

Stabilizing Quicksand – Simulations

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Motivation

The ground in Norway is rich in clay, a natural sheet-like crystalline mineral that is held together via ionic bonds. Thousands of years ago the land was under saline sea water stabilizing this clay-rich ground mainly via a combination of electrostatic and van der Waals forces. Today, when exposed to rain or an earthquake the force balance is disturbed, causing massive landslides or the 'drowning' of buildings like the Tasmanian devil in the figure above¹. Build roads and constructions in a save way require the use of large quantities of cements which is bad for the environment. We want to explore new, sustainable ways to achieve the stability of ground.

Your Project

In this project the student will first develop a Molecular Dynamics model of two clay surfaces interacting with each other across an aqueous layer^{2,3}, using the software package LAMMPS. The challenge will be finding the appropriate force fields to realistically reflect the interactions between the particles. In a second step we will explore how these interactions can be modified by the presence of various salts or other natural materials such as plant or bacterial based bio-polymers⁴.

Requirements

Background in Soft Matter physics would be advantageous. We would like an applicant who is interested in numerical model.

Other aspects

The main supervisor will be the Associate Professor Cabriolu, expert in molecular simulation studies of condensed, soft matter and yield-stress fluids. The project is in collaboration with Prof. Eiser, whose is an experimental expert in the rheology of self-assembling DNA systems and soft matter, and with Prof. De Wijn, whose is an expert in theory and modelling analytical of tribology and surface science.

- [1] A. Khaldoun, E. Eiser, G. Wegdam, D. Bonn, 'Liquefaction of quicksand under stress' *Nature* **437**, 635 (2005)
- [2] B. Ruzicka et al. 'Observation of empty liquids and equilibrium gels in a colloidal clay' *Nature Materials* **10**, 56 (2011)
- [3] P. Bacle et al., 'Modeling the transport of water and ionic tracers in a micrometric clay sample' *Applied Clay Science* **123**, 18 (2016)
- [4] P. Xu, T. Erdem, E. Eiser, 'A Facile Approach to Prepare Self-Assembled, Nacre-Inspired Clay/Polymer Nano-Composites', *Soft Matter* **16**, 3385 (2020)