# Localization Analysis for Granular Materials by using Micropolar Continua

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Granular materials, such as sands, consist of an aggregate of particles with different sizes and shapes which interact with each other through contact forces (both normal and tangential) at their points of contact. Considering the particles essentially incompressible, deformation of the granular assembly occurs as the particles translate, slip and/or roll, and either form or break contacts with neighboring particles to define a new microstructure. The result is an uneven distribution of contact forces and particle densities, and this microstructural deformation process manifests itself in the form of macroscopic material behavior such as "plastic" deformation, anisotropy, and localized deformation.

Shear banding in sands inherently exhibits a length scale, whether as the shear band width or a relation between shear band width and particle size. Thus, a length scale should be considered for numerical studies of shear banding in sands. In order to explain these effects, higher order terms such as moments that reflect the particle geometry may be incorporated which in turn leads to asymmetry of shear stress and micropolar (or Cosserat) effects. The importance of an internal length scale on constitutive modeling of granular materials will be analyzed computationally by comparing classical and Cosserat continua. The objective of this paper is to discuss the classical and micropolar approaches for localization analysis on granular materials.