Master Thesis

Topic:

Experimental and numerical investigations on ice lens formation in frozen soils

Introduction:

Ground freezing is a construction technique that has been used for over 150 years in engineering applications to temporarily increase the stiffness and strength of the subsoil and to provide protection against ground water flow. A major risk of ground freezing is related to the change of the pore volume and the associated soil deformations that can be induced by pore water freezing and thawing. The volume changes and hence deformations have two different sources: First, the increase of the volume of the frozen water in comparison to the unfrozen water and second, the formation of ice lenses during freezing. The formation and propagation of ice lenses is a complex physical phenomenon, which is until now not understood in order to simulate and predict deformations from soil freezing. The formation of ice lenses is investigated by experiments since decades. Multiple influencing parameters such as the soil type, density, permeability and pressure as well as the temperature gradient and the time dependent change of the temperature gradient were identified. Still, models can only describe the processes independently and for a rather limited variation of the boundary conditions. Moreover, it is already known that contributing processes are highly coupled and as well regarding experimental works more effort needs to be taken to create data from specially-adopted tests under well controlled parameters looking at largely varying scales.

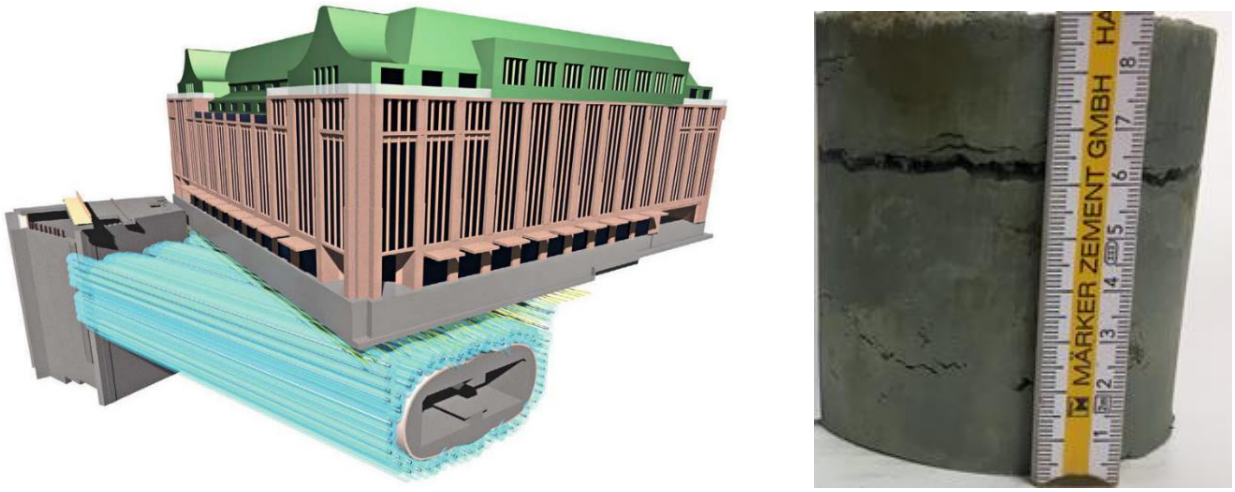

Figure: Planning of a soil stabilization by soil freezing during tunneling (left), soil sample illustrating the formation of a ice lens (right)

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Scope of work:

- Literature review of the existing experimental and numerical investigations on the behaviour during soil freezing (measurement data from field and laboratory tests from case studies and fundamental research, prediction and back-calculation of soil freezing)
- To conduct laboratory tests for the investigation of ice lens formation in silt and fine sand including temperature measurement with high spatial resolution under varying boundary conditions as given by stress and temperature gradient
- Evaluation and interpretation of the freezing tests in the context of know theories by analytical and empirical methods

Prerequisites:

Conducting state of the art laboratory tests at outstanding reliability.

Issued to:

Date of issue:

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