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Comput. Methods Appl. Mech. Engrg. 353 (2019) 44–65
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Phase-field study of crack nucleation and propagation in elastic–perfectly plastic bodies

1. Introduction

The variational fracture field approach following [1,2] has emerged as a powerful tool for the study of fracture in brittle materials. This approach is based on a regu5arization of the variational formu5ation of brittle fracture

The situation in plane stress is different. A plastic zone forms at the crack tip and gradually extends ahead of it. Failure occurs by the formation of a region of intense shear due to the high deviatoric stress induced by the stiffness. The latter, introduced for the sake of numerical convenience, has been proven not to have any significant influence on the obtained results [

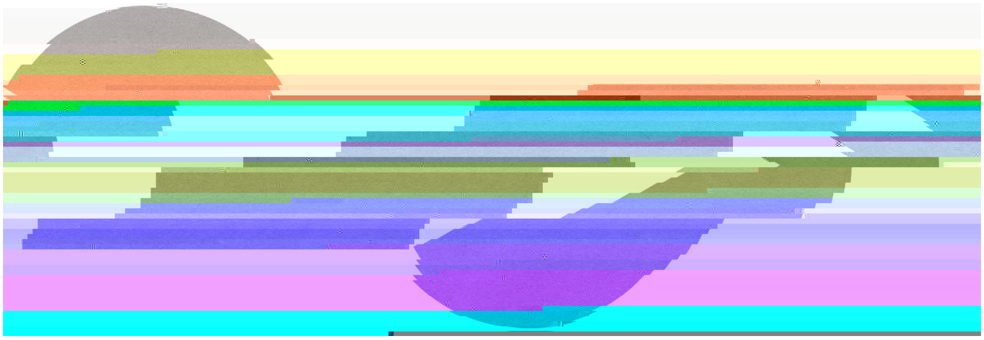

Fig. 1. (a) Notch specimen undergoing a proportional loading used to study crack nucleation. (b) Long specimen subject to surfing boundary conditions used to study crack propagation.

equivalent plastic strain $_{p}^{eq}(\bar{t})$ D

Fig. 4. Crack initiation at a sharp notch in plane stress conditions. J-integral as a function of the time for an elastic–plastic material with different values of ductility ratio r_y.

Fig. 5. Crack initiation at a sharp notch in plane stress conditions. Fracture field computed for different values of the ductility ratio r_y.

Fig. 6. Crack initiation at a sharp notch in plane strain conditions. Plastic process zone and crack growth, for an elastic–plastic material with r_y D 0:1 and r_y D 5.

Fig. 7.

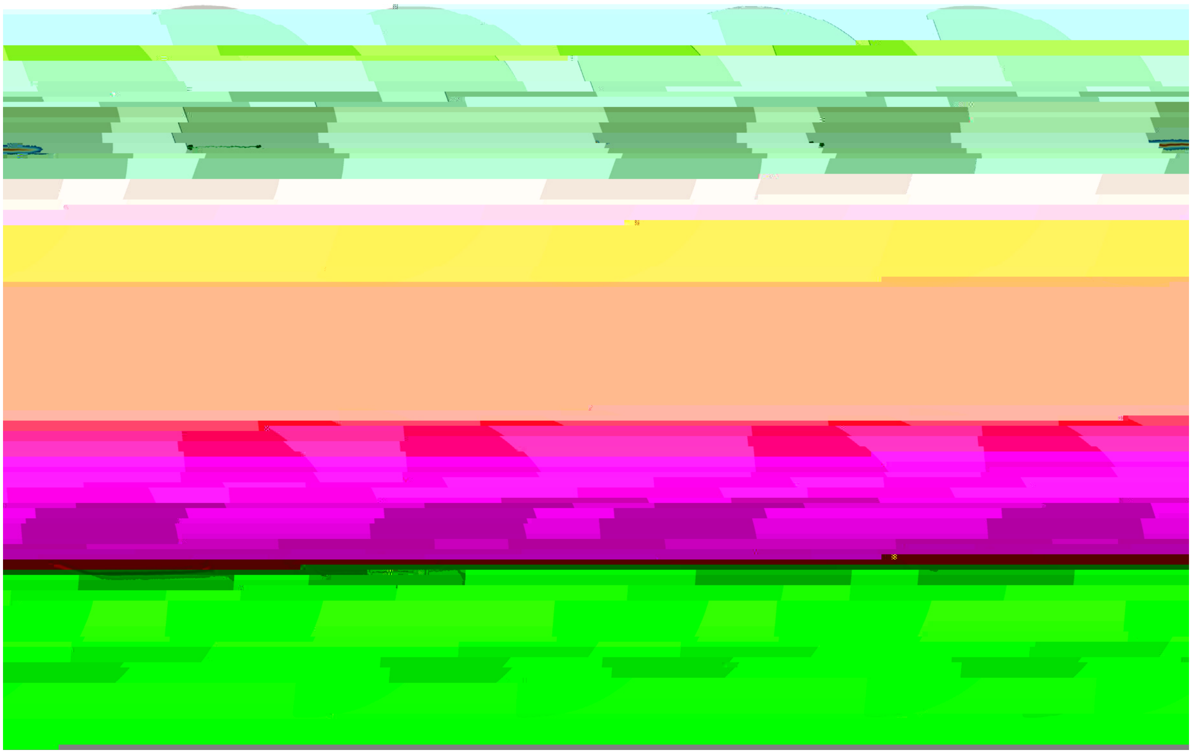

Fig. 10. Crack nucleation at a V-notch in plane stress conditions for an elastic–plastic m0terial with ductility ratio r_y D 2. (a) Energies as a function of time t. (b) Crack nucleation and plastic process zone, for [illegible] D 70 . (b) Crack nucleation and plastic process zone for [illegible] D 85 .

rise again with [illegible] for higher values of ductility ratio. This is highlighted for the case [illegible] D 60 where the behavior of k_c vs. r

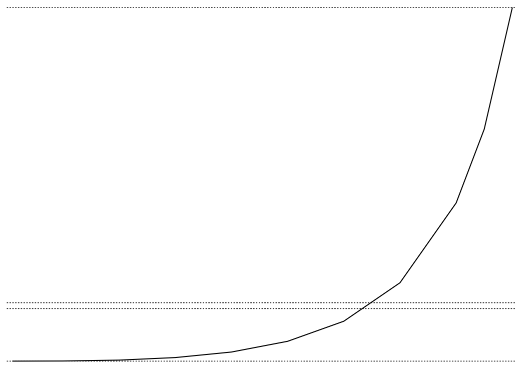

Fig. 11.

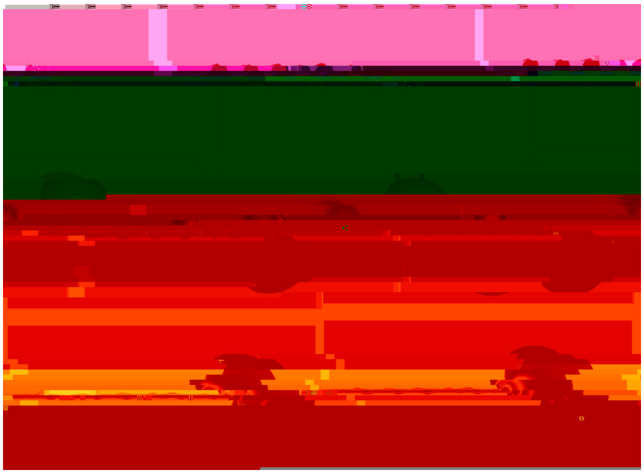

Fig. 14. Crack propagation in plane strain conditions. Comparison between an elastic M_e and elastic–plastic M_{ep} material, for ` D 0:1. (a) J

[35] Erwan Tanné, Tianyi Li, Blaise Bourdin, J.-J. Marigo, Corrado Maurini, Crack nucleation in variational phase-field models of brittle fracture, J. Mech. Phys. Solids 110 (2018) 80–99.

[36]