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AN EFFICIENT SEMI-ANALYTICAL FINITE FRACTURE MECHANICS APPROACH FOR THE PREDICTION OF INTERLAMINAR CRACK INITIATION IN COMPOSITE LAMINATES

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The layer-wise discontinuous stiffness properties of laminate composite structures induce theoretically infinite stresses at free edges. These highly localised interlaminar stresses may lead to a premature failure by interlaminar crack onset. Due to the singular character of the stress field and the abscence of a pre-existing crack, neither classical strength based nor purely energy based failure criteria allow for reliable strength and failure load predictions. These drawbacks are overcome by a coupled stress and energy criterion within the framework of the finite fracture mechanics (FFM), proposed by Leguillon [1]. This approach has already proven succesful for the analysis of interlaminar cracking in angle-ply laminates [2].

In the present study, interlaminar crack initiation at a free-edge in symmetric laminates based on a generalized plane strain model is investigated in the framework of FFM. In order to significantly decrease the numerical effort the scaled boundary finite element method (SBFEM) is used to determine the required singular stress fields. The SBFEM, first introduced by Song and Wolf [3], reduces the dimension of the problem by one. Only the boundary is discretized in 2D by one-dimensional finite elements whereas the variation of field variables inside the considered body is represented analytically. Results are validated using a clssical finite element reference solution. The predicted effective laminate strength is compared to experimental data from literature.

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