Dimension reduction for elastoplastic rods and homogenization of elastoplastic lattices

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We derive effective equations for periodic lattices of linearly elastoplastic rods in the limit of both infinitesimal periodicity and infinitesimal relative width of the rods. For this derivation we use the method of evolutionary Γ-convergence for quadratic rate-independent systems.

As a first step towards that goal we derive effective equations for a single rod. After introducing appropriate scalings, the main difficulty lies in the proof of Γ-convergence for the stored energy. For the study of periodic lattices we then introduce the notion of periodic graph frameworks, discuss infinitesimal rigidity properties of such frameworks and define a simple notion of two-scale convergence. The stored energy of a lattice of rods ist just the sum of the energies of the individual rods, coupled by boundary conditions at the nodes. For this energy we again prove Γ-convergence. In the presence of volume loads we observe qualitatively different behaviour depending on the relative rate of convergence of the periodicity parameter and the thickness parameter.