AN INTERFACE CONSTITUTIVE MODEL FOR FRACTURED CLAYEY FORMATIONS IN THE CONTEXT OF NUCLEAR WASTE DISPOSAL

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In the context of nuclear energy production, the storage of radioactive waste deep underground in geological disposal facilities (GDF) is a promising solution to ensure the protection of people and the environment in the short and long term.

Due to the tunneling and storage operations, the thermodynamic equilibrium of the site is disturbed, triggering some damage and generating an interconnected fracture network around the gallery where the hydraulic conductivity can increase by several orders of magnitude [1] and facilitating the potential release and migration of radionuclides into the soil. However, once the gallery is closed and after the emplacement of waste, fractures can be sealed through resaturation by water coming from the claystone as a function of its self-sealing potential, i.e., the capacity of the rock to restore its hydraulic permeability leading to the hydraulic closure of the fracture [2]. During this self-sealing process, no structural changes are observed, meaning that this is a purely hydraulic process inducing any mechanical strengthening or bond at the interface. Due to their low permeability and their swelling capacity that favors the recovery of their hydraulic properties, clay materials prove to be eligible for nuclear waste storage. In France, Andra (Agence Nationale pour la gestion des Déchets Radioactifs) has selected the Callovo Oxfordian claystone (Cox), while the Boom Clay is studied as the host rock in the Belgian context and the Opalinus Clay in MontTerri in Switzerland. Over the last two decades, many experimental studies have been carried out to better understand the self-sealing process of such clay formations. In all cases, the final permeability is very close to the original one, which is not actually really achieved. Moreover, plastic clays such as the Boom clay and the Cox show that the resaturation induces some secondary micro-cracks around the main fractures where the material can swell quickly favoring the sealing process. Based on these experimental observations, the objective of the following work is to describe the hydro-mechanical behavior of the fracture taking into account the self-sealing capacity through an appropriate constitutive equation that is implemented in a 2D finite element model. This model will then be validated through comparison with experimental results on Boom clay and Cox claystone samples tested in the laboratory and will allow further insight into the physical phenomena.

REFERENCES

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