedom than 3D finite elements are usually required. In this paper, the governing equations are derived using the Principle of Virtual Displacements (PVD) and the hygrothermal effects are included. The through-the-thickness hygrothermal profile is assumed linear or calculated by solving the Fourier heat conduction equation and Fick diffusion law. The Mixed Interpolated Tensorial Components (MITC) method is employed to contrast the membrane and shear locking phenomena that usually affects shell finite elements. The results are compared with those from literature.*