Effectiveness of Solidification/Stabilization of a Heavy Metal-Contaminated Soil Using a Sustainable Binder

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Cement and lime are currently extensively used in solidifying/stabilizing heavy metals contaminated soils. However, cement and lime production is associated with intensive consumption of energy and nonrenewable resources. Under the drive of environmental friendliness, some by-products-based binders such as ground granulated blast furnace slag, pulverized fuel ash, and cement kiln dust have been successfully used in the remediation of contaminated soil. The authors have recently developed a sustainable binder, basic oxygen furnace slag (BOFS) activated by calcium carbide residue (CCR) and phosphogypsum (PG). The binder has almost no negative environmental impacts, and it can be used as an excellent substitute for cement.

This study presents a preliminary evaluation of the effectiveness of the BOF-based binder to stabilize mixed nickel (Ni) and zinc (Zn) contaminated soil collected from a vacant lot of an electroplating plant. The effects of binder dosage and curing time on soil pH, leachability and strength properties of the stabilized soils were examined. In addition, modified European Communities Bureau of Reference (BCR) sequential extraction procedure (SEP) and mercury intrusion porosimetry (MIP) analyses were performed to investigate the mechanisms that control the variations in heavy metal speciation and soil structure.

The results showed that soil pH and unconfined compressive strength (UCS) increased with increasing binder dosage and curing time. After 90 days of curing, the UCS of stabilized soils was approximately 2.9 - 6.6 times higher compared with those of untreated soil. Leaching concentrations of Ni and Zn were significantly reduced with increases in binder dosage and curing time. With 8% of binder addition and 28 days of curing, the leaching concentrations of both Ni and Zn were well below their corresponding remediation goals. The SEP results indicated that the binder addition significantly reduced the acid-soluble fractions of heavy metals while increased their residual fractions. The MIP test results showed that the soil pore volume reduced notably and soil structure changed remarkably after stabilization, inducing higher UCS compared with the untreated soil.

Keywords: Solidification/Stabilization, Heavy metal, Contaminated soil, Sustainable binder

