Leachability, strength and microstructural characteristics of CPC binder stabilized Pb, Zn and Cd contaminated industrial soil

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Synthetic hydroxyapatite is used as an immobilization material to remediate heavy metals in soil and show promising performance of reducing the leachability. However, hydroxyapatite stabilization technology has several drawbacks including the high cost of raw material, difficult in preparation, as well as poor mechanical properties of stabilized matrix. This study presents a new binder, CPC, composed of calcium oxide and single superphosphate. The CPC can effectively solidify and stabilized contaminated soil through acid-base reaction with a final product of hydroxyapatite in the soil. A comprehensive laboratory investigation is carried out with respect to the effect of the CPC content and curing time on the pH, leachability and strength properties of Pb, Zn and Cd contaminated industrial soil stabilized with CPC binder. In addition, microcosmic studies including sequential extraction procedure, X-ray diffraction, scanning electron microscopy, and mercury intrusion porosimetry are undertaken to interpret the mechanisms controlling the changes in leachability, strength properties of the stabilized soils. The results show that the soil pH and unconfined compressive strength increase with an increase in CPC content and curing time. The CPC stabilized soils exhibit an alkaline character regardless of the binder content. After cured for 28 days, the strength of CPC stabilized soils is 2.21 to 5.68 times that of the untreated soils. For all stabilized soils, the leachability of Pb, Zn and Cd is effectively reduced and the corresponding leached concentrations can meet the regulator limit. Moreover, CPC can significantly reduce acid soluble fractions of heavy metals and transfer them to residual fractions in the stabilized soils. The CPC also significantly reduce the pore volume and change the pore-size, which can well explain the measured impact of CPC content on the compressive strength of stabilized soils. It is also found that the formation of heavy metals hydroxyapatite and phosphate-based products are the major immobilization mechanisms for Pb, Zn and Cd in soils.

Keywords: Heavy contaminated soils, Leachability, Strength, Hydroxyapatite, Single superphosphate, Solidification and stabilization

