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NUMERICAL MODELING OF DELAINATIONS IN MULTI-LAYERED PLATES

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The delamination is one of the most frequent types of failure that can occur in multi-layered structures. It is mostly caused by the external loads that lead, in effect, to decohesion between the neighboring layers. The numerical modeling of such phenomena is challenging [1]. The reliable numerical model requires an adequate decohesion model and an effective computer method for the non-linear analysis to trace the delamination process. In this work, the novel approach for the numerical modeling of the delamination is presented. The numerical model is based on the FEM23 [2] which is combined with the discontinuous Galerkin method [3]. The FEM23 is the method that allows full 3D analysis of layered plates or shells using only the 2D finite element method. In the standard version of the FEM23, the approximations in the transverse direction are continuous. However, in this case, the approximations are discontinuous, where the discontinuities are located in the boundaries between the neighboring layers. The discontinuous approximation is the idea taken from the discontinuous Galerkin method. In spite of the discontinuous approximation in the method, the displacements have to be continuous for the undamaged plate, which is enforced by the cohesion tractions, acting between the layers. The physical model includes the diminishing of the cohesion tractions when the relative displacements of the neighboring layers exceed a certain threshold, which leads, in effect, to delaminations.
The combined method, which couples the FEM23 and discontinuous Galerkin method, is shown to be effective for numerical modeling of the delamination process in the multi-layered plates. In the method, it is possible to analyze the situation when the delamination occurs in many places showing their mutual interactions in the failure process. The new method is illustrated with some examples where the multi-layered plates are subjected to external mechanical loads leading to delaminations in the plates. It is shown in these examples how the failure proceeds when the delamination is initiated in many places of the plate.

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