

Thesis proposal:

Study of Freezing and Thawing processes in granular soils

Background

The proposed experimental project aims to investigate the response of saturated soil samples under induced freezing and thawing cycles. The phase change of the pore liquid water into ice upon freezing temperatures (below 0°C) significantly affects the overall hydro-mechanical behaviour of the soil. The freezing process results in the soil element's expansion due to the ice's lower density and the pore water migration towards the frozen front. The reverse thawing process rarely recovers the initial unfrozen state due to the alteration in the microstructure that occurs during the freezing phase. Previous studies have revealed that the significance of these volumetric effects is primarily influenced by the fine content and the water availability.

Aim

A deeper understanding of the soil volumetric response under controlled freezing and thawing paths would contribute to predicting and preventing instability of earth (infra-)structures, uplift or subsidence. Such phenomena are common in permafrost regions or areas subjected to artificial ground freezing.

The goal of this project will be to:

- (i) Characterise different mixtures of sand with clay
- (ii) Understand how the mixtures behave under freezing and thawing cycles.
- (iii) Compare the results obtained with those derived from 3D image reconstructions from x-ray tomography.

Method

Experimental research within the Soil Micro Mechanics Chair @ University of Twente (NL).

The student will conduct experiments with the following objectives:

- 1) Characterise mixtures of sand with different clay percentages in terms of maximum and minimum void ratios, repose friction angle, and grain size distribution.
- 2) Design the experimental campaign (sample features, test duration, and monitoring program).
- 3) Prepare the samples and conduct tests involving cycles of freezing (within the freezer) and thawing (at room temperature) cycles.
- 4) Compare and interpret the results obtained with 4D images (3D + time) results upon simple image processing procedures.

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.