M.Sc. Thesis Project

Wave propagation in clays: Physical experiments and particle simulations

Multiscale Mechanics (Utwente) and Strathclyde University (UK)

Background: Clay soils, when subjected to wave propagation laboratory experiments involving different saturation fluids or PH levels, show an anomalous behavior that cannot be explained by classical continuum theories. The development of physically meaningful mathematical models for describing the engineering behaviour of clays requires an understanding at the particle level. This is a great challenge due to the small size of the constituent particles and the many interactions involved. Among the three most important interparticle forces, the mechanical force and the double-layer repulsive force play key roles in the macroscopic behavior of these materials.

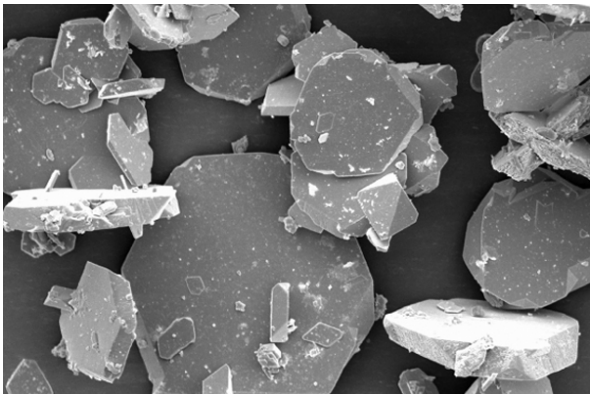

Figure 1: SEM image of clay particles.

Main Goal: The research will focus on P-wave propagation in clay packings subjected to uniaxial compressions, comparing numerical simulations and laboratory experiments.

Method: A particle-level numerical simulation technique known as the Discrete Element Method (DEM) could be used for developing such an understanding for clays. The numerical method is state of the art in the MSM group, where the algorithm has been recently adapted to reproduce elementary clay particles. Numerical results can reveal certain other aspects of the behaviour of clays that are diffcult to observe by regular laboratory means (e.g. evolution of interparticle contacts, anisotropy and size of particle clusters), thus providing new information on the behaviour of clays. By means of DEM simulation of wave propagation we aim to "follow" the wave path along force chains formed by particles.

Plan: The thesis project will include:

1. optimization of the numerical method for the micromechanical description of clays;
2. simulation of uniaxial compression of clays and wave propagation along the deformation path;
3. comparison with existing experiments of wave propagation of clays in different fluids and environments (PH);
4. study of the micromechanics of the samples during compression.

The M.Sc project will be run in collaboration with a partner research in Strathclyde University, Glasgow (UK), where the laboratory experiments are carried out. The project will include an internship in Strathclyde in order to perform complementary experiments. The experimental plan and the actual length of the internship will be arranged with the M.Sc candidate and the partner universities.

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