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A discontinuous Layerwise method for the composite laminated beam with multiple delaminations and in-plane cracks

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For the delamination prediction of composite laminated structures, the methods based on damage mechanics and fracture mechanics are most commonly used. In addition to this, Heaviside function is also introduced into the displacements assumption in thickness direction to model the multiple delaminations. However, there are very few methods can deal with the delamination and in-plane cracks together, although the in-plane cracks away exist alongside the delamination when the composite laminated structure is under the action of impact load.

In the present work, an analysis method for the composite laminated beam with multiple delaminations and in-plane cracks was developed based on the layerwise theory and the extend finite element method (XFEM). In the the displacement assumption model, the standard nodes in the thickness direction are located at the neutral surface of each single layer, the top surface and the bottom surface in this method. The displacement assumption model contains the linear lagrange interpolation functions, the one-dimensional signed distance function and Heaviside function. The Heaviside function and weak discontinuity function are applied in the displacements assumption in thickness direction to model the displacement discontinuity induced by delaminations and the strain discontinuity induced by the interface between the layers, respectively. Because of the standard nodes in the thickness direction are located at the neutral surface of each single layer, the scheme of two dimensional XFEM can be employed to deal with the in-plane matrix crack. Therefore, the most basic ideas of the present method is translated a complex three dimensional fracture problem into a one dimensional and a two dimensional fracture problem.

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