Research Project 31

Permeable Reactive Barriers for Contaminant Control in Beneficial Use Applications in Highways

Recycled Materials Resource Center

University of New Hampshire

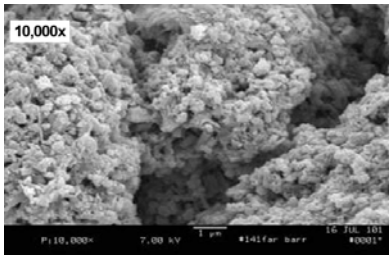
Federal Highway Administration

Project Objectives

- Develop new technology that can be used as a permeable reactive barrier below large recycled materials applications (road base, embankments) to intercept heavy metal and oxyanion contaminants that may leach at low levels from the applications.
- Conduct basic research into the mechanisms of contaminant attenuation, model reaction and transport, verify at the bench and field scale.
- Develop manual of practice for use of permeable reactive barriers.
- Promote the new technology through technology transfer forums, technology commercialization, and outreach activities to State DOTs.

Project Description

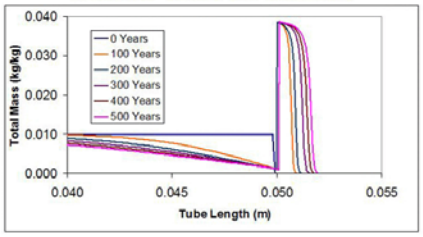
When considering recycled materials for unbound app lications such as embankment fill or base layer aggregate, one of the major issues is determining potential groundwater impacts from contaminant leaching. Unfortunately, the processes of leaching in the highway environment are not completely understood, and actual data on leaching in the field is relatively sparse. One method to mitigate potential leaching is to use permeable reactive barriers to intercept and remove contaminants from groundwater flows. The barriers would be deployed beneath embankments or base course layers containing recycled materials with potentially leachable contaminants. The permeable reactive barrier would allow the necessary downward migration of water from the pave ment structure or embankment while removing contaminants as the water migrates through the barrier. A variety of granular materials are used in such barriers, though this project is investigating the phosphate mineral apatite ($Ca_5(PO_4)_3OH$). Apatites bind a variety of metals and oxyanions, and have a strong affinity for most of the RCRA metals. The mechanism of removal usually involves specific adsorption reactions between functional groups on the surface of the apatite and the contaminant. Subsequent surface precipitation reactions will immobilize the contaminant as insoluble and stable phosphate minerals.



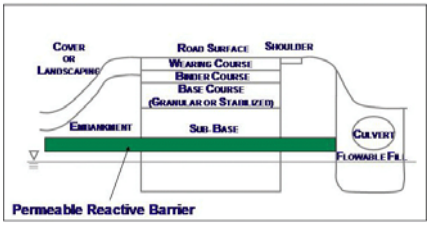
North Carolina Apatite

The research will focus on contaminant (Pb, Zn, Cd, As, Se, Cr) removal kinetics, characterization of reaction mechanisms, and hydrodynamic fate/transport modeling with various synthetic apatites. Sorption experiments are now underway using the high purity synthetic minerals hydroxyapatite, $Ca_5(PO_4)_3OH$, fluorapatite, $Ca_5(PO_4)_3F$, and carbonate apatite, $Ca_5(PO_4,CO_3)_3(OH)$. Dr. Eighmy and graduate student Carolina Gonzalez visited Japan's synchrotron radiation facility, SPring 8, to conduct EXAFS analysis of the zinc-apatite sorption samples from the solubility experiments. Additional samples from experiments on the sorption of zinc, copper, selenium and arsenic onto Phosfil (a naturally mined apatite) were analyzed as well.

Reaction Transport Modeling



Permeable Reactive Barrier Concept



Project Partners

Louisiana State University, Kyushu University

End Products

Permeable reactive barrier manual of practice.

Further Information

The Recycled Materials Resource Center (RMRC), a cooperative agreement between the University of New Hampshire and the Federal Highway Administration, is a national center that promotes the appropriate use of recycled materials in the highway environment. Its focus is on the long-term performance and environmental implications of using recycled materials.

For detailed quarterly progress reports for Project 31, as well as all RMRC-funded research projects, please see: http://www.rmrc.unh.edu/Research/researchlevel2.asp.

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