Effect of Discretization and Stochastic Material Distribution on Crack Initiation in Peridynamics

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The simulation of the structural behavior and particularly damage response is a key instrument for the development of lightweight structures as required in aerospace engineering or wind rotor blade development. The prediction of damage initiation and propagation in main structural elements as well as their adhesive bonds is a challenging task, even for state-of-the-art numerical procedures, such as the finite element method (FEM).

The peridynamic theory presents a promising approach for these requirements. It is a non-local theory which takes long-range forces between material points into account. The theory assumes that a material point interacts with all its neighboring particles within a finite radius. The formulation of its governing equations is based on integral equations, which are valid everywhere - in a non-disturbed material region as well as in the vicinity or directly at a discontinuity such as a crack. Damage is directly incorporated in the material response [1, 2]. Additionally, the mesh-free peridynamic implementation in the open-source code Peridigm promises to overcome the mesh dependency problems currently present in FEM or extended FEM (XFEM) methods.

In the current publication, the effect of a varying discretization and the stochastic distribution of material properties is investigated and compared to other fracture mechanical methods based on a tensile test on an epoxy specimen. It is examined if a more realistic representation of the stiffness distribution can lead to improved results regarding crack initiation and propagation compared to the standard models. These normally assume perfect symmetry. The applied framework and the underlying theory and its numerical implementation are introduced.

References

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