Title: Understanding Ant Tunneling Soil Mechanics

Center: ERC for Bio-mediated and Bio-inspired Geotechnics (CBBG)

Achievement Date: 2016

Outcome/Accomplishment:

Initial results from Discrete Element Modelling (DEM) simulations are that the presence of multiple cavities in ant hill structures reduce the size of force chains (particles deemed critical to supporting surrounding soil particles) in the vicinity of the openings and that more stable structures exist when multiple large cavities are present. A comparison of force chain plots for a single versus double cavity is shown in Figure 1.

Impact and Benefit:

It has been estimated that ants use less than 0.1% of the energy that the most advanced human tunneling machines do to excavate the same volume of soil. Insights into ant tunneling activities have been gleaned from both observing their behavior while tunneling as well as studying the characteristics of castings of the ant hill structures they create.

Explanation and Background:

It is believed that ants are able to use comparatively little energy for tunneling because they perform their tunneling activities using a variety of approaches. These approaches seem to minimize the amount of energy expended at each step including tunneling around obstacles, not removing particles that are deemed critical to supporting the surrounding soil particles (particles that are part of primary force chains) and creating clumps of several smaller particles as appropriate before removing them from the tunnel. An image with a “harvester-ant” nest casting is shown in Figure 2.

In the current study, DEM simulations are being used to model and analyze the effects of soil arching on cavity stability within granular media. To construct the model, 10,000 particles were poured inside a rectangular container. Particles were randomly generated and their size varied. Once the assembly reached a state of equilibrium after the pouring process, bonds were created between at particle contacts in order to simulate capillary forces that allowed for the creation of stable cavities of different sizes. On-going studies are investigating the topology of ant hill structures and in particular, the geometrical configuration of the larger open structures which appear to be spaced apart by approximately equal distances.