MATHEMATICAL ANALYSIS OF THE MICROMECHANICS OF SHEAR BANDS

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Recently reported micromechanically-based analyses on shear bands [1] in granular media offer several insights not available from those based on traditional continuum theories. Traditional theories identify conditions under which the governing equations become ill-posed, which often is interpreted as equivalent to a localization condition. However, these theories only provide a condition for non-uniqueness by which displacements fields are possible that correspond to localization. One of the most important features of micropolar models is the ability to extend the solution into the post bifurcation range and thus capture the localization of strains. When the micropolar model is derived from micromechanics, it has the added advantage of providing a link between mathematical analysis and experimental observation. The analysis is reviewed including specific observations on the role of rotational effects, shear band thickness and the effect of softening on its evolution, and the issue of continuity of coupled stress. Of particular interest is the role of softening on the post-bifurcation deformation. It is noted that softening can be related to dilation as a general behavior observable under uniform strain fields. However, in micropolar theories softening can emerge as a byproduct of localization, particularly for those mechanisms related to rotations. Thus, the apparent softening observed in experiments is much more pronounced when failure is dominated by shear banding compared to experiments where the strain is nearly homogeneous.

Many of the conclusions derived from the analyses are independent of the details of the micropolar model, but instead result from the form of the model. The micromechanical approach provides additional information on the evolution of shear band thickness, shear band inclination, effect of density, as well as statistics of contact force distribution [2]. The implications shear-band mechanics to micromechanically-based constitutive laws will be presented in a companion paper [3].

References

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Keywords: shear bands, bifurcation, micromechanics