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PROCEEDINGS

A Unified High-Order Damaged Elasticity Theory and Solution Procedure for Quasi-Brittle Fracture

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ABSTRACT

A unified high-order damaged elasticity theory is proposed for quasi-brittle fracture problems by incorporating higher-order gradients for both strain and damage fields. The single scale parameter is defined by the size of the representative volume element (RVE). It formulates the degraded strain energy density to capture size effects and localized damage initiation/propagation with a damage criterion grounded in experimental observations. The structural deformation is solved by using the principle of minimum potential energy with the Augmented Lagrangian Method (ALM) enforcing damage evolution constraints. This simplifies the equilibrium equations, enabling efficient numerical solutions via the Galerkin finite element method with quadratic elements. Numerical investigations validate the ability of the theory to predict non-singular deformation at crack tips, accurately model size-dependent fracture in perforated brittle plates, and achieve mesh-independent failure predictions in benchmark problems.

KEYWORDS

Damaged elasticity; brittle fracture; size effect; finite element method

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