How large is an elastic regime in granular material packings?

B.Sc or M.Sc. Thesis Project

Goal: To study the dependence of the elastic and plastic moduli on particle properties in closely packed, dense granular systems by means of small perturbations.

Motivation: In our daily life, we are surrounded by granular materials like soil, coffee, sand, nuts, etc. These constitute over 75% of raw materials feedstock in industry, including pharmaceutical, mining, agriculture, chemical, biotechnological, textile. Many industrial systems display unpredictable behavior during processing, storage and transport. This gives rise to considerable challenges for the design and operation of unit-processes and plants, other in soil mechanics, material science and physics applications. Because of its discreteness and disorder at the microscopic scale, it is necessary to employ a multi-scale approach which can link the kinematics of small scale to a continuum description (Fig.1). The Discrete Element Method (DEM) is a new, powerful tool to help us to get a better understanding, by modeling the motion line of the simple particles.

In this research, polydisperse packings of non-frictional, frictional and cohesive particles are modeled by using DEM (Fig.2), to investigate the size of the reversible (elastic) regime of the granular assembly. To understand the influence and role of particle properties, at the micro level of the interactions between two particles, for the macro properties will be the main focus here.

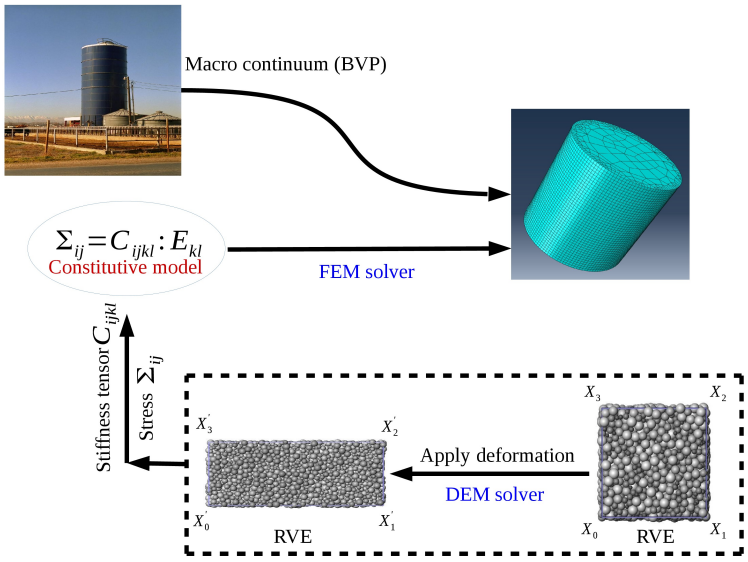

Figure 1: Multi-scale approach.

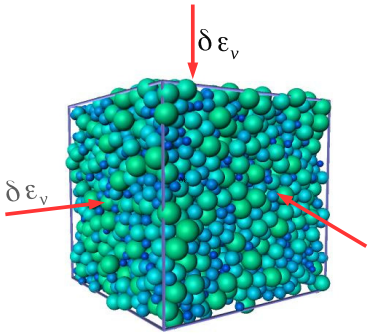

Figure 2: Small isotropic perturbation.

Agenda:

- Literature review, research plan and questions
- Sample preparation and testing procedures
- Calculating the elastic moduli of the granular assembly, isotropic vs. deviatoric
- Understanding the connection of the elastic moduli of granular materials to micro-scale particle properties
- Discussions, presentations and writing thesis (i.e, a scientific paper)

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