Evaluation of the Unconfined Compressive Strength in Solidification and Stabilization of a Phenol-Contaminated Soil using Ordinary and Organophilic Clays

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Extended Abstract

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Introduction

One of the most important 1-ring aromatic organic pollutants is phenol and its related compounds. These compounds are classified as hazardous wastes base on U.S. EPA primary contaminates list. The phenolic compounds are very poisonous and these are harmful for human health and also for other biota.

To control the movement of such hazardous organic waste in a contaminated soil, solidification/stabilization (S/S) process can be an effective alternative. Due to the negative impact of organic compounds on the cement hydration, the cement-based S/S may be not effective for controlling the movement of such pollutants. To avoid these effects, using some additives during solidification period has been recommended. One of the proposed of such compounds is organophilic clay that is the modified montmorillonite by quaternary ammonium salts (QAS). There are several researches to evaluate the organophilic clay effect on adsorption and stabilization of organic compounds during S/S process. The effectivity of S/S process can be examined by several tests such as leaching test, durability, unconfined compressive strength (UCS), etc.

In this study, efficiency of ordinary and organophilic clay was evaluated in the solidification and stabilization process based on unconfined compressive strength of a phenol-contaminated soil.

Material and methods

In this study, an artificially phenol contaminated sand was considered to evaluate the effectivity of the white cement based S/S process by using two different additives of ordinary and organophilic clay.

The contaminated sand contains 2000 ppm of phenol. S/S process was conducted on 14 samples with different amounts of white cement (15 and 30 wt%) as binder and ordinary/organophilic clay (0, 8, 15, and 30 wt % for each of them) as the additives. Two zero percent additive samples are considered as control samples.

All samples were cured for 28 days and then UCS test was performed for all of them.

Results and discussion

Unconfined compressive strength of all examined samples were ranged from 2226 to 6999 kPa. In the samples with equal amount of cement, the higher UCS values can be observed in blank samples (without any additives and phenol). By adding phenol in the examined sand, UCS of the solidified sample reduces 3 -3.5%. Moreover, results showed that UCS was reduced by increasing the amount of clays. The reduction of the samples containing organophilic clay was higher than samples containing ordinary clay. Unconfined compressive strength values of all samples met the minimum standards indicated by France, Netherlands, Britain and America for disposal in a sanitary landfill. The sample with 30% white cement and 8% bentonite has the maximum amount of UCS (4856 kPa) and the sample with 15% white cement and 30% organophilic clay has the minimum one (2226 kPa). In this study, the average cost of organophilic clay-based solidified samples was 2.3 to 2.8 times more than the average cost of the bentonite-based solidified samples.

Conclusion

In this study, the strength of the cement-based solidified samples contaminated by phenol was investigated. The summary of the findings of the research is as follows:

1. By adding the phenol to pure sand, the UCS of the samples can be reduced 3-3.5 %.
2. Addition of organophilic clay reduces the UCS of the samples more than the ordinary clay (bentonite) in the same amount.
3. All samples met the recommended UCS level for the S/S process. The minimum UCS level is for the sample with 15% of cement and 30% of organophilic clay.

The cost of S/S process is between 23 and 650 $/ton of contaminated soil depending on the amount of used additives and binder. The samples containing organophilic clay has a higher cost than the similar sample containing ordinary clay.

4. To evaluate the S/S process effectivity, a leaching test of phenol (such as TCLP) is recommended

Keywords: Solidification and stabilization, Unconfined compressive strength, Phenol, Organophilic clay.

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