MASS-CONSTRAINED MINIMIZATION OF A ONE-HOMOGENOUS FUNCTIONAL ARISING IN STRAIN-GRADIENT PLASTICITY

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ABSTRACT. We consider a minimization problem for a one-homogeneous functional, under the constraint that functions have a prescribed mean value. The problem originates from a one-dimensional strain-gradient theory of plasticity developed in [Anand-Gurtin-Lele-Gething, J. Mech. Phys. Solids 53, 2005]: the minimizer represents the (normalized) time-derivative of the plastic strain in a strip-shaped sample undergoing simple shear with a given shear stress. Of particular interest in this theory is the dependence of solutions on a "dissipative length-scale" which quantifies the rate of free energy dissipation due to the plastic-strain flow. In arbitrary space dimension we identify the relaxation of the functional, we characterize its sub-differential, and we prove the existence of a minimizer. In addition, we identify a relation between the value of the minimum, the shear stress, and the Lagrange multiplier of the problem, and we use it to infer a monotonicity property of the shear stress with respect to the dissipative length-scale. Such property confirms that the strain-gradient theory under consideration is able to model the experimental evidence that smaller samples have higher relative strength. In one space dimension, where the model is proposed, we also prove uniqueness, regularity, and qualitative properties of the minimizer in the space $\mathcal{S}$BV.

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