MULTI-SCALE ANALYSIS ON SOIL IMPROVED BY ALKALI ACTIVATED FLY ASHES

Enza Vitale, University of Cassino and Southern Lazio, Italy
e.vitale@unicas.it
Dimitri Deneele, Institut des Matériaux Jean Rouxel (IMN), Université de Nantes, CNRS; IFSTTAR
Michael Paris, Institut des Matériaux Jean Rouxel (IMN), Université de Nantes
Giacomo Russo, University of Cassino and Southern Lazio, Italy

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The development of soil treatment techniques using alkali-activated binders is a relevant issue since the increasing interest into the use of new binders as an alternative solution for geotechnical engineering applications, such as soil improvement.

Alkali activated binders are formed by alkaline activation of an aluminosilicate source, containing precursor materials like fly ash, silica fume, steel sludge, which chemically react with an alkaline solution (i.e. sodium hydroxide, sodium silicate) forming a three-dimensional aluminosilicate gel with cementitious properties (Duxon et al. 2007, Provis and van Deventer 2014, Davidovits 1991, Xu and van Deventer 2000, Shi et al. 2006). Recycling of waste materials such as by-product from industrial process to synthesize a new binder favors a closed loop of material use, which minimizes the generation of waste and reduces the costs of production. Alkali activated binders represent a viable sustainable alternative to the use of ordinary binders for soil improvement (Vitale et al. 2017a; Vitale et al. 2017b).

In the present study, an insight into the mechanical improvement induced by alkali-activated binders based on the activation of two different type of fly ashes on a clayey soil has been presented. An experimental multiscale analysis on chemo-physical evolution of the systems and its influence on microstructural features of treated soil has been developed highlighting the link between alkaline activation processes and macroscopic evolution of soil properties. Mechanical tests have been performed and interpreted taking into account the chemo-physical evolution of alkali activated fly ashes. Effects of binder content and curing time have been also considered. Addition of alkali-activated binders increases shear strength of the treated samples since the very short term. A reduction of compressibility and an increase of yield stress of treated samples have been also detected, whose extent depends on the curing time and on the binder content. Macroscopic behaviour of treated soil has been linked to the experimental evidences at microscale. Mineralogical and fabric changes induced by alkali-activated binders have been monitored over time by means of X ray diffraction (XRD), thermogravimetric analysis, ^{29}Si NMR spectroscopy and Mercury Intrusion Porosimetry (MIP). Test results showed a high reactivity of alkali activated fly ashes as alumino-silicate source promoting precipitation of new mineralogical phase forming chains and networks with cementitious properties, responsible of the mechanical improvement of the treated soil. The efficiency of treatment has been also highlighted by comparing the mechanical performance induced by alkali-activated binder with the one promoted by ordinary Portland cement.

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