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Effect of impurities in rock salt samples on laboratory tests - consequences on rock mass representativity

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Abstract

Experimental measurements are crucial for elaborating reliable dilatancy criteria for underground facilities in rock salt formations. In this paper, we analyzed experimental results of conventional triaxial compression tests and found that in many cases the dilatancy limit of a specimen is different depending on the measurement technique that is used (strain gauges, extensometers, LVDT + confining oil volume variation…). Previous studies proved that such anomalies can neither be explained by the specimen preconditioning nor by loading conditions such as the friction between the specimen and the loading platens. For this reason, we carried out a numerical investigation on the effect of impurities within the tested specimens. Since the aim is not to reproduce the complex microstructure of a given rock salt specimen, we modeled rock salt as a two-phase material composed of pure halite (salt) and impurities (non-salt content).

The experimental tests were simulated and the results showed that, when the tested core contains impurities, the dilatancy limit measured by strain gauges may differ depending on the strain gauges location on the sample: the presence of impurities leads to a non-uniformity of the strain and stress fields within the core. We also found that, because of non-salt content, the cores tested in the laboratory can be too small when compared to the required representative volume element of the rock mass. In addition, the representative volume element size was correlated to that of the non-salt inclusions.

Since usually laboratory equipment can only host a limited core size, one can have no options other than testing non representative cores that cannot provide reliable information on the rock mass. To overcome this issue, we suggest a method that combines the laboratory test results (non-representative) with a numerical work consisting in the modeling of the tested core and retrofitting its mechanical parameters on the experimental measurements. This will allow to identify the parameters of the equivalent homogeneous behavior of the rock mass.

Key words: Caverns for Gas Storage, Rock salt heterogeneity, Dilatancy, Computer Modeling, Finite element method