Dynamic Versus Static Analysis of Fracture in Soft Materials

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While cracks mostly propagate dynamically, their analysis is usually quasi-static. Quasi-static analysis is simpler, of course, than the dynamic one. Will the dynamic analysis provide results similar to the quasi-static ones? We address the answer to this question in the present work. We compare results of the dynamic and quasi-static simulations of cracks initiated by quasi-static loads in aneurysm material.

We use the material-sink (MS) approach [1-4], which is based on the notion of the diffused bond breakage. The latter feature implies a local loss of material and, consequently, decrease of mass density, which, in its turn, means that both stiffness and inertia go down in the damaged zone. The cancellation of inertia is an important feature of the MS approach in contrast to more formal regularization theories as phase field, gradient damage, and other nonlocal formulations.

The MS approach is implemented within commercial finite-element software ABAQUS. A reduced mixed finite-element formulation is adopted to circumvent the volumetric locking and an implicit staggered solution algorithm is developed via the user-defined element subroutine UEL.

Considered examples show that the onset of crack instability under static loads is followed by the dynamic rather than quasi-static crack propagation. Moreover, dynamic and quasi-static simulations, generally, provide different results.

References

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