DYNAMIC ENERGY BALANCE AND FRACTURE

Robert Lipton, Debdeep Bhattacharya

ABSTRACT

A nonlocal model for dynamic damage evolution consisting of two branches one elastic and the other inelastic is considered. Evolution from the elastic to the inelastic branch depends on material strength and is mediated through the constitutive law relating force to strain. The field theory is of peridynamic type and also involves a 2 point phase field that depends on the displacement. The energy for the model interpolates between elastic energy for small strains and surface energy for sufficiently large strains that fail the material. For three dimensional problems with a flat crack, power balance delivers the crack tip velocity in terms of the rate of work done by the load and the change in both the kinetic energy and elastic potential energy of the specimen. The fracture energy is the Griffith fracture energy. Subsequent passage to the limit of vanishing non-locality in a pre-cracked plate subjected to mode I loading delivers a sharp fracture evolution that recovers classic dynamic fracture mechanics. Several numerical examples are given that complement the theory.

REFERENCES

[1] D. Bhattacharya, R. Lipton, and P. Diehl, Quasistatic fracture evolution using a nonlocal cohesive model. *International Journal of Fracture*, doi.org/10.1007/s10704-023-00711-0, 2023.

[2] R. Lipton and D. Bhattacharya, Energy balance and damage for brittle fracture: nonlocal formulation, *ArXiv.2401.01861v1* [mathAP] 3 Jan 2024.

[3] R. Lipton, E. Said, and P. Jha, Free damage propagation with memory, *Journal of Elasticity*, **133**, 129–153, 2018.