

Abstract

The growth of crystals is a frequent cause of expansive deformations in natural soils, compacted soils, ornamental rocks, rocks and concretes. Crystallization of ettringite as result of sulphate attack on concretes and the gypsum crystallization by pyrite oxidation in black shales are the two cases fairly discussed in literature. Another equally important case, but which has not been studied in detail, is the sulphate crystallization, in particular the gypsum crystallization in discontinuities and cracks due to evaporation of highly mineralized solutions. It is suggested that this mechanism can contribute in an important way to the displacements and swelling pressures that usually appear in tunnels excavated in anhydritic-gypsiferous argillaceous rocks.

The present work is aimed at studying the basic mechanisms that control the hydrated sulphate mineral growth in anhydritic-gypsiferous argillaceous rocks due to the evaporation of watery solutions. The investigation presents fieldworks as well as laboratory tests. The fieldworks have been based on the detailed reconnaissance of the materials in which tunnels of the high speed railway line Madrid-Barcelona-French Frontier at Lilla stretch (Tarragona, Spain) have been excavated, as well as the study of the state of degradation of the surrounding slopes. The laboratory works have contemplated the mineralogical and micro-structural analysis, also the design and development of new free swelling tests on undisturbed sulphated argillaceous samples from different zones of the Ebro basin.

The mineralogical and micro-structural analysis has been realized in order to characterize the main geotechnical properties and the mineralogical variations of the studied materials before and after subjecting them to the free swelling tests. Experimental techniques related to mineralogical characterization has been done by X-Ray Diffraction and Electronic Microscope.

Free swelling tests were done in order to reproduce the displacements that usually appear in tunnels and deep foundations in sulphated argillaceous rocks. The equipments and test protocols were developed focusing on the capacity to discern the role carried out by the geo-chemical properties of the water, the main environmental variables (temperature and relative humidity) and the degree of cracking of the samples on expansive behavior of studied materials. The free swelling tests are done controlling relative humidity using different saline solutions and imposing wetting-drying cycles.

The results have contributed to enhance the knowledge of the expansive phenomenon in tunnels and deep foundations in sulphated argillaceous rocks, emphasizing the importance of the sulphate precipitation as a result of changes in the environmental conditions.