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Uncovering the Intrinsic Deficiencies of Phase-Field Modeling for Dynamic Fracture

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ABSTRACT

The phase-field fracture (PFF) approach has achieved great triumphs in modeling quasi-static fracture. Nevertheless, its reliability in serving dynamic fractures still leaves something to be desired, such as the prediction of the limiting crack velocity. Using a pre-strained fracture configuration, we discovered a disturbing phenomenon that the crack limiting speed identified by the dynamic PFF model is not related to the specific material, which seriously deviates from the experimental observation. To ascertain the truth, we first ruled out the correlation between the limiting crack velocity on the phase-field characteristic scale and external loading. Afterward, by switching between different crack surface density functions and degradation functions, we reach an astonishing conclusion that the limiting crack velocity predicted by the dynamic PFF model relies on the model itself. This non-physical phenomenon signifies that the commonly used dynamic PFF model has inherent defects. From the perspective of classical linear elastic fracture mechanics (LEFM), the local wave velocity degradation can be responsible for the limiting crack velocity in the phase-field modeling of dynamic fracture.

KEYWORDS

PFF model; dynamic fracture; limiting crack velocity; wave-velocity degradation

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