Crack propagation analysis using the peridynamic approach in the Cosserat pseudo-continuum framework

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Abstract

The classical formulation of continuum mechanics does not explicitly account for the internal structural composition of materials. Consequently, when simulating materials characterized by discontinuities or significant microstructural influence, effects lacking a clear physical interpretation often arise. To address this, higher-order gradient theories, such as the Cosserat theory, are frequently employed. In this study, a peridynamic model based on a simplified Cosserat theory (SCPD) is proposed to investigate the impact of microstructure on crack propagation. Within SCPD, the peridynamic (PD) forces and moments are derived using a bond-based correspondence model, where PD forces and moments are linked to stress and coupled stress components. The effect of microstructure on crack propagation is analyzed by varying the characteristic length scale. Additionally, the results obtained using the SCPD model are compared with those from a bond-based peridynamic model. The SCPD model demonstrates closer agreement with experimental observations, particularly in capturing the qualitative and quantitative characteristics of crack propagation.

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