Wednesday, 3/15/2017

9:45–11:15 a.m.

Soil and Groundwater Remediation 2

Chairs: Arvin Farid, Boise State University; Krishna Reddy, University of Illinois at Chicago

Acidic Groundwater Remediation in the Shoalhaven Floodplain

Buddhima Indraratna, Ana Heitor, and Udeshini Pathirage, Univeristy of Wollongong

Acidic groundwater resulting from the oxidation of pyrite in acid sulfate soil (ASS) is a major geo-environmental problem in low-lying coastal regions. While the pyrite submerged is relatively inert, if exposed to atmospheric oxygen, it will rapidly oxidise to form sulphuric acid. This poses a serious challenge for floodplain management due to the catastrophic consequences associated with agriculture and aquaculture productivity, environmental damage to river ecosystems and acid damage to steel and concrete infrastructure.

This paper reports the results of different methodologies adopted in the Shoalhaven floodplain (NSW, Australia) over two decades for remediation of acidic groundwater. Different approaches implemented over the years are compared in terms of their efficiency in halting pyrite oxidation and neutralizing the acidic groundwater and removing heavy metals, mainly dissolved Al and Fe resulting from the oxidation of the pyrite in the local acid sulfate soils.

Effect of Carbonation on Engineering Properties and Microstructural Characteristics of Cement Solidified Lead-contaminated Soils

Zhiguo Cao and Dingwen Zhang, Southeast University; Tao Zhang, Jiangsu Province Communications Planning and Design Institute Ltd. Co.

Carbonation of cement-treated soils results in physical and chemical transformations that can affect the long-term effectiveness of stabilization/solidification. In order to ensure safety of further utilization, it is necessary to investigate the effect of carbonation on the performance of cement-solidified contaminated soils. Artificial contaminated soils with different lead contents were solidified using cement, moisture content, density, pH value, strength, and microstructure of solidified samples before and after carbonation were tested. The experimental results show that carbonation decreases moisture content of samples, and increases dry density. Unconfined compressive strength of carbonated samples is 5-25% higher than that of non-carbonated samples. The pore solutions of non-carbonated samples are highly alkaline (pH=11-12), whereas those of carbonated samples exhibit lower pH values (pH=8-9). Thermogravimetric analysis test and scanning electron microscopy test results confirm the transformation of cement hydration products to calcium carbonate during the carbonation process.

Comparison of Various Filter Media Mixtures' Hydraulic Properties from a Laboratory Testing Program

Joshua Swanson, David Saftner, and Rebecca L. Teasley, University of Minnesota, Duluth

This paper describes the laboratory investigation of hydraulic properties in filter media mixtures designed for use in bioslopes along roadways. The accumulation of pollutants on roadways can result in contaminated stormwater runoff that has a negative effect on receiving water quality, groundwater quality, and aquatic ecosystems. Additionally, roadways increase impervious surface area resulting in an increase in runoff volume and peak discharge intensity. Therefore, current requirements focus on

retention of the first inch (2.54 cm) of highway stormwater runoff. Current Minnesota Department of Transportation (MnDOT) specifications were developed using mixtures of clean sand and organic compost. However, mixtures of locally available organic materials in rural areas have not been tested. While there are industry-accepted methods of measuring infiltration rates in situ (i.e. the double ring infiltrometer and the modified Phillip-Dunne infiltrometer (MPDI)), there is no current standard for testing new mixtures on a smaller scale prior to field implementation. This project compares filter media mixtures to material passing current MnDOT specifications using a laboratory testing program. Laboratory constant and falling head tests were used to determine steady-state infiltration rate on samples using different combinations of various locally available organic material with screened sand or taconite tailings. Data from new filter media mixtures are compared to filter material passing current MnDOT specifications. Alternative media mixtures of peat, muck and taconite tailings were found to match the hydraulic conductivity of compost-sand mixtures. These results indicate that alternative media mixtures are suitable for stormwater biofiltration applications, allowing the authors to select mixtures for larger-scale field testing. Applying this laboratory testing program to previously untested filter media mixtures will allow for better design of filter media mixtures.

Laboratory Remediation Test of MTBE-contaminated Sands with Surfactant-enhanced Air Sparging
Zhibin Liu, Songyu Liu, and Boyang Mao, Southeast University; Yuan Cheng, Suzhou Rail Transit Group Co. Ltd.
Based on saturated sands contaminated by methyl tert-butyl ether (MTBE), one-dimensional laboratory column tests were performed, through which the removal ratio of common air sparging (CAS) and foam-based surfactant enhanced air sparging (FSAS) were systematically studied. The sands with particle size of 0.5-1.0 mm and 2.0-4.0 mm were used. Test results indicate that the concentration of VOC contaminant at the top layer of soil strata will first increase and then decrease during FSAS, and under the condition of bubble flow during CAS. The long-term remediation effect of FSAS is almost the same as that of CAS for homogeneous sands as in this research. Due to the special property of foam movement, FSAS is actually a kind of pulsed air sparging, which may resolve the traditional tailing problems. In addition, the effects of FSAS should be comprehensively considered under two- or three-dimensional conditions, and complex soil strata.

Experimental Investigation of the Effects of Biochar on the Hydraulic Conductivity of Soils
Jing Jin, Kokeb Abera, Paul Imhoff, and Kalehiwot Nega Manahiloh, University of Delaware
The addition of biochar to soil has been shown to improve soil quality for agronomic applications, demonstrating its usefulness in altering soil physical and chemical properties. While biochar has been suggested as an additive to stormwater treatment media, little is known about its impact on hydraulic properties, especially the saturated hydraulic conductivity (Ksat). In this research, Ksat of a stormwater bioretention media and a uniform sand amended with 4% by weight wood biochar prepared in three different sizes was measured. Based on the Ksat results and the physical properties of the biochar and biochar-amended media (i.e. d50, void ratio, etc.), the Kozeny-Carmen model was evaluated for its ability to predict the changes in Ksat due to biochar addition.

The bioretention medium consisted of a mixture of sand, clay, and sawdust at 88%, 8% and 4% (w/w), respectively. Addition of the biochar universally decreased dry bulk density and increased the porosity compared to the unamended medium, regardless of biochar particle size. Ksat increased for all bioretention media: small biochar caused less increase (67%), and unsieved and large biochar

amendment resulted in greater increases (306% and 213%). The effect of biochar amendment was also investigated on a uniform sand. In contrast to the bioretention medium, all biochars decreased the Ksat of the uniform sand. The Kozeny-Carmen model predicted observed Ksat changes well for small biochar particle amendments, but it predicted Ksat would increase with large biochar amendment by 450-700% while experiments showed it decreased by 20-40%. This unexpected result when large biochar particles were mixed with a uniform sand is postulated to be caused by changes in tortuosity of the pore space by the generally more irregularly large biochar particles, effects that are not accounted for in the Kozeny-Carmen model.