Mixing layer-wise and refined equivalent-single layer FEs based on Lagrange expansions

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In the aeronautic engineering, in case of the design of an aircraft system, the finite element model of the structure is usually developed by combining 1D and 2D elements, which opportunely approximate the mathematical domains of ribs, stringers, panels, and other components. Clearly, this discretization results in a simplification of reality. Indeed, in many applications, a complete description of the 3D stress field of a certain portion of the model may be mandatory. To accurately capture these localized 3D stress fields, solid models or high-order theories are demanded. However, in order to make the model more efficient, i.e. to balance computational cost and accuracy of the results, a global/local approach can be adopted. A popular approach for the global/local analysis of structures consists of formulating multiple kinematic models. In particular, different subregions of the structure are analyzed with different mathematical models, so that particular areas of interest can be described through an accurate description, as the Layer-Wise (LW) approach when dealing with laminated materials, whereas lower-order kinematcs can be employed in the remaining zones. Although accurate, LW models may require the use of high computational efforts. Thus, in the last years, several efforts have been addressed by researchers to make the composite plate and shell models as accurate as efficient. One of the simple types of multiple-model method, for composite laminates analysis, is the concept of selective ply grouping or sublaminates (see [**?**]). This approach consists in creating some local regions in the plate/shell thickness direction, identified by specific ply or plies, whithin which accurate stresses are desired. The purpose of this work is the development of a mathematical model able to arbitrarily select multiple plies, within which the interlaminar stresses have to be accurately defined. The approach is developed in framework of the Carrera Unified Formulation [**?**], which allows the user to define the order of model as an input of the analysis, so that low- to higher-order models can be built in a global/local meaning without the need of any ad-hoc model. The proposed approach is applied to 1D beam and 2D plate/shell models, as well as on a stiffened panel from a real aeronautic application. The results show the capability of the present model to accurately describe the localized interlaminar phenomena in terms of stresses using the global/local approach.

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