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NUMERICAL SIMULATION OF MATERIAL INSTABILITIES

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Departing from the general notion of (in)stability the paper first shows the distinction between structural and material instabilities, illustrated with references to literature, e.g. [3], and examples. Attention is then briefly directed to unstable behaviour of geomaterials, simulated assuming small strains and involving strain localization. The ill-posedness of the considered boundary value problem is thereby discussed [2]. The loss of ellipticity and options of regularization to avoid the induced discretization-sensitivity are reviewed. The issue of examination of ellipticity loss as an instability indicator is then discussed for large strain plasticity.

The main part of the paper presents the numerical analysis of localized deformations in isotropic large strain thermo-mechanical models for metallic materials, incorporating elasticity and plasticity. The localization is caused by instabilities in the form of geometrical and material or thermal softening. The constitutive model is based on multiplicative decomposition of the deformation gradient into thermal, elastic and plastic factors, and on a suitable free energy potential [5]. Full thermo-mechanical coupling and non-stationary heat flow are considered. The models are developed using the automatic code generator *AceGen* within *Mathematica* environment.

It is confirmed that, if thermal softening is accompanied by significant heat conduction, the ill-posedness problem is removed [1]. However, when adiabatic conditions are approached, the simulation results remain mesh-dependent. To regularize the problem the yield strength can be made a function of a non-local relative temperature [4], obtained from a gradient-type averaging equation. The internal length introduced this way sets the width of the localization zone. The paper is concluded with another classification of instabilities into stationary and propagative as well as some simulation results for the phenomenon of Lueders bands.

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