Study of the thermal dissipation of heat-emitting buried systems: Application to high-voltage cables or pipelines

Supervisor: Bertrand François (Bertrand.francois@ulb.ac.be)

Industrial collaboration: Fugro Geoconsulting (Belgium), J-F. Wintgens

Contact person: Bertrand François (Bertrand.francois@ulb.ac.be)

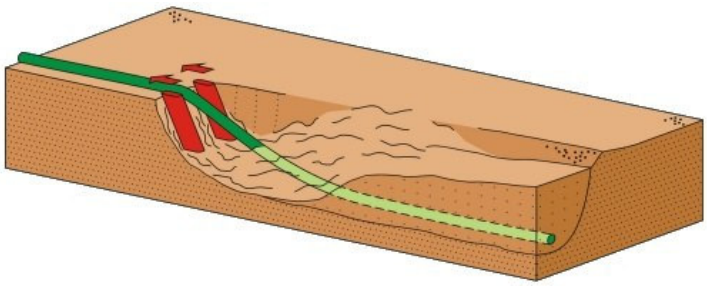
Working language: English/ French

Student profile: Civil Engineering

Prerequisites/special skills: An interest in experimental work and numerical modeling in relation with soil behaviour and thermal transfer

Summary: Due to its relatively low thermal diffusivity, soil provides thermal insulation to heat-emitting systems in contact with the ground. This insulation can be an advantage if the system must keep an elevated temperature or, on the contrary, it is a shortcoming if the buried system requires to be cooled. For pipeline (surface laid or buried), soil insulation contributes to keep the product "hot" and to prevent formation of hydrates and/or wax. On the contrary, for buried high voltage cable, the temperature elevation must be limited. In high voltage cables, the maximum temperatures depend on the operating tension. The load capability of the cable is strongly restricted by the thermal behaviour of the soil and its ability to dissipate the generated heat.

In both applications, an accurate reproduction of soil and backfill thermal behaviour may allow to optimize the behaviour of those systems. However, uncertainties in the measurement of the thermal conductivity of the soil restrict a correct assessment of the thermal response of the ground. In this work, it is proposed to review current testing devices and processes in order to identify main limitations for reliable measurements. Findings could be then used to modify/develop new processes and testing devices.



This work will be performed in collaboration with Fugro Geoconsulting (Belgium), specialized in geotechnical site investigations on- and offshore and consultancy services. In particular, they are specialist in offshore pipeline/cable route survey and burial assessment (Figure).

Study of the volume variation of an expansive clayey soil upon drying/wetting paths

Supervisor: Bertrand François (Bertrand.francois@ulb.ac.be)

Other contact person: Mohamed Oualmakran (moualmak@ulb.ac.be)

Working language: English/ French

Student profile: Civil Engineering

Prerequisites/special skills: An interest in experimental work related to soil mechanics

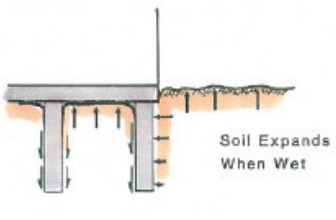
Summary:

Expansive soils undergo large volume variation upon wetting (i.e. swelling) or drying (i.e. shrinkage, Figure (a)). Such behaviours are related, first, to the modification of the internal stress state (through the suction change) and, second, to physico-chemical phenomena at the scale of the particles that modify the distance between clay platelets.

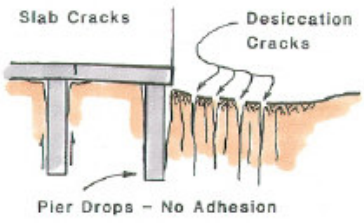
Those expansive soils may induce major troubles when they are used as embankment or foundations ground for infrastructure constructions because they may damage the structures due to movement of the foundations when the hydraulic conditions of the ground are modified (Figures (b) and (c)).

This work aims at quantifying experimentally those effects through the application of drying and wetting processes of soil samples. The key aspects will be the control of the soil suction and the measurement of the volume variations of the sample. Also, various chemical compositions of the pore fluid will be imposed in order to evaluate the role of physico-chemical effects on the swelling/shrinkage behaviour. The behaviour will be interpreted in the framework of the mechanics of unsaturated soils through the elaboration of a conceptual model.

(a)



(b)



(c)

Reference

Birle E., Heyer D, Vogt N. (2008). Influence of the initial water content and dry density on the soil–water retention curve and the shrinkage behavior of a compacted clay. Acta Geotechnica 3, 191-200.