Discrete Shear Transformation Zone Plasticity

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Plastic deformation generally occurs by a series of discrete events including for example, glide of dislocations between obstacles, deformation twinning or the atomic rearrangements known as shear transformation zones (STZs). A method for solving small strain plasticity problems with plastic deformation arising from the evolution of a collection of discrete carriers of plasticity is discussed. The focus will be on metallic glasses where the carriers of plastic deformation are STZs, modeled at the mesoscale as transforming Eshelby inclusions. At each instant, superposition is used to represent the boundary value problem solution in terms of a collection of Eshelby inclusions, which are given analytically for an infinite elastic medium, and an image solution that enforces the prescribed boundary conditions on the finite solid of interest. The image problem corresponds to a standard linear elastic boundary value problem. Constitutive relations are specified for the kinetics of the transformation. Various solutions are presented to illustrate the capabilities and potential of the framework. Particular attention will be given to analyses of notched and un-notched tensile bars. Computational issues will also be discussed.