MODELING SAND BEHAVIOR UNDER NONPROPORTIONAL LOADING

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Recent decades have seen extensive developments of constitutive models for soils. A majority of these models were based on incremental or flow plasticity concept. They were designed and validated for specific stress paths, for example, conventional triaxial compression and were not validated for or made useful for other loading paths, which clearly occur in general boundary value problems of geotechnical engineering and soil-structure interaction [1].

A constitutive model within the framework of fuzzy set plasticity [3] was developed to account for the soil response under nonproportional loading. Its cone fuzzy surface is a three-stress-invariant function in stress space. An ellipitical function, proposed by Willam and Warnke [4], is adopted and considered as the third deviatoric stress invariant in the cone fuzzy surface. It is a function of the Lode angle θ and the elliptically χ, which controls the shape of the cone fuzzy surface in deviatoric stress space. The effect of nonproportional loading, ranging from compression to extension, is captured by varying the Lode angle. The ellipticity is also dependent of effective mean confining stress, which is anticipated that the deviatoric trace of the cone fuzzy surface will become almost circular for large values of the mean confining stress. For low mean confining stress levels, the trace degenerates to a triangle. Four typical stress paths, 0°, 20°, 33°, and 45° principal stress rotations, in directional shear cell (DSC) tests [2] were chosen to validate the model response on nonproportional loading and principal stress rotation.

References

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