A seamless transition method from continuity to discontinuity for crack in an elasto-plastic material

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ABSTRACT

The objective of this contribution is to develop a method for seamless transition from continuity to discontinuity of displacement field due to crack in an elasto-plastic material. The fracture process can be divided into two stages by the development of the displacement field during the formulation of the crack surface. At the first stage of the fracture process, the continuity of displacement field is change into weak-discontinuity by the reduction of the material stiffness at a macro-scale due to the evolution of defects at a micro-scale. At the final stage, the displacement field develops into strong-discontinuity by an explicit crack opening due to the coalescence of the microscopic defects. In this study, the macroscopic stiffness reduction at the first stage is represented by embedding a cohesive zone model (CZM) into the elasto-plastic constitutive law, which is similar with conception of a smeared crack model. Then, the proposed method bridges a transition from weak- to strong-discontinuous displacements by the combination of the same CZM employed to represent the first stage of the fracture process and the finite cover method (FCM). In other words, a finite element in which the cohesive traction attains the critical value is adaptively divided into two domains to represent the strong discontinuity by the FCM combined with the CZM. Moreover, these two stages of the fracture process are seamlessly connected with theoretical consistency of cohesive fracture. After conducting simple validation, we demonstrate the capability of the proposed seamless transition method throughout the propagating crack in the elasto-plastic material.

REFERENCES