BSc Thesis proposal:

Study of Freezing and Thawing processes in granular soils

Background

The proposed experimental project aims to investigate the response of soil samples under induced freezing and thawing cycles. The water and the ice formation during freezing determines the overall hydro-mechanical behaviour of the soil and more in general of a porous medium.
When soil temperature falls below 0°C, the pore liquid water changes phase turning into ice. The freezing process generally implies an expansion of the soil element due to: (i) the lower density of the ice and (ii) the pore water migration towards the frozen front. Previous studies revealed irreversible effects due to the increase of fissures in fine grained soils, and the increase of permeability.

Aim

A deeper understanding of the soil volumetric response under controlled freezing and thawing paths would contribute to predict and prevent instability of earth (infra-)structures, such as embankment damages, uplift or subsidence.
Such phenomena are common in permafrost regions associated with frost heave or areas subjected to artificial ground freezing.

The goal of this project will be understanding:
(i) How a porous media behaves under continuous cycles of freezing and thawing.
(ii) How does the microstructure of soil and ice evolve?

Method

Experimental research within the Soil Micro Mechanics Chair @ University of Twente (NL).
The student will be performing experimental campaigns aimed to study:
1) Effect of pores distribution, mean and average pores.
2) Variation of temperature during the cycles, Tmax and Tmin to see different behaviours in the process.
3) Importance of time intervals in between freezing and thawing steps.
A combination of x-ray computed tomography, high resolution cameras and thermocameras will be used to quantify the 4D (3D + time) microstructure deformation, variation of the water front, formation of ice lenses.

Contact people

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Figure 1: Scan to see the thawing of a silty sand.

Figure 2: Scan to see the ice front formation of a silty sand.