Hydro-mechanical behaviour of Boom Clay investigated through high capacity consolidated drained triaxial tests.

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In Belgium, the national organization responsible for the management of radioactive waste, ONDRAF/NIRAS, considers the disposal for long lived intermediate and high level radioactive waste in deep geological layer. The Boom Clay Formation is one of the potential host formation under study for that purpose. The HADES underground research laboratory built beginning of the eighties at a depth of 223 m in the Boom Clay Formation is in the Mol-Dessel area in the North-East of Belgium [1][4]. Over these past 40 years, many geomechanical laboratory tests were performed and analyzed on specimen cored from the underground laboratory leading to well-known hydro-mechanical properties of Boom Clay at this depth [2] [3] [4] [5] [6].

The future depth of a geological disposal facility (GDF) in Belgium is not defined yet. For design purpose, a reference depth was fixed at 400 m in poorly indurated clay. In this case, the knowledge of Boom Clay hydro-mechanical properties at HADES level is not sufficient and need to be extended to greater depths. With that perspective, this study aims to analyze the variability of Boom Clay hydromechanical properties and behaviour with depth.

As a first step, triaxial tests are performed on cores of Boom Clay taken at a depth of 223 m from HADES URL and under conditions representative of this depth. A high capacity triaxial cell able to develop a confining pressure up to 40 MPa and axial load of 350 kN, with control of pore water pressure up to 35 MPa, is used (Figure 1). The equipment is calibrated to consider the compressibility of the drainage systems for the measurement of the Skempton coefficient and the effect of membrane stiffness on confining and axial stresses sustained by the specimen. After reconsolidation up to 2.25 MPa followed by the saturation phase under a pore water pressure of 2 MPa, consolidated drained triaxial compression tests are performed at effective confining pressure between 1 and 4 MPa. The rate of axial displacement during compression is fixed at a value of 0.25 μm/min, low enough to guarantee drained conditions during compression.

For the sake of comparison, additional tests are also performed on Boom Clay specimen with lower capacity triaxial cell, up to 1.5 MPa of total confining pressure. Saturation protocol is slightly different in the sense that it is performed under a pore water pressure of 0.5 MPa. Also, the effective confining pressure is limited to 1 MPa.

From these two types of tests, testing protocols and their effects on results were carefully examined. Analysis of test results were done to estimate cohesion, friction angle, Young modulus and Poisson ratio in these conditions and compared to literature review. Up to now, specimens are tested in the direction perpendicular to bedding, such that mechanical anisotropic features is not yet considered. This first stage of the research aims at gaining deep knowledge on the behaviour of Boom Clay cored at a depth of 223 m and calibrating the triaxial testing equipment for the investigation of Boom Clay cored at greater depth.

In a second step, this current research will be pursued by focusing on the hydro-mechanical behaviour of Boom Clay at other depths (either around 400m deep then close to the surface). This will be done by performing triaxial tests on Boom Clay cores taken from surface drillings. The objective will be to identify if trends exist on parameter evolutions with depth and how the knowledge acquired about the hydro-mechanical behaviour of Boom Clay at 223 m can be transferred to other depths.

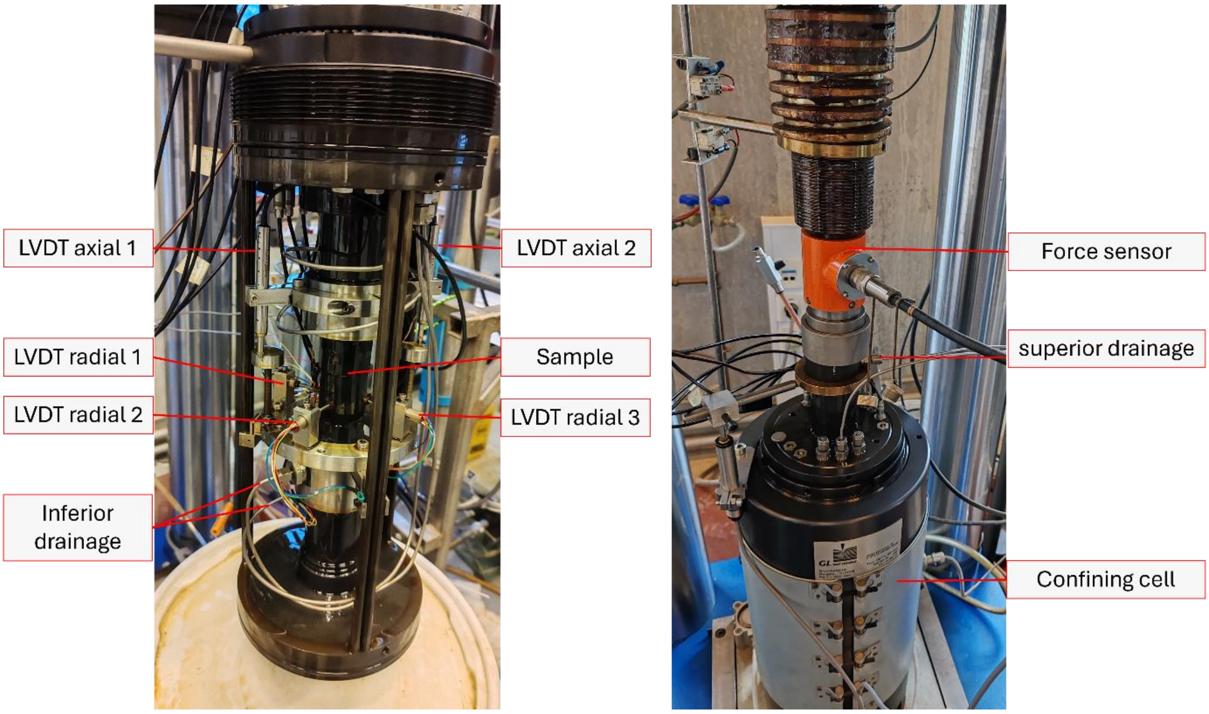

Figure 1: High capacity triaxial cell used in the geomechanical testing of Boom Clay.

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