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VARIATIONAL APPROACHES TO MODEL THE EFFECTIVE BEHAVIOUR OF ADIABATIC SHEAR BANDS

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Shear localization is a common phenomenon in ductile materials undergoing high strain rate loading. An adiabatic shear band (ASB) is a relatively narrow band, typically a few tens of micrometers in width, presenting large deformation and high temperature, occurring in various ductile materials (metals, polymers, ...) where thermal softening is significant. The adjective adiabatic can actually be considered as a misnomer, since heat conduction plays a key role in their formation. Although an ASB can appear as a strong displacement or velocity discontinuity at the macroscopic scale, it is actually a weak discontinuity, whose width and intensity are controlled by the balance between heat production from mechanical dissipation and heat diffusion by thermal conduction. The main objective of this work is to bridge the two descriptions, which are each relevant to different scales.

The proposed approach consists in adopting a parameterized description of the displacement/velocity and temperature profiles within the shear band (microscopic scale). These parameters are then determined through a variational procedure, optimizing an incremental energy potential accounting for elasticity, work hardening, and heat conduction. This procedure yields an effective constitutive model for the macroscopic shear band (seen as a discontinuity), with internal variables corresponding to the above parameters.

The approach has been applied to steady-state regime [1] as well as to transient regime, with non-monotonic loading, and in the presence of hardening [2]. In this previous work, canonical velocity and temperature profiles were used. But alternative parameterizations can be used, and we will compare differents possibilities in terms of precision and efficiency. We will also illustrate how the resulting effective behaviour can be used as a cohesive-type model in boundary-value structural problems.

REFERENCES

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