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Fragile Points Method for Modeling Complex Structural Failure

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ABSTRACT

The Fragile Points Method (FPM) is a discontinuous meshless method based on the Galerkin weak form [1]. In the FPM, the problem domain is discretized by spatial points and subdomains, and the displacement trial function of each subdomain is derived based on the points within the support domain. For this reason, the FPM doesn't suffer from the mesh distortion and is suitable to model complex structural deformations. Furthermore, similar to the discontinuous Galerkin finite element method, the displacement trial functions used in the FPM is piece-wise continuous, and the numerical flux is introduced across each interior interface to guarantee the consistency of the method. For this reason, it is convenient to explicitly introduce crack across any interior interface in an FPM model, and this method is suitable to model complex structural failure [2]. It is also worth mentioning that, the FPM is stable since its formulations is based on Galerkin weak form, and simple polynomial trial functions can be used in the FPM since the displacement is not strongly enforced to be continuous between subdomains. The authors' group has already derived the static and dynamic weak form formulations of the FPM, proposed an interface debonding model based on the numerical flux, and implemented an implicit static and an explicit dynamic FPM code. This presentation starts with an introduction on the theory and implementation of the FPM. Then the FPM results on three structural failure examples are discussed including the fracture of U-notched specimens with brittle materials [3], the coupled inter- and intra-ply damage of composite laminates, and the dynamic fracture of brittle materials. The examples show that the proposed FPM approaches are able to reliably predict static and dynamic fracture behaviors, and this method has potential to serve as a powerful tool for modeling complex structural failure in engineering fields.

KEYWORDS

Discontinuous meshless method; polynomial trial functions; interface debonding model based on numerical flux; explicit cracks in models; static and dynamic fracture

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