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Localization analysis of a three-invariant plasticity model with combined isotropic/kinematic hardening

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Geomaterials exhibit a wide variety of complex behaviors that include dependence on pressure and triaxial stress state, Bauschinger effect, and porosity effects. These behaviors make prediction of localization difficult. The onset of localization can be determined by a loss of uniqueness in the stress response for a given strain variation, instability conditions that have been explored by a number of researchers. However, the complexity of the models needed to capture true geomaterial behavior make closed-form solutions difficult if not impossible to derive.

The Sandia Geomodel is a constitutive model that has been developed to capture the behavior of porous rocks, and includes the features mentioned above. Initial tests, though, suggest that the original, associative model predicts localization after observed results. The model is modified to account for nonassociative dilatational behavior that is well documented in geomaterials. To detect localization under complex and evolving stress states, a numerical scheme is developed for detecting localization for a general model. Based on earlier work of Ortiz and Wells and Sluys, the algorithm is adapted to account for nonsymmetries that result from nonassociativity and kinematic hardening. This algorithm is used to detect localization in three-dimensional tests. The effects of nonassociativity, third invariant, and other parameters on the onset and orientation of localized bands are explored.