Research Project: ***SHA/UM/2-30***
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RESEARCH SUMMARY

GEOTECHNICAL AND ENVIRONMENTAL IMPACTS OF STEEL SLAG USE IN HIGHWAY CONSTRUCTION

Problem

Steel slag is a byproduct of iron and steel production by the metallurgical industries. Annually, 21 million tons of steel slag (SS) is produced in the United States. Most of SS is landfilled, which represents a significant economic loss and a waste of valuable land space. Steel slag has great potential for the construction of highway embankments; however, its use has been limited due to its high swelling potential and its alkalinity. The swelling potential of steel slags may lead to the deterioration of the structural stability of highways, and high alkalinity poses an environmental challenge as it affects the leaching behavior of trace metals.

Objective

This study seeks a methodology that promotes the use of steel slag in highway embankments by minimizing the two main disadvantages mentioned above, consisting of the following tasks:

1) Determining the mechanical properties of steel slag and evaluating its swelling behavior.
2) Conducting batch (small-scale) water leaching tests for a quick estimate of metal leaching behavior.
3) Conducting long-term sequential column leaching tests to study leaching behavior and controlling mechanisms for the trace metals from pure and treated steel slag, and to study the effects of underlying subgrades on fate and transport of these chemicals in the environment.
4) Determining the evaluation of the impact of effluents from steel slags on surface water and groundwater through two recent numerical models.

Description

Accelerated swelling tests were conducted to evaluate the swelling behavior of pure steel slag and SS treated with water treatment residual (WTR), a clean and alum-rich by-product of drinking water treatment plants. Sequential batch tests

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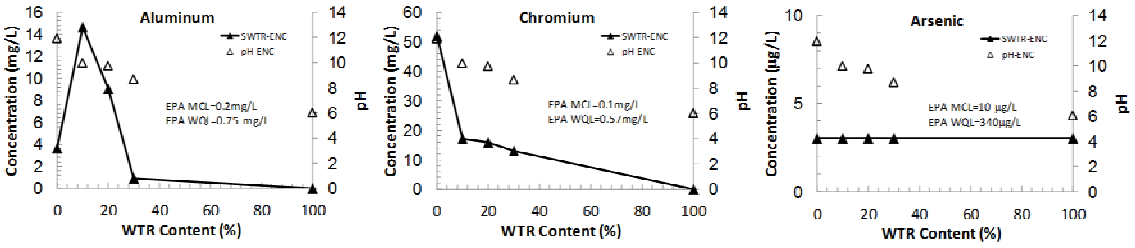
and column leach tests, as well as two different numerical modeling analyses, UMDSurf and WiscLEACH, were carried out to check the environmental suitability of the treatment method. Tests were conducted to study the effect of a common borrow fill material that encapsulated the slag in the embankment and the effects of two subgrade soils on the chemical properties of slag leachate.



Results

The results indicated that an increase in WTR content in the steel slag-WTR mixtures yielded a decrease in pH and most of the leached metal concentrations, except aluminum. The change in the levels of pH, after passing through encapsulation and subgrade, depends on the natural pHs of materials; the tests showed that the metal concentrations exhibit mostly a pH-dependent behavior. Both UMDSurf and WiscLEACH predicted that field metal concentrations would be significantly lower than the metal concentrations obtained in laboratory leaching tests, and field concentrations would decrease with time and distance due to dispersion in surface waters and the soil vadose zone.

Report Information

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Link to Final Report: http://www.roads.maryland.gov/OPR_Research/MD-16-SHA-UM-2-30_Steel-Slag_Report.pdf