Numerical Simulation of Dynamic Crack Growth Using Peridynamic Theory

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Fracture behavior of structural materials has been a sustained research area to understand the phenomena behind the failure of the materials. Linear elastic fracture mechanics (LEFM) is used to predict the propagation of cracks in brittle materials. LEFM concept considers propagation of existing cracks rather than the nucleation of new cracks. However, modeling of cracks in Finite Element Analysis (FEA) has some difficulties. The main problem comes from the governing equations of continuum mechanics which require spatial derivatives. Spatial derivatives are not defined at crack tips by definition. As a remedy, Silling proposed a new nonlocal theory of continuum mechanics called Peridynamic Theory (PD) [1]. Peridynamic Theory (PD) is a nonlocal version of Classical Continuum Mechanics. In PD, equations of motion are formulated using interaction of material points in a finite horizon. Thus, a special treatment at the crack tip is not necessary and crack initiation and crack growth can be analyzed without requiring external criteria [1].

Coker et al. [2] investigated crack growth in a bimaterial interface (Carbon Composite-Homalite Interface) subjected to impact shear loading both numerically and experimentally. They found out that interfacial crack speeds are faster than any characteristic elastic wave in the solid and that sustained crack tip speeds are obtained at specific intersonic values. In this study, dynamic crack growth at the Homalite-carbon composite material interface subjected to impact shear loading will be investigated using Peridynamic approach. The Peridynamic solutions for stress fields and Intersonic crack growth will be compared to experimental and numerical solutions by Coker et al in [2].

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Keywords: Peridynamic Theory, Dynamic Crack Growth, Impact shear loading

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