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Nonlocal Constitutive Model for Impact Damage in Metals

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Classical continuum mechanics models of inelastic deformation processes are size scale independent. There is considerable experimental evidence that plastic flow and damage in materials is size-dependent. As soon as material failure dominates a deformation process, the material increasingly displays strain softening (localization) and the finite element computation is considerably affected by the mesh resolution and alignment and gives non-physical descriptions of the localized regions. Gradient-enhanced constitutive viscoplastic-viscodamage equations that include explicit and implicit micro-structural length scale measures are presented in this work. The governing equations are derived using a thermodynamically consistent formulation. Numerical simulations are performed to study the effect of including these material lengths on the dynamic localization of plastic flow in shear bands for impact-damage related problems. It is shown that the inherent material length scale predictions agree well with the width of the shear bands in ductile metals as compared to the experimental results.

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