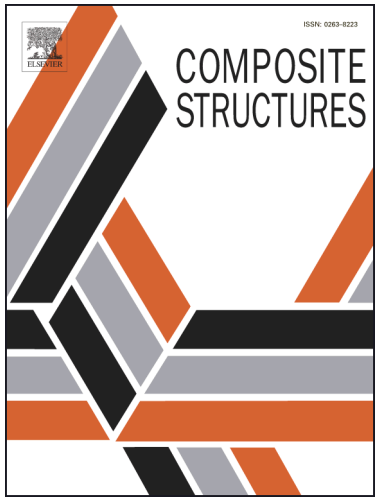

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Phase field based peridynamics damage model for delamination of composite structures

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Abstract

We extend and exploit a phase field based peridynamics (PD) damage model (Roy *et al*., 2017) for studying delamination of composite structures. Utilizing a phase field augmented PD framework, our idea is to model the interfacial cohesive damage through degradation functions and the fracture or fragmentation through the critical energy release rate. Our model eliminates the conventional traction-separation law (TSL) that is known to result in the popular cohesive zone model (CZM). In the process, the approach potentially addresses some limitations of the existing techniques, for example, CZM, virtual crack closure technique (VCCT) and so on, which make use of an empirical interaction among different modes of loading (e.g., mode I, mode II etc.). By regarding delamination under different loading conditions as problems that differ only in their boundary conditions, our approach provides for a more general scheme for tracking delamination growth. Our proposal thus accords no special treatment to the different modes and can handle general spatial locations of weaker interface layers. With no special crack tracking algorithms or additional ad-hoc criteria for crack propagation, considerable computational simplicity also accrues. The approach admits an easy extension to cases where cracks can propagate even in the bulk material body. The new bond breaking criterion that we employ replaces the ad-hoc approach inherent in bond-stretch-based or bond-energy-based conditions. Unlike standard phase field models, physical fragmentation of the body is feasible in the present model. The proposed methodology also eliminates the problem of matter interpenetration by its very construction. Apart from an initial validation exercise for a laminated composite plate with a hole where no or little damage occurs, we also use numerical simulations on mode I, mode II, and mixed mode delamination cases in order to assess the performance of our model by benchmarking it