

Internal time for nonlocal integral framework

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Abstract

Nonlocal damage models are now commonly used. Their ability to make finite element computations with softening laws robust and mesh independent is well established but the effect and the formulation of boundary conditions - such as free edges, notches and initial cracks - remain an open question. The definition of natural boundary conditions of vanishing strain normal derivative at a free edge is still under discussion even for gradient formulations [1, 2]. The main drawback of the classical integral nonlocal theory [3] consists in the nonphysical interaction, through the nonlocal averaging process, of points across a crack or a hole. A few remarks can be made on this topic:

- The continuous nucleation of a crack of zero thickness is not so simple as the thickness of a localization band is more or less proportional to the internal length introduced. Local behavior along free edges - i.e. with a vanishing internal length - has been obtained by some authors [4].
- The consideration of an internal length evolving with damage [5] seems a way to properly bridge Damage Mechanics and Fracture Mechanics as the internal length may then vanish for large values of damage.

One focus in the present work on the boundary conditions problem and on the feature that points separated by a crack or a hole should not interact as they do in the classical integral nonlocal theory. Instead of defining an internal length one proposes to make the nonlocal weight function as a function of the information time propagation of an elastic wave normalized by an internal time τ_c [6]. The cracks and notches presence is naturally taken into account within the wave propagation study and the classical integral nonlocal theory is recovered far from the boundaries. The proposed approach makes equivalent a crack and a highly damaged zone, as points across a notch have a small contribution in the nonlocal averaging.

References

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