PARAMETRIC SENSITIVITY OF STRAIN LOCALIZATION IN GRANULAR MATERIALS

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This paper presents a parametric analysis of the sensitivity of strain localization in granular soils to changes to in constitutive parameters. Strain localization is analyzed in terms of Vermeer's [3] compliance approach which is re-derived and generalized. A simple elastoplastic constitutive model for biaxial loading condition is introduced which adequately captures the monotonic response of granular soils particularly the variation of dilatancy and mobilized friction with shear deformation. Using the constitutive model, a strain localization criterion expressed in terms of constitutive parameters is developed. Both the model and the strain localization criterion are verified against experimental data.

The constitutive model and the strain localization criterion are shown to satisfactorily simulate the stress-strain response and predict the bifurcation points of Nevada and Hostun sands. For Nevada sand, satisfactory prediction of the shear band orientations were also made. For Hostun sand, the predicted shear band orientations were smaller than the measured values. The discrepancy in predicted and measured shear band orientations in Hostun sand is consistent with the observations by Desrues and Hammad [2], and Bardet [1] that shear band orientations in sand do not always obey existing analytical expressions for shear band orientation. The strain localization criterion was shown to adequately capture the effect of confining stress on the friction angle at localization and the shear band orientations, a phenomenon first observed in [2].

An advantage of linking the localization criterion directly to the constitutive parameters is that parametric analyses of the localization conditions can be made without full simulation of the stress-strain response. It was found that the ratio of the elastic to plastic shear modulus G/Gp, particularly for G/Gp>10, and the mean stress at bifurcation sB, particularly for sB>100 kPa, have the strongest effects on the friction angle at bifurcation. An increase in G results in more plastic deformation in relation to the elastic deformation and lowers the bifurcation friction angle. On the other hand, because hardening modulus h increases with the mean stress s, the mean stress was shown to have a stabilizing effect on the stress-strain response and an increase in mean or confining stress results in higher bifurcation friction angle. The mean stress at bifurcation sB depends on the stress path (in addition to the initial stresses), hence the bifurcation point is also stress path dependent particularly at low stress levels. It is noted that of the different parameters required in the model, the elastic shear modulus G is probably the most difficult to determine, yet in combination with the plastic shear modulus Gp, the elastic modulus has a strong influence on the bifurcation point.

References

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