Phase field modeling of brittle fracture in an Euler-Bernoulli beam

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ABSTRACT

The advantage of the phase field method for fracture is that the cracks are a natural outcome of numerical computation and requires no explicit tracking of the crack paths. Such idea has been generalized to structural elements such as shells [1]. In [1], the phase field is assumed constant across the thickness, thus only allowing complete fracture in the thickness and precludes fracture by bending. In this work we present a phase-field model to simulate brittle fracture in an Euler-Bernoulli beam. We start from formulating the problem with the principle of minimum potential energy in a 3D solid, with the displacement field and the phase field as primary arguments. We then select, for each cross section, representative fields that characterize the said cross section, including the beam deflection and rotation, and up to three quantities that represent the phase field within the cross section. The problem then reduces to a one-dimensional nonlinear differential equation and can be solved with the finite element method. A feature of the proposed method is, without discretizing the phase field within the cross section, it can represent its variation within the cross section, allowing to simulate fracture due to bending as well as axial loads.

References

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