Project 8:

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An evolution model for microstructure in pressure-dependent plasticity

In [1], we investigated an energy-based model for pressure-dependent plastic materials, as for example granular media, assuming that the elastic domain is bounded, i.e. that the yield limit is zero outside a finite interval in pressure direction. The corresponding (condensed) energy turned out to be non-convex. We calculated a relaxed envelope via convexification and found that the corresponding minimizing microstructures consisted of three components: an elastic one and two located at the boundary points of the finite interval in pressure direction.

This result encouraged us to devise an evolution model for microstructure in the format introduced in [2]. For this purpose, we assume arbitrary volume fractions of the three components found before. It is then possible to derive in a natural way expressions for the free energy as a function of the volume fractions and for the dissipation potential as a function of the corresponding rates. Via a variational approach, it is then possible to derive evolution equations for the volume fractions. We demonstrate features of the developed model by presenting various numerical results.

[1] F. Behr, G. Dolzmann, K. Hackl, and G. Jezdan; Analytical and numerical relaxation results for models in soil mechanics; Continuum mechanics and thermodynamics, 35, 2019–2041, 2023

[2] D.M. Kochmann and K. Hackl; The evolution of laminates in finite crystal plasticity: a variational approach; In: Continuum mechanics and thermodynamics, 23, 63–85, 2011