STUDY OF STRAIN LOCALIZATION IN AN INTERPHASE SYSTEM SUBJECT TO QUASI-STATIC SHEAR

Jianfeng Wang, Marte S. Gutierrez and Joseph E. Dove

Department of Civil and Environmental Engineering
Virginia Tech
Blacksburg, VA 24060, USA

Strain localization is closely associated with the stress-strain behavior of an interphase system subject to quasi-static shear, especially after peak state is reached. In geotechnical engineering, many problems involve granular material in contact with manufactured surfaces. Therefore, understanding strain localization behavior is very important to the design of interphase systems as it is closely related to their stability. In the literature, while significant experimental and numerical investigations such as [1], [2] have been conducted on the shear banding of granular material, there is little work on the strain localization of an interphase system.

This paper presents a numerical study on the strain localization inside an idealized interphase system composed of densely-packed spherical particles in contact with rough manufactured surfaces using two-dimensional DEM simulations. The manufactured surface is made up of regular or irregular triangular asperities with varying slopes. A new simple method [3] of strain calculation, which employs a grid type discretization over the volume of whole assemblage is used in this study to generate strain field inside the interface shear box. The method calculates the displacements of each grid point by assigning each grid point to a particular particle. The new method is able to take into account the particle rotation and can capture the characteristics of strain localization more accurately than other methods.

Results show that strain localization initiates with the occurrence of nonlinear stress-strain behavior. During the initial period of shearing, deformation of the whole assemblage is in a pure shear mode. A distinct but discontinuous shear band emerges above the surface around peak state. Particles can be seen to be trapped inside the asperity valleys and travel along with them. The shear band develops fully into a thicker, continuous and uniform with post-peak strain softening at large shear displacement. It is found that the shear bands developed by surfaces with flatter asperity slopes are much thinner than those by surfaces with steeper asperity slopes. This is because the asperity with steeper slopes is capable of resisting more shear deformation and sustaining higher stress ratio. The thickness of the most intense shear zone is observed to be about 10 median particle diameters above the surface. However, a change of the shear band thickness is observed along the length of the shear band due to different degrees of boundary effects, with the maximum thickness occurring at the middle of the box. The orientation of the shear band is nearly horizontal in all the cases, resulting from the kinematic constraint of boundary movement.

References

[1] G. Scarpelli and D.M. Wood, “Experimental observations of shear band patterns in direct shear tests,” *Proc. IUTAM Conf. Deformation and Failure of Granular Materials*, August 1982, Delft, 472-484.

[2] N.R. Morgenstern and J.S. Tchalenko, “Microscopic structure in kaolin subjected to direct shear,” *Géotechnique*, **17**, No. 4, 309-328. (1967).

[3] J. Wang, J.E. Dove and M.S. Gutierrez, “Discrete-continuum analysis of shear banding in the direct shear test,” *Géotechnique* (2005, In review).

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