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Use of Biomass Ash as a stabilization agent for expansive marly soils (SE Spain)

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In recent years, several biomass power plants have been installed in Southeastern Spain to reuse olive oil industry residues. This energy production tries to reduce the high costs associated with fossil fuels, but without entering into direct competition to traditional food crops. The waste management in these biomass energy plants is still an issue since there are non-flammable materials which remains after incineration in the form of ashes. In Southeastern Spain there is also a great amount of clayey and marly soils whose volume is very sensitive to changes in climate conditions, making them unsuitable for civil engineering. We propose the use of biomass ash (both fly ash and bottom ash) as a stabilization agent for expansive soils in order to improve the efficiency of construction processes by using locally available materials.

In this work biomass ashes from a biomass power plant in Southeastern Spain have been used to stabilize 6 samples of local marly soil. Those 6 samples of expansive soil were mixed with different dosages of biomass ash (2%, 4% and 7%) to create 18 specimens of treated soil, which were submitted to Proctor, Atterberg Limits, pH and Free Swell Index tests, following Spanish Standards UNE by AENOR. X-Ray Diffraction (XRD) tests by powder method were also carried out, using a diffractometer Philips X'Pert-MPD.

The results obtained for the original untreated marly soil were: PI = 34.6; Free Swell = 12.5; pH = 8. By adding biomass ash the value of the plasticity index (PI) became slightly lower although it was not low enough as to obtain a non-plastic soil (PI under 25). However, there were dramatical decreases of free swell index (FSI) after the stabilization treatment: FSI < 8.18 (2% biomass); FSI < 6.15 (4% biomass); FSI < 4.18 (7% biomass); These results suggest that treated soil is quite less susceptible than the original soil to moisture changes. The pH of the mixes after adding biomass ash rose from 8 to 11 ± 1 leading to an alkaline environment which, as reviewed literature points out, helps to the development of pozzolanic reactions and stabilization process. Finally, XRD tests indicated a sharp decrease in the intensity of reflection of the Smectite peak, suggesting a reduction in the amount of this expansive mineral in treated soils. This positive and durable effect may be related to cation exchange from Na+ to smaller cations or even the formation of mixed-layered clay minerals.

A further research must be conducted to determine the pozzolanic properties of biomass ash (i.e. its suitability for concrete composites), the optimum dosages, etc. The further research is also necessary to better understand the mineralogy changes occurred within the crystalline structure. Nevertheless, these first results let us infer that biomass ash from power plants has a high capacity to enhance mechanical properties of expansive soils. Given the widespread use of biomass in industry today, the secondary use of biomass ash might improve the sustainability and efficiency of the biomass generation, incineration and waste management process.