Boom clay drying behavior: experimental and numerical study

Julien Hubert[1*], Frédéric Collin[1], Noémie Prime[3], Angélique Léonard[2], Erwan Plougonven[2]

*[1] Université de Liège, Dépt. ArGEnCo, Chemin des Chevreuils 1, 4000 Liège, Belgium, *julien.hubert@ulg.ac.be*
[2] Université de Liège, Dépt. de Chimie appliquée, Chemin des Chevreuils 1, 4000 Liège, Belgium
[3]Université Savoie Mont-Blanc LOCIE, Campus Universitaire - Savoie Technolac, 73376 Le Bourget du Lac, France

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In geotechnical engineering, the desiccation cracking of soil is commonly observed. This phenomenon is detrimental to the behavior of earth material and earth structure. Desiccation cracks can lead to the overall failure of many geotechnical structures:

- They can affect the slope stability of earth dams or embankments;
- They can initiate internal erosion of embankments due to water flow through the cracks;
- They can compromise the efficiency of soil barriers such as landfill liners and top covers.

Nowadays, the storage of nuclear waste in deep impermeable geological layers is considered. These storages are based on the multi-barrier principle, the last of which being the host rock, typically a clayey material. In this context, maintaining the very low hydraulic conductivity of the host rock is crucial. Unfortunately, the ventilation of excavated galleries causes convective drying of the host material and can lead to crack formation. This work aims to understand in which conditions exactly, during convective drying, does cracking occur in clayey materials.

An experimental campaign has been carried out to characterize the drying behavior of Boom clay which is the host rock at the underground research facility in Mol (Belgium). X-Ray micro-tomography has been used to analyze crack development as well as shrinkage. The experiments are used to calibrate the transfer parameters of a convective drying law based on the limit layer model. This calibration is based on agreement of the drying kinetics.

A numerical study is then performed and aims at reproducing the behavior observed during the experiments. A thermo-hydro-mechanical coupled model is used to determine the stress distribution during the drying and a tensile failure criterion is suggested to predict crack genesis. Simulations are performed using the in-house built FEM code LAGAMINE.

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