DR2008237

Title: **Contraction-driven shear failure in compacting uncemented sediments**

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Additional information on Numerical and experimental procedures

Finite Element Model Study (Figure 1). The numerical finite element simulation employed a frictional constitutive model to capture the behavior of uncemented particulate sediments:

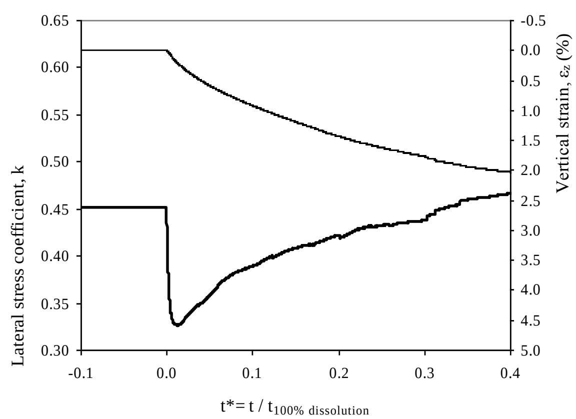
- Drucker-Prager model with non-associated flow rule (Desai and Siriwardane, 1984).
- Mesh: 100x100 plane strain 8-node elements.
- Boundaries: constant vertical stress on upper and lower boundaries, no friction against any boundary, zero lateral strain condition.
- Parameters $\sigma_z/E = 10^{-3}$, Poisson's ratio $\nu=0.3$, friction angle $\varphi=30^\circ$.

Experimental Study (Figure 2).

- <u>Mixture</u>: insoluble grains (round glass beads, mean grain size 0.7 mm) and soluble salt grains (NaCl, mean grain size 0.3 mm)
- <u>Cell</u>: The saturated mixture was placed inside a calibrated zero lateral strain oedometer cell instrumented with strain gauges to measure the horizontal stress (Cell diameter: 66 mm. Specimen height: ~40 mm. Wall designed for a radial strain < 0.005%, according to observations in Okochi and Tatsuoka, 1984. Instrumentation: 2 strain gages are bonded at the mid-height of the cell and 2 dummy gages are included for temperature compensation. The evolution of vertical strain monitored using an LVDT).
- <u>Procedure</u>: Homogeneously mixed in NaCl brine. The granular mixture was allowed to reach chemo-mechanical equilibrium under an applied nominal load (constant vertical effective stress: σ_z=40 kPa). Then, the fluid concentration was gradually decreased during advective flow to cause the controlled dissolution of the salt grains and minimal thermal changes.
- <u>Scope</u>: A total of 20 tests were conducted with near-identical boundary conditions but for varying mass fractions of salt m_{salt} (5% to 20%).

Discrete Element Model Study (Figure 3). Arrangement of discrete particles satisfying Newtonian equations (Cundall and Strack 1979). Results shown in Figure 3:

- Software: PFC-2D
- Arrangement: 2D packing of 9999 disks
- Grain Properties: particle diameter ≈ 1/100 of the domain height, coefficient of variation in particle diameter =0.25. interparticle friction =0.5, hindered particle rotation, vertical stress/particle stiffness: 10^{-3}.
- Boundaries: constant vertical load imposed, zero lateral strain boundaries, particle-to-wall friction=0.5.
- Simulation: the diameter of 20% of the particles -randomly selected- is gradually reduced while keeping boundary conditions constant
- Procedure - Time: The time step in the numerical simulation is selected to allow for numerical stability. Dissolvable particles are gradually reduced in size in 50,000 equal steps; at each dissolution step, the vertical plate displacement is servo-controlled to maintain constant vertical stress and force equilibrium. Deformation and k-data in Figure 3 are shown bellow versus time normalized by the time for complete particle dissolution $t_{100\%}$.



Finite Element Model Study (Figure 4).

- Drucker-Prager frictional model with non-associated flow rule (Desai and Siriwardane, 1984).
- Mesh: 140x70 plane strain 8-node elements.
- Boundaries: constant vertical stress on upper and lower boundaries, no friction against any boundary, zero lateral strain condition.
- Parameters: $\sigma_z/E= 10^{-3}$, $\varepsilon_v E/\sigma_z=1.15$, Poisson's ratio $\nu=0.3$

- Facilitate Nucleation: Correlated random field for volume contraction (coefficient of variation 20%; correlation length=20% of the model height, as in Kim and Santamarina, 2008; methodology for correlated random field generation in El-Kadi and Williams, 2000)
- Figure 4A: perfectly plastic medium $\varphi_{residual}=\varphi_{peak}$.
- Figure 4B: post-peak strength softening medium $\varphi_{peak}=30^{\circ}$, $\varphi_{residual}=10^{\circ}$, softening modulus h/E=-0.05

Additional References Cited

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