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An isotropic higher order plasticity model - homogenization theory from meso to macro

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Classical plasticity models, being scale independent, cannot capture any size dependent behavior. One remedy is to adopt a gradient plasticity model at the (meso) granular scale. In this contribution, we adopt the (meso) isotropic gradient plasticity model by Gurtin (2004). For a typical engineering problem, however, it is computationally expensive to adopt the mesoscopic model since the discretization has to be done at a sub-granular level. This motivates a novel homogenization theory that translates the isotropic plasticity model from meso to macro. Due to the consistent scale transition, three length scale parameters – the intrinsic length scale, the grain size and the characteristic structural length scale – manifest themselves in the homogenized solutions. The close predictions between the homogenized solutions and those obtained from detailed mesoscopic analyses are illustrated.

Keywords: homogenization, gradient plasticity, higher order continuum, micromorphic continuum