Mechanical Degradation of clay sulphate rock and its effect over the expansivity

Author: Tarragó Munté, Dani
Tutor: Alonso Pérez De Agreda, Eduardo E.
External Tutor: Berdugo De Moya, Iván Rafael

Abstract:

In the framework of the studies to explain the expansive phenomena that took place in three tunnels of the Madrid - Barcelona High Speed Railway, research works were conducted in one of the tunnels (Lilla tunnel), excavating some clay sulphate rocks. The mention tunnel is located between Lilla and Vilaverd (Tarragona, Spain). This studies opened different lines of investigation that help in the orientating the objectives of the present thesis project.

Due to the expansive phenomena in the Lilla tunnel, the floor was risen up to one meter which led to the construction of a new section in the tunnel. Since that problem arose, a new issue was to study and better mind how such phenomenon could have taken place. Previous studies were focused on looking for geologic and geotechnical parameters to try and explain how the rock's expansion had happened. Those studies, once finished, brought new ideas for the investigation leading to the proposal of the current study.

The present study aims to analyze the rock's expansion by degradation of samples of the rock and proving that, in the rock's alteration, the clay was the main precursor and responsible of the complex process of degradation which led to the expansion of the Lilla tunnel.

Therefore, a vast geologic study has been carried out where two different components of the rock were identified: The clay matrix and the veins or nodule of the sulphate. The matrix is form by reddish materials and green nodules, and its composition is based on clays, carbonates and in a minor degree, quartz or mica. The associated tectonics to this materials were also analyze since the area were the tunnel was built is strongly tectonized. It was revealed that the tunnel is located in the surroundings of a big fault which would explain the existence of sub horizontals plains being distinguishable in the rock. Finally, a protocol has been develop for the rock’s degradation. The degradation was perform using two techniques: wetting-drying with controlled relative humidity in order to avoid possible phenomena of dissolution and/or precipitation of the existing sulphates, and multicycle analysis of load - unload without confining to star or reopen fissures in the rock.

The degradation’s protocol was perform in cylindrical samples of unaltered material. The samples were analyzed before, during and after the application of the degradation process. The analyses were carried out with geotechnical and petrologic parameters. The analyzed geotechnical parameters were: humidity, sulphate content and deformation modules. The geologic parameters were studied after to use these techniques: samples, thin section, X-Ray diffraction and Electronic Microscopy. The main phenomenon in the degradation was the expansion of the matrix, the samples expanded in a non homogeneous way. Matrix expanded but the surface nodules just showed superficial degradation and were not contributing to the global expansion. Their only effect was to become a bounding condition for the degradation of the material.

The described procedure/technique, along with the support of the geological study, has allowed us to pose some theories that can explain the expansive phenomena of the Lilla tunnel.