The Yield Behavior of Leighton Buzzard Sand in a Hollow Cylinder Apparatus

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Introduction

The yield behavior of Leighton Buzzard sand was studied under generalized stress conditions using a hollow cylinder apparatus. Segments of yield surfaces were determined from identically prepared, hollow cylindrical test specimens of the sand.

The experimental yield data was compared with the theoretical values predicted by the Mohr-Coulomb, Matsuoka-Nakai and Lade yield criteria to establish whether these criteria are suitable for predicting the onset of yielding in sand under generalized stress conditions.

Yield Criteria

Mohr-Coulomb

$$\frac{\sigma'_1 - \sigma'_3}{\sigma'_1 + \sigma'_3} = \text{Constant}$$

Matsuoka-Nakai

$$\frac{J_1 J_2}{J_3} = \text{Constant}$$

Lade

$$\frac{J_1^3}{J_3} = \text{Constant}$$

where J_1 , J_2 and J_3 are the first, second and third effective stress invariants, respectively

Leighton Buzzard Sand

Property	Coefficient of uniformity	Coefficient of curvature	Mean particle diameter D_{50} (mm)	Specific gravity	Maximum void ratio	Minimum void ratio
Value	1.32	0.96	0.52	2.64	0.77	0.50

Stress and deformation in the hollow cylindrical test specimens

Applied tractions

Sample normal stresses

Specimen dimensions and deformations measured

Principal stresses

Typical stress path followed

Stress-strain responses of test specimen Y0530

Variation of the deviator stress at yield in generalized stress space

Experimental data expressed in terms of the Mohr-Coulomb, Lade and Matsuoka-Nakai yield criteria

Conclusions

The following points are concluded from this study of yielding in Leighton Buzzard sand:

1. The stress paths successfully identify segments of different yield surfaces in generalized stress space from identically prepared test specimens using a hollow cylinder apparatus.
2. The magnitude of the deviator stress at yield was dependent on the initial value of the b parameter, but was largely independent of the magnitude of the rotation of the major principal stress.
3. The Matsuoka-Nakai and Lade yield criteria were both found to adequately predict the onset of yielding under generalized stress conditions.
4. The Mohr-Coulomb yield criteria generally deviated more from the theoretical values than the other two criteria examined and did not appear to follow a consistent pattern.
5. The experimental yield surfaces indicate that the prediction of yielding by all three criteria is predominately independent of the magnitude of the rotation of the major principal stress during the initial consolidation stage.