A gradient-extended damage-plasticity model for large deformations: Theory and numerical aspects

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ABSTRACT

Incorporating gradient effects into 'local' damage models is an effective way to counteract the well-known pathological mesh-sensitivity issue which otherwise shows up in finite element simulations involving material softening behavior. More recently, due to the progressive increase in computing power, such models are more and more employed also in practical problems and their properties are being tested in closer detail. Nevertheless, research in this area can still be considered to be in its infancy and there are many open questions that need to be addressed. One of these is the appropriate coupling between the two phenomena 'gradient damage' and 'plasticity', particularly in the case of large deformations, which offers great potential for practically relevant applications.

The present work is concerned with this issue. A gradient-enhanced damage-plasticity model is presented which is valid for large deformations. It can be considered the geometrically nonlinear version of a model for small strains proposed recently by the authors ([1, 2]). The modeling of plasticity and damage is based on a so-called 'two-surface' strategy: both are treated as independent (but coupled) dissipative phenomena with separate yield and damage criteria as well as loading / unloading conditions. Such an approach leads to a wide applicability of the model in which the real material's damage behavior can either be more brittle- or ductile-like. Special emphasis is also put on the way how nonlinear kinematic hardening of Armstrong-Frederick-type can be considered in the formulation. The model's gradient-extension is based on the modern version of the micromorphic approach as proposed by Forest (see [3, 4]). Both theoretical and numerical aspects of the model are discussed and several examples are used to illustrate the model's good mesh regularizing properties in coupled damage-plasticity finite element simulations.

REFERENCES

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