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Improving the geotechnical properties of expansive soils by mixture with olive mill wastewater

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In Southern Spain, Olive grove is an artificial forest which has a surface of 18.000 km2, representing more than 25% of olive oil world production. During the manufacturing process of this oil, different types of residues are generated. The most important is a biomass called olive mill wastewater. It is a dark colored liquid which can not be directly poured onto natural watercourses. On the one hand, part of this biomass is burnt to produce electrical energy or treated to make a bio-diesel. On the other hand, we propose the use of olive mill wastewater as a stabilization agent for expansive clayey soils. Using raw biomass as a stabilization agent two objectives are achieved: adding value to biomass and reducing the problems of expansive soils. Moreover, an important reduction of economic costs can take place.

A pure bentonite clay was chosen as a sample of original expansive soil. It is abundant in Southern Spain and its main component is Na-Montmorillonite. Bentonite is very susceptible to changes in the environmental available moisture and very unsuitable for its use in civil engineering due to its low bearing capacity, high plasticity and volume changes. Several dosages (5%, 10%, 15%) of olive mill wastewater were added to the original sample of bentonite. To study eventual improvements in the mechanical properties of soil, Proctor, Atterberg Limits, California Bearing Ratio, Swelling Pressure and X-Ray Diffraction tests were carried out, following Spanish standards UNE by AENOR. Both geotechnical and mineralogical characterizations were developed at two different curing times: 15 and 30 days.

The Plasticity Index (PI) of the original bentonite soil was 251 (High Plasticity). The addition of 15% of olive mill wastewater yielded reductions of PI similar to those produced by the addition of 5% of Portland cement. The California Bearing Ratio (CBR) values increased slightly after the treatment with biomass leading to very similar values to those obtained after the conventional treatment with coal fly ash. One of the most important parameters to evaluate the swelling potential, swelling pressure, dramatically decreased in samples treated with olive mill wastewater, from 220kPa in the original sample of bentonite to values under 60kPa after 30 days. Regarding the mineralogy of the treated soil, X-ray Diffraction tests suggested a noticeable reduction in the amount of smectite within the crystalline structure of treated soils. Moreover, the smectite 001 peak shifted to right indicating a smaller d-spacing and hence a more stable mineral structure.

To sum up, the improvements achieved by adding olive mill wastewater were, to some extent, similar to those produced by lower dosages of conventional additives (Portland cement or coal fly ash). The first results obtained in this work therefore indicate promising properties of biomass for its use in stabilization of expansive soils. A further research is still necessary. Finally, it must be pointed out that the use of raw biomass proceeding from olive grove might considerably improve the waste management in olive oil industry while offering new opportunities to civil works.