

Bayesian learning of random soil properties for slope reliability assessment of quick clay sites

Background

Landslide in quick clay is a serious problem threatening lives and critical infrastructure in many countries (Norway, Sweden, Finland, Canada and Alaska). Hence, the proper characterization of quick clay sites is essential for ensuring the safety and resilience of infrastructure.

The goal of this project is to develop a methodology that employs ERT (electrical resistivity tomography) survey and other data from geotechnical ground investigation to estimate the slope reliability of quick clay sites. ERT is an innovative non-intrusive geophysical technique for geotechnical site characterization (see Figure 1). Data from the quick clay geotest site in Tiller closed to Trondheim, Norway (managed by the Norwegian Geotechnical Institute) will be used to model the spatial distribution of the soil resistivity through a random field modeling approach. The model will be subsequently used to assess the influence of uncertainty on the reliability associated with retrogressive slope failure at sensitive clay sites.

Previous knowledge expected

We expect that the student has background on probability theory, e.g., through successful completion of one of the following courses offered by the Engineering Risk Analysis Group: Risk Analysis, Stochastic Finite Element Methods, Estimation of Rare Events and Failure Probabilities. Good command of either Matlab or Python will certainly prove helpful in this project.

Objectives and methods

The objectives of the proposed master thesis are as follows:

- Analyze a set of ERT profiles (such as the one shown in Fig. 1) to construct a random field model of the soil resistivity at the quick clay geotest site. The random field model will be constructed through application of a novel Gaussian process regression approach that employs Bayesian analysis, developed in ref. [1].
- The random field model, identified in the first step, will be further used to conduct reliability analyses for estimating the probability of retrogressive slope failure in quick clay slopes. Reliability analysis will be performed by, for example, Monte Carlo simulation methods.

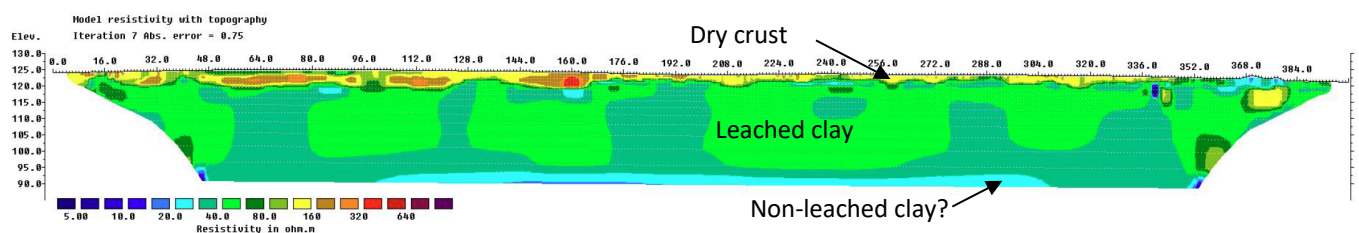


Figure 1. Example of soil characterisation from ERT from survey at the Tiller-Flotten site in Norway.



Technische Universität München

This project will be conducted in collaboration with the Norwegian Geotechnical Institute and the student will be funded to travel for a short visit to Norway for the first part of the project.

Supervised by:

Iason Papaioannou (iason.papaioannou@tum.de), Engineering Risk Analysis Group, TUM

Thi Minh Hue Le (thi.le@ngi.no), Norwegian Geotechnical Institute



Ingenieursfakultät Bau Geo Umwelt
Engineering Risk Analysis Group
Prof. Dr. Daniel Straub

References

[1] Geyer, S., Papaioannou, I., & Straub, D. (2021). Bayesian analysis of hierarchical random fields for material modeling. Probabilistic Engineering Mechanics, 66, 103167.