Accurate Mode-Separated Energy Release Rates for Delamination Cracks

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Abstract

Following Irwin's argument, the energy release rates are computed by using nodal forces a head of the crack front and relative displacements behind the crack front. Furthermore, the quarter-point singularity elements were used for most finite element computations. Recently, Babuska and Oh introduced a new approach, called the method of auxiliary mapping (MAM), that can effectively handle singularities in the framework of the p-Version of the FEM. In this paper, this new approach is modified so that it can yield highly accurate mode-separated energy release rate for the cracks in composite materials. The results obtained by this method are more accurate than those obtained by the conventional methods. It is known that the mode separated energy release rates for interfacial cracks of bimaterials do not converge. However, we show that in practical point of view, the mode-separated energy rates of interlaminar cracks of a laminate does converge whenever layers are of the same material and may have different fiber orientations. Moreover, the total energy release rate will directly computed by differentiating the total strain energy with respect to the crack length.

Key words and phrases: Method of Auxiliary Mapping, the p-Version of the Finite Element Method, Mode-Separated Energy Release Rate Interlaminar Cracks, Quarter-Point Singularity Elements.

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