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An Efficient Solution Strategy for Phase Field Model of Dynamic Fracture Problems Based on Domain Decomposition

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ABSTRACT

Dynamic fracture is an important class of damage widely present in engineering materials and structures, e.g., high-speed impact and explosion. In recent years, the phase field approach to fracture proposed by Bourdin et al. [1] becomes popular for complicated fracture problems for its ability to simulate crack nucleation, propagation, branching, and merging without extra criteria, and the crack path does not need to be tracked, which makes the implementation straightforward and the calculation efficient. However, one of the major issues of the phase field method is the high computational cost due to the need of a very fine mesh, which usually limits its applications.

In this work, we propose an efficient parallel solution strategy for phase field model of dynamic fracture problems based on a domain decomposition method, specifically, the dual-primal finite element tearing and interconnecting (FETI-DP) method proposed by Farhat et al. [2]. The whole computational domain is decomposed into multiple non-overlapping subdomains. A coupled parallel explicit-implicit solution strategy is proposed, where the displacement field is updated in parallel between subdomains by an explicit scheme, and the phase field is reformulated in the domain decomposition framework and solved by the FETI-DP method in parallel. In the computational process, there is merely a little information exchange between subdomains, which significantly improves efficiency. Moreover, the solution strategy is able to solve large scale phase field simulations with implicit scheme, and has flexible extensibility for existing phase field codes. It is expected that excellent performance can be achieved by the proposed method without the loss of accuracy.

KEYWORDS

Phase field model; dynamic fracture; domain decomposition method; FETI-DP method; parallel computation

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