Étude de l'essai au vérin plat dans la mine de syénite néphélinique de Stjernoy

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Study of the flat jack test in the Stjernøy nepheline syenite mine.

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The determination of the *in-situ* state of stress is essential before excavating in a rock environment. The presence of old excavations as well as numerous physico-chemical processes influence this state of stress. In some places, it can reach values close to the ultimate strength of the rock. The redistributions and concentrations of stresses brought by a new excavation in this zone could then jeopardize the stability of the rock mass.

This *in-situ* state of stress is even more difficult to predict analytically in underground mining complexes, where many excavations have already taken place. To characterise it, a practical test is often carried out in the gallery walls : the flat jack test. A detailed study of this test in the Stjernøy mine, in Norway, is the main subject of this thesis. The mine in question consists of a complex network of vertical and horizontal galleries for the extraction of nepheline syenite. By means of numerical models, the different parameters of the flat jack test will be studied to allow a better understanding of the physical phenomena around it.

The work is divided into three main parts. The first part describes the Stjernøy mine and presents a state of the art. The purpose of this section is to recall various theoretical notions on underground excavations and to present the flat jack test in detail. The importance of determining the *in-situ* state of stress is highlighted throughout this first part.

The second part of this work is an experimental analysis of the geo-mechanical properties of nepheline syenite. These are determined by analysing data from a test campaign that took place in 2020 at the University of Liège. During this campaign, uniaxial and triaxial compression tests as well as Brazilian tests were performed. The objective is to determine adequate parameters to be implemented in the numerical models of the flat jack test.

The third major part of the work is therefore the actual study of the flat jack test. Using the finite element software Lagamine, two and three-dimensional models were made. Different geometries of the test and different constitutive laws are tested in these models. The objective of these numerical simulations is to provide a better understanding of the displacements and stresses generated in the wall by the test. A better interpretation of the test results is also possible after the analysis of the finite element models. The interpretation is made with a chart, linking the pressure injected into the jack to the *in-situ* state of stress, for different test geometries. This chart takes into account the uniaxial loading and the shear stresses generated by the jack, which allows a more accurate and realistic interpretation of the measurements. The impact of a non-homogeneous stress state and material plasticity is also studied.