Computational Geomechanics

Micro-inspired continuum modeling using virtual experiments

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Our Plan



PEER Researchers' Workshop

Grain Scale



LS-DEM in Brief

- Level set discrete element method (LS-DEM), a DEM variant
- Level set functions as geometric basis
- Arbitrary shape in particular, those used in experiments
- Computationally inexpensive and parallel
- Able to simulate specimen of 54,000 grains (pictured)



LSDEM Results



LS-DEM Results: Meso Shear Strains



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LS-DEM Results: Grain Rotations



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Cyclic Loading

Cycles of triaxial compression and extension



Cyclic Loading

Necking occurs at high amounts of extension, also seen experimentally



Cyclic Loading

Necking occurs at high amounts of extension, also seen experimentally



Micro-inspired Constitutive Models



Calvetti, Viggiani, Tamagnini 2002



Figure 5. a) Stress probes: IC/E = isotropic compression/expansion, TC/E = "triaxial" (axi-symmetric) compression/extension; DC/E – purely deviatoric compression/extension. b) Representative RE to stress probes (total strain increment, initial state of stress B).





Figure 3.6 Results of rectilinear compression paths in the deviatoric stress plane. Arrows indicate the direction of plastic strem rate at failure (tan Φ₁ = 0.35; k₂ = 100 kN/m; k₃ = 25 kN/m).

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Stress Probing Overview

Program:

- Pluviation
- Load to State A
- Probing at State A
- Load to State B
- Probing at State B
- Load to State C then back to B
- Probing at State B once more

Grains







Details of specimens:

- Grains are hostun sand taken from XRCT
- Each sphere has same volume as respective grain
- Void ratio = 0.6 for both specimens
- 18953 Grains
- 16981 Spheres



Pluviation

Virtual Pluviation Example:



State B'





Volumetric and Deviatoric Strians

State B':



Future Work



Computational Geomechanics

Thank You!