Hydromechanical behaviour of argillite-based sealing materials

In the context of deep nuclear wastes storage deep galleries will be backfilled with clay-based materials. These backfill must have specific hydromechanical properties to prevent water circulation along the repository after its closure. The backfill material will be partly made from the excavated material, i.e. Callovo-Oxfordian argillite that would have been stored at surface during the exploitation period, and mixed with sand to reach the target design properties. The hydromechanical properties of the backfill must remain stable over time. It is thus necessary to determine the relative impact of several factors such as the setting conditions, nature and dosage of treatment product, etc. on the properties of the backfill. The thesis will be focused at understanding the cross relationship between macroscopic hydromechanical properties, the reorganization of the material microstructure due to the swelling of clay particles upon hydration as well as the alteration processes associated to the circulation of alkaline water.

The thesis will comprise three main tasks.

1. Multiscale analysis of the hydromechanical behaviour of sand/argillite mixtures. The objective of this task will be to analyse the impact of the sand addition on the behaviour of the mixture at several scales. Small scale experiments will be performed with a specific oedo-tomometer to monitor both the mechanical properties and macropososity deduced from microfocus X-ray computed tomography measurements [1]–[4].
2. Long term behaviour of sand/argillite mixtures. The phenomenon known as alkaline plume triggers the dissolution and modification of clay minerals in the backfill material, altering its structure and, in turn, its performance. The impact of this process will be investigated, considering its impact on the compressibility of the mixtures but also on the behaviour of the interface between the backfill and the lining of the tunnel [5]–[8].
3. Medium scale hydration tests. A model experiment will be developed during the PhD. Such experiment will be considered as an intermediate scale between the laboratory testing and the in situ experimentation of backfilling that will be carried out in the coming years[9]–[11].

PhD works will be of experimental and numerical nature, relying on state-of-the art laboratory equipment and numerical modelling resources of LEMTA. The work will also benefit of cooperation with ANDRA and other institutions. The development of in-situ experimentation at Bure underground laboratory is also an objective of the PhD work.

Candidates must own, at the time of the start of the PhD, a Master Degree in Civil, Geotechnical or Geological engineering, and have a strong interest in Mechanics of Geomaterials.

Knowledge of the French language is not mandatory. The PhD thesis can be written in English.

Conditions

Starting date: September 2023 for a total duration of three years
Gross Salary: 2044 € per month plus social benefits
Institution: LEMTA (http://lemta.univ-lorraine.fr/comp_thmc_sols.html)
Université de Lorraine (www.univ-lorraine.fr)

How to apply?

Send by e-mail before **24th February 2023** a CV (2 pages max), if available a copy of the Master thesis, any relevant publication, full certified transcripts, and the name of one referee to both supervisors:

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