Thin film asymptotics in a model related to single-slip crystal plasticity

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We perform a 2d-1d dimension reduction analysis of a model featuring strong local constraints: incompressibility and inextensibility in a particular direction. The model can be interpreted to describe either the first discrete time step of the evolution of a single-slip elastoplastic body in large deformations with fully rigid elasticity, or, alternatively, the static equilibrium of a fibre-reinforced incompressible elastic body. We show that in the thin-film limit, deformations can essentially freely bend despite the restrictive constraints, exploiting suitable nonsmooth deformations. We also prove this nonsmoothness of almost optimal configurations is crucial in general; in fact, an energy gap (a Lavrentiev phenomenon) occurs if we artificially restrict our model to smooth deformations. The latter phenomenon is absent if the differential constraints are appropriately softened.

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Reference: https://arxiv.org/abs/2211.15345