Gradient of damage enhancements & cohesive models

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Summary

Gradient enhancements have become increasingly popular in the last decades for dealing with problems in Mechanics suffering from spurious mesh sensitivity induced by strain softening. Many proposals exist in this sense and various regularization techniques have been presented and successfully applied to study localization and fracture. In short, the idea underlying almost all such techniques is that of using some extended constitutive equations in which information about material microstructure is represented via a length scale-related parameter.

From a computational standpoint, once spatial gradients and/or length scales are introduced in the constitutive equations the latter are no longer defined at the local (quadrature point) level but they are established at a larger scale, i.e. the scale of the structural model. Basically, for usual local models stresses, strains and internal variables are defined in a point-wise fashion whereby their values can be regarded as the parameters of a piece-wise constant interpolation. Hence, variables computed at the Gauss point level in classical displacement-based finite element methods can be understood as fields that are in general discontinuous across elements boundaries and inside elements as well. Contrariwise, for nonlocal and gradient-enhanced models the presence of gradient or averaging operators in the constitutive equations enforces a greater regularity of strains stresses and internal variables and the resulting solution will be globally smoothed through elements.

In this communication the implementation of the gradient concept to cohesive zone models is addressed and numerical results will be presented that demonstrate the common features with continuum damage models as well as the performances of the proposed approach in finite element computations.