DISTINCT ELEMENT ANALYSIS OF EARTHQUAKE SURFACE FAULT RUPTURE THROUGH GRANULAR MEDIA

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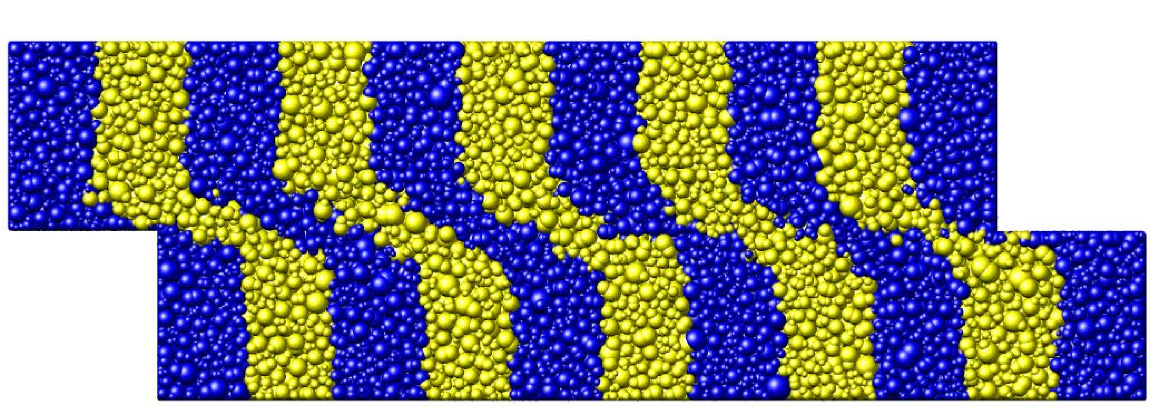
1. Overview

Drained failures of dilatant granular soils often involve the localization of shear strains in a thin shear band. The formation of shear bands in nature has important implications for geologic hazards including earthquake surface fault rupture. The distinct element method (DEM) is well-suited for shear rupture in boundary displacement problems due to its inherent capability of capturing the large shear strain response of particulate media. This research utilizes 3D DEM to capture the shear rupture process in boundary displacement problems with direct application to earthquake surface fault rupture.

Above: Recent example of earthquake surface fault rupture from the 2016 Kaikoura Earthquake (from NSF-sponsored QuakeCoRE-GEER-EERI Earthquake Reconnaissance Report: M7.8 Kaikoura, New Zealand Earthquake on November 14, 2016).

2. Research Objectives

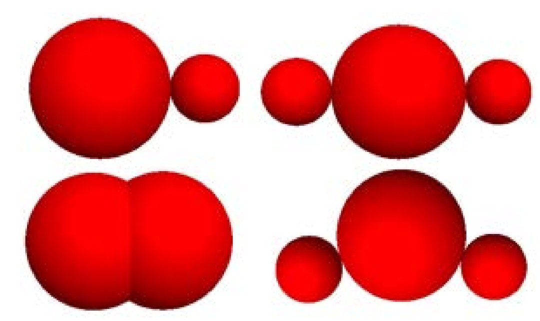
- Develop a procedure for characterizing analogue soil particles in shear (below).

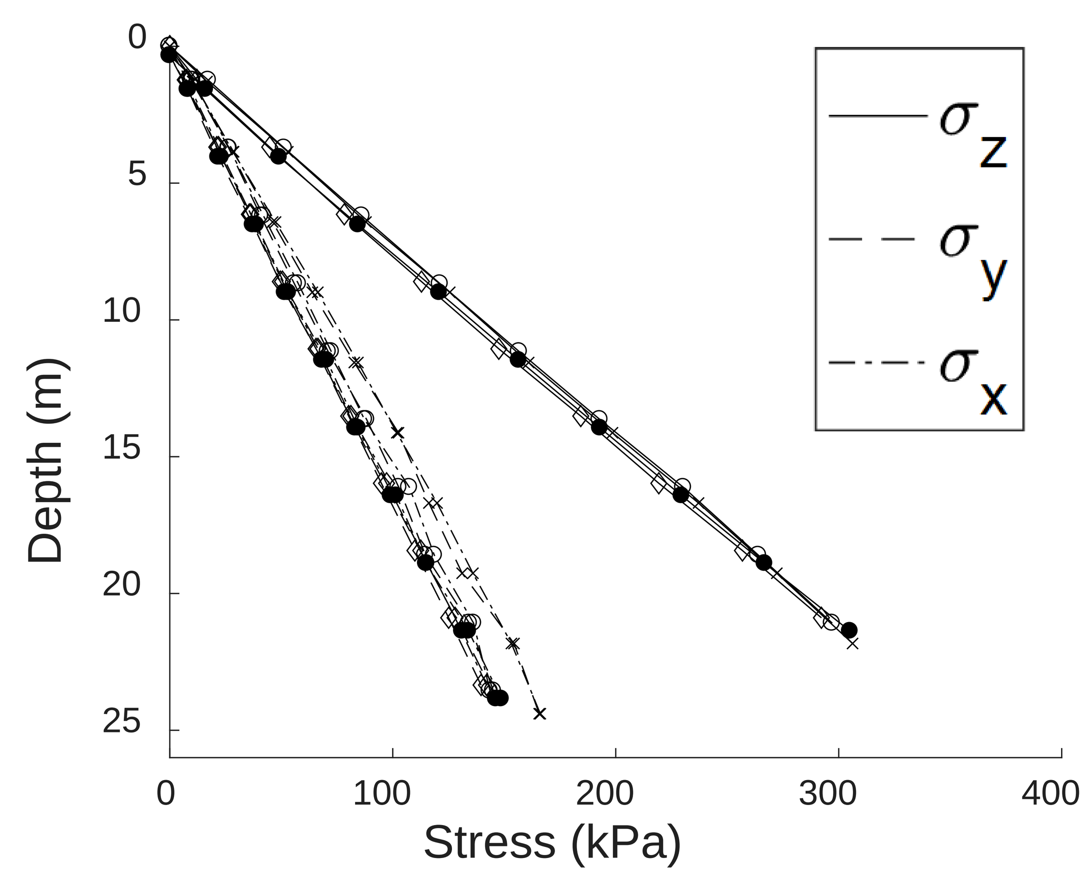


- Perform and analyze 3D DEM simulations of surface fault rupture through dilatant and contractive granular media.
- Explore the application of DEM towards analyses of fault-rupture soil-foundation-structure-interaction.

3. Model Preparation

Below: Stress distributions for 3D assemblies of non-spherical particles (shown right).

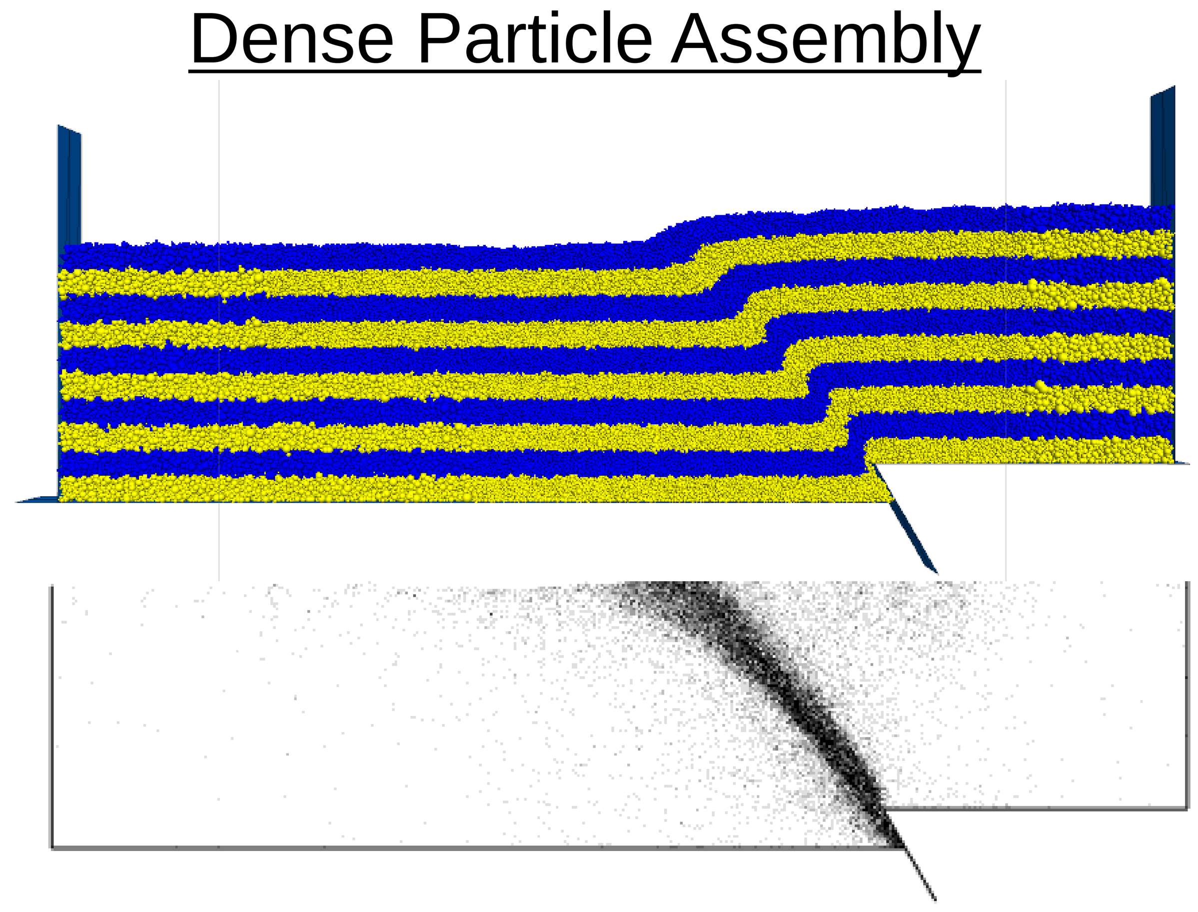




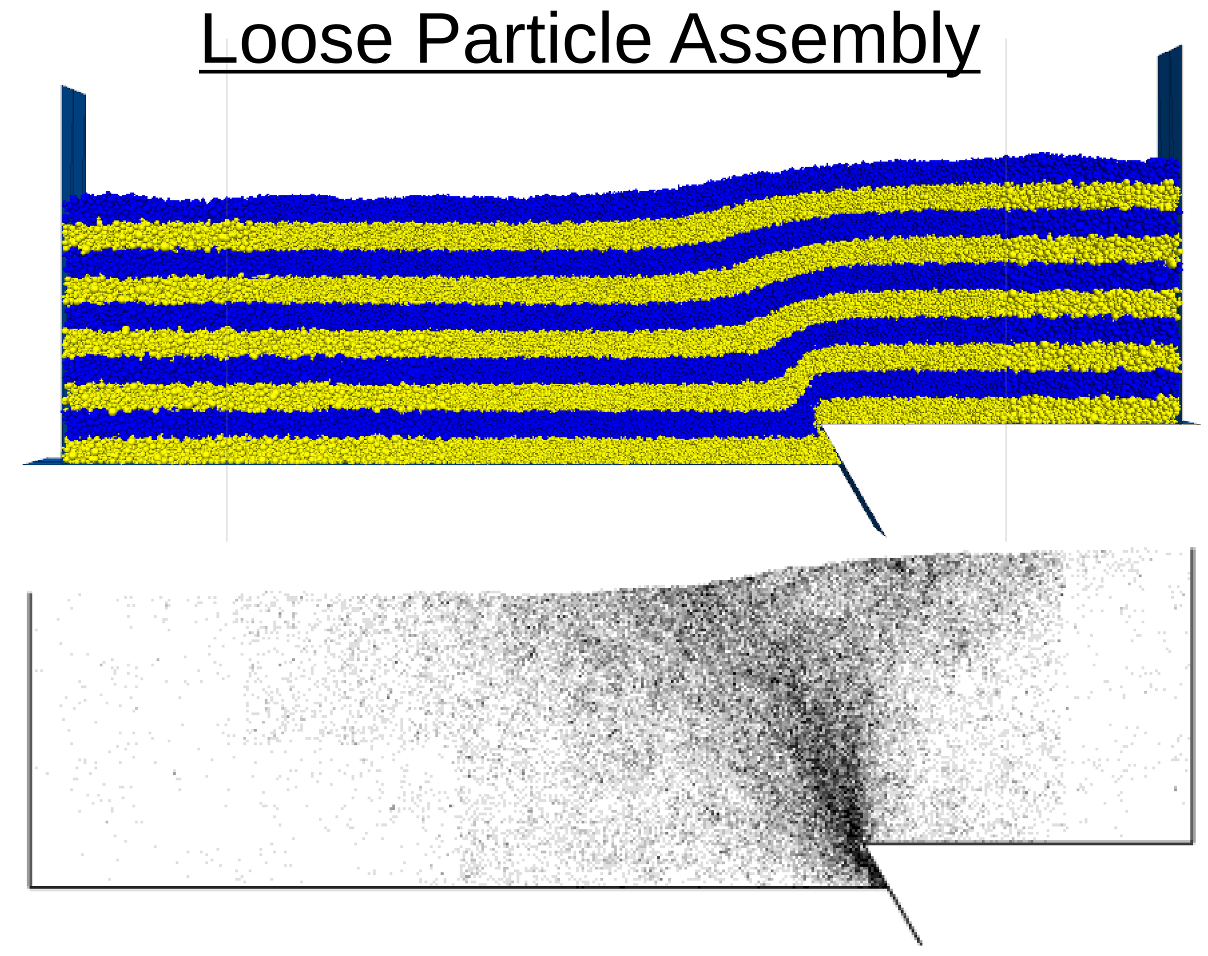
4. Reverse Fault Rupture

Below: Zones of shear are effectively delineated using magnitudes of particle rotations.

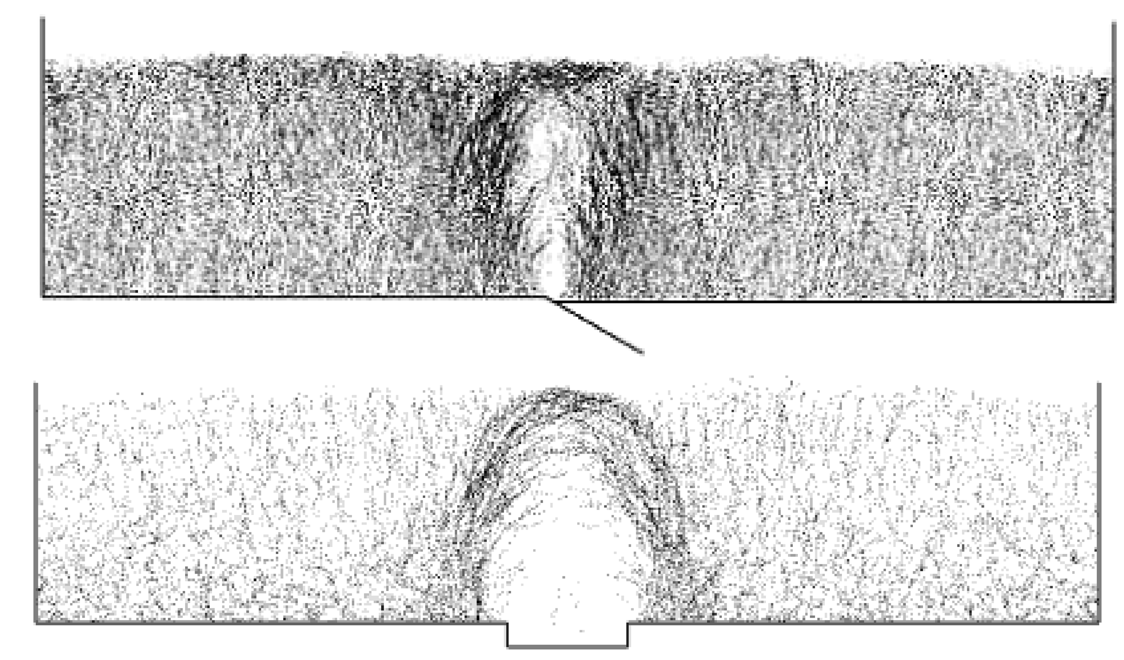
Dense Particle Assembly



Loose Particle Assembly

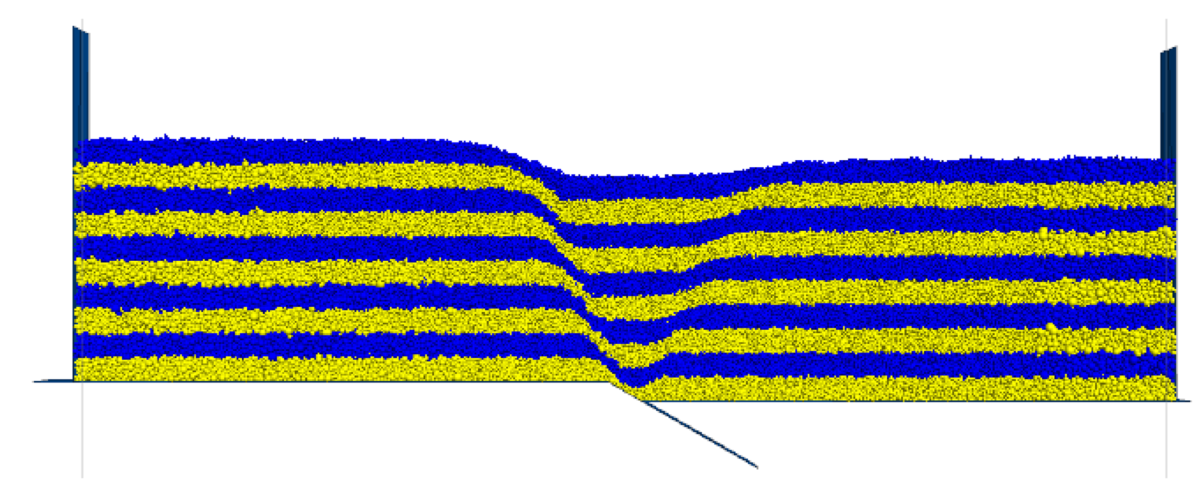


5. Normal Fault Rupture

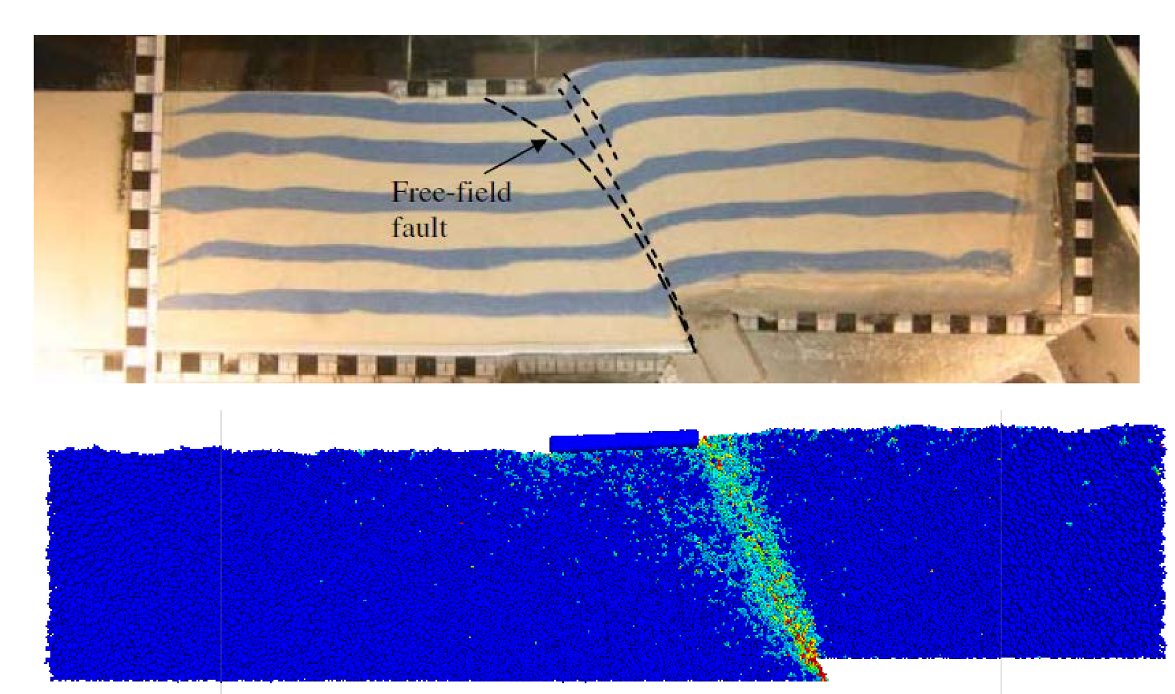


Above: Distribution of strong contact forces showing the stress arching phenomenon during shallow normal fault rupture (upper) and trapdoor displacement (lower).

Below: Formation of a graben between primary and secondary rupture planes.



6. On-Going Research



Above: Rupture plane deflection in the presence of a rigid foundation in centrifuge experiments by Bransby et al. (2008) and DEM simulations from this study.

Further work is in progress on the application of high-performance computing to analyses of surface fault rupture.

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