Testing the Efficiency of a Reactive Core Mat to Remediate Subaqueous, Contaminated Sediments

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Abstract:

The remediation of contaminated sediments presents a global environmental challenge that requires new, innovative approaches. The remediation of subaqueous sediments is particularly difficult given their interface with overlying water that creates the potential for resuspension of particulate–associated contaminants during remediation operations. In large part due to their typically high organic content, sediments often have a significant adsorption capacity and can retain contaminants ranging from heavy metals to PCBs that can pose substantial human and ecological health risks.

Currently available methods for the remediation of contaminated subaqueous sediments include dredging with ex-situ treatment, and capping the contaminated area with a thick, clean layer of sediment. However, during dredging, residual contamination due to suspended sediment can be spread by transport via the overlying water flow. The dredged material dewatering process produces wastewater that requires onshore treatment. Capping the contaminated sediment with thick (≅2-3 ft) clean layer of sediment to block the interaction between contaminated media and water column interaction is not always applicable in places such as harbors or fairly shallow waterways due to navigational depth limitations. In addition to that, weak spots in the cap are vulnerable to erosion and loss of the overlying barrier between water and contaminated sediment.

Reactive geocomposites (Figure 1) represent a new class of reactive caps that have been developed with the potential to substantially improve the management of subaqueous contaminated sediments. The reactive geocomposite, which consists of 0.5 in thick reactive geocomposite and 3-4 in overlying sand for stability, can provide the same physical isolation of the sediment from the overlying water provided by traditional soil caps. However, the geocomposite overlay has the potential to: provide a remediation layer that will adsorb and/or neutralize target dissolved contaminants from the underlying sediment; prevent migration of fine sediment particles that may contain high concentrations of contaminants; and serve as a stable, protective foundation material for new, overlying sediment (Sheahan et al., 2003).

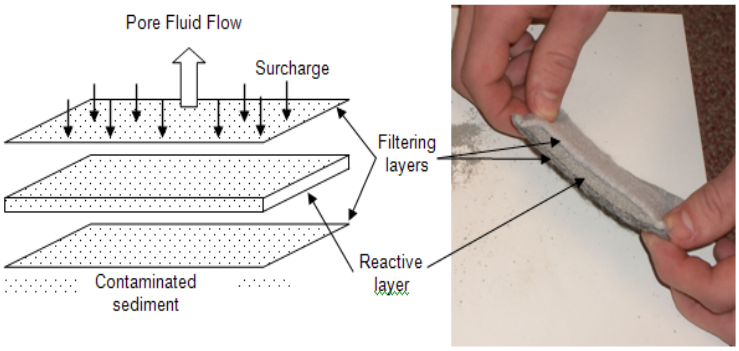

Figure-1 Composition of Reactive Core Mat

Our task in the research is to test the efficiency of the reactive core mat for different sediment contaminant types (e.g. PCBs, PAHs and heavy metals) and different environments (e.g. fresh water, sea water) using different reactive materials (e.g., organoclay, zero valent iron). For this purpose, a new testing device (Figure 2) and testing procedure is being developed that accounts for large strain consolidation of the high water content sediment, which in turn governs the contaminant transportation process from sediment to overlying reactive mat and water.

The device consists of consolidation column -which includes contaminated sediment, reactive mat, porous piston, bioregeneration zone and overlying water-, pressurized water pumps to create up/down flow and backpressure on sample prior to loading and pulley loading system that allows application of constant incremental loads with amplification factor of 4. Mainly two types of tests performed with the device such as short term; application of 10-25-55kPa(higher stresses than predicted site stress) loads incrementally with 24hrs duration after backpressuring the system with 350kPa and long term; application of 10kPa(predicted site stress) for 28 days after backpressuring the system. The soil-nutrient material in the bioregeneration zone is tested by research partners at the Harvard School of Public Health using bioaccumulation tests with chemical tracer worms.

Results from the initial testing on Neponset River sediment indicates device is capable of testing the consolidation behavior of high water content sediment and also providing consolidation parameters consistently with CS2 Piecewise-Linear Model (Fox and Berles, 1997).

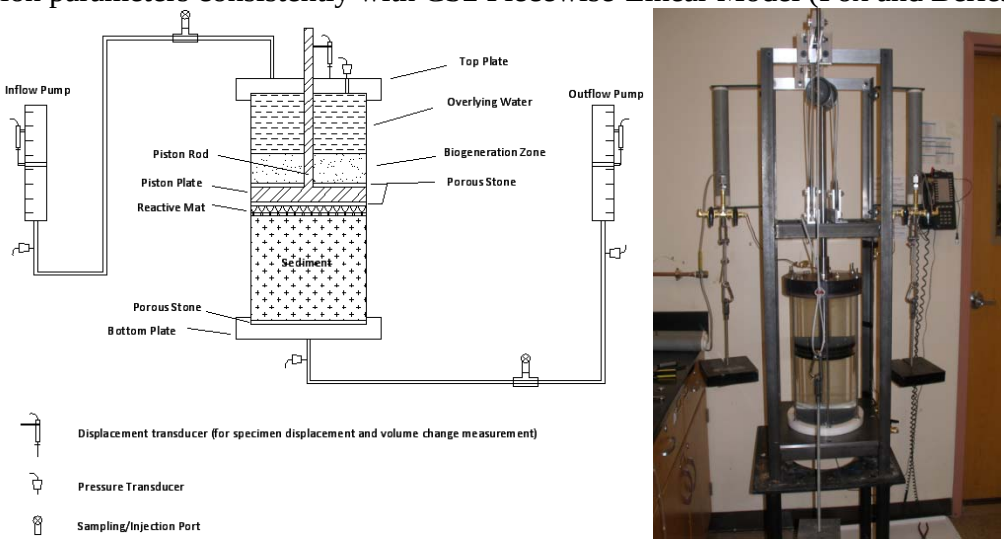

Figure-2 New Large Strain Consolidation Testing Device

References:

- Sheahan, T.C., Alshawabkeh, A., Fernandez, L.A. and Henry, K.S. (2003). "A Reactive Geocomposite to Remediate Contaminated, Subaqueous Sediments." Contaminated Sediments: Characterization, Evaluation, Mitigation/Restoration, and Management Strategy Performance, ASTM STP 1442, J. Locat, R. Galvez-Cloutier, R.C. Chaney and K.R. Demars, Eds., ASTM International, West Conshohocken, PA, pp. 236-247
- Fox, P.J. and Berles, J.D. (1997). "CS2: A Piecewise-Linear Model for Large Strain Consolidation." International Journal for Numerical and Analytical Methods in Geomechanics, Vol.21, pp. 453-475