Research Project Highlight

DEM Modeling of the Influence of Depositional Fabric on the Mechanical Properties of Granular Sediments using XRT Data

TSRP Topic G3 - Constitutive Modeling

Principal Investigator
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Research Team
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Start-End Dates:
8/1/2019-7/31/2020

Abstract
The goal of this project is to use computed X-ray Tomography (XRT) to characterize the 3-D fabric of naturally deposited sands and to observe deformation characteristics in triaxial compression. This data will then be used to drive discrete element method (DEM) modeling of micromechanical properties of naturally deposited sands in order to observe the role of fabric in the development of shear zones and its effect on the deformation properties of the material. The specific objectives are:

1) Use computed X-Ray tomography to observe shear zone formation in undisturbed samples of sand from at least 2 different environments in order to contrast their behavior with previous work on samples pluviated in the laboratory.
2) Develop a realistic mathematical description of the fabric and then use DEM to model the micro-mechanical behavior of these materials in order to advance the state of the art toward more realistic multi-scale constitutive models for the response of sedimentary deposits under different types of loading.

Deliverables
Deliverables will consist of a PEER report, participation at PEER meetings, a paper and a conference presentation. In addition, all software developed as a part of this project will be archived at PEER and available as open source.

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Research Impact

This research effort represents initial investment in a major research thrust to accurately characterize the fabric of natural deposits and to use these results to develop mechanistic based models of granular deposits using massively parallel DEM codes. Specifically, the role of depositional environment is currently not being taken into account in typical field characterization of potentially liquefiable deposits even though the differences in observed site response due to the different origin of the materials have been addressed extensively in recent research. Similarly, due to the lack of data, to-date the natural fabric of the granular deposits, sands in this case, has not been modeled either by DEM or by using an appropriately configured constitutive model using continuum representations, e.g. finite element method (FEM) or material point method (MPM). Our preliminary results from trial scans show that due to the intimate contact and packing of particles, naturally deposited sands exhibit much high mobilized friction angle at low confining pressures than either hydraulic fill or pluviated samples used in most of the studies to date. We expect that our work will show that there is a significant difference between reconstituted and naturally occurring deposits that has a significant impact on their behavior under both static and cyclic loading. Most importantly, the results of the experimental work will allow the development of higher fidelity representations in DEM simulations and allow for development of more accurate and representative parameters for constitutive models used in continuum simulations.

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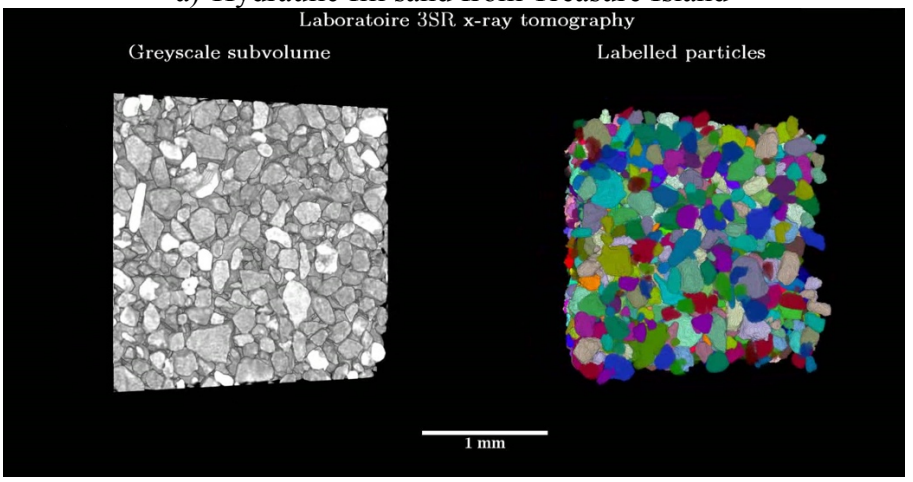
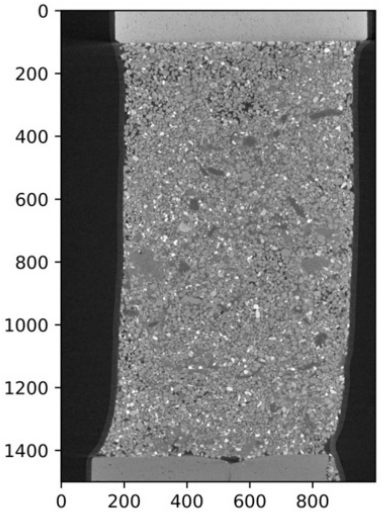
Figure 1. X-Ray Tomography Scans of Fine Sand Fabric

a) Hydraulic fill sand from Treasure Island



b) Deformed sample in a miniature (11 mm dia) triaxial test



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