Relative Erosion Resistance

AquaBlok™

TEST REPORT #6: Relative Response of Typical Fresh-water AquaBlok and Non-Cohesive Substrates to Fluvial-Like Erosive Forces

Background and Purpose of Testing

According to the U.S. Army Corps of Engineers (Palermo et. al., 1998), one principal function of an in-situ remedial sediment cap – in addition to reducing contaminant flux, as discussed in Test Report #3 – should be to stabilize contaminated sediments, preventing their re suspension and subsequent transport to other (e.g. downstream) locations. Installation and maintenance-in-place of remedial caps that withstand significant erosional forces related to hydrologically dynamic systems (like rivers or estuaries) will minimize exposure, redistribution, and dispersion of the sediments being capped.

The purpose of this set of laboratory tests was to demonstrate the relative physical resistance of typical freshwater AquaBlok™ and other, less cohesive materials to significant, fluvial-like erosive (shear) forces of known velocity and duration.

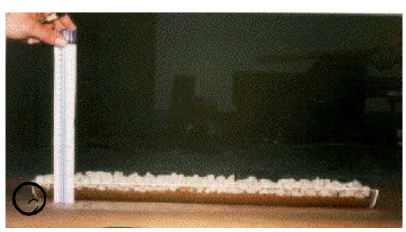
Note that these tests were conducted under highly controlled laboratory conditions and using substrate conditions that may not be representative of actual field conditions. Consequently, the data should not be interpreted as indicative of the expected response of these different capping materials under specific field conditions.

Methods

For several different projects, the relative resistance of a variety of selected AquaBlok formulations, fine-grained sediment, and sand samples have been characterized in the laboratory using a circulating flume system. This flume system (Photograph 1) is comprised of a 7.5 foot long x 4 inch- internal-diameter, clear PVC sample chamber, a pump, and a holding tank that supplies and receives flow to and from the sample chamber. The sample chamber is connected to the rest of the flume system through flexible hosing and threaded unions.

Photograph 1. Large-Scale Circulation Flume System

Depending on project needs, specific parameters and procedures for flume testing can vary with respect to induced flow velocities, flow duration, sample size or configuration, pretest hydration periods, etc. Nevertheless, the general procedure typically used during testing of these samples was as follows: a pre-weighed sample was placed into the clear, semi-circular, two-foot-long x 1.5-inch high acrylic sample holder (Photograph 2); samples were typically placed into the holder to result in a surface that was approximately 0.4 to 0.8 inches above the top edge of the holder, thus placing a portion of the sample directly into the flow path.



Photograph 2. Side View of AquaBlok-Over-Sand Sample Prior to Testing

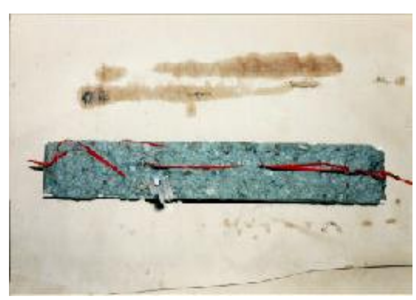
The sample was then carefully inserted into the sample chamber. Flat and sloped spacer sections were placed into the flume chamber – both "upstream" and "downstream" - to establish more uniform flow over the test sample.

Once the flume chamber was closed and secured, municipal tap water was pumped across the sample surface at controllable flow velocities (as manipulated through the use of in line valves). The system configuration allows for establishing and periodically checking flow velocities by diverting flume-chamber discharge from the holding tank into a volume-calibrated drum and measuring the time required to pass a specific water volume across the test sample. Flow velocities over a given sample - in units of feet per second - could then be calculated using bulk-flow measurements together with estimates of the cross-sectional surface area over the top of a sample. Flow velocities are referred to in terms of approximate ranges because cross sectional areas can vary along sample length (due to variable surface topography) and also over time (due to continued clay hydration and/or erosional losses).

After testing, a sample can then be removed from the chamber and reweighed to estimate mass loss through erosion. The physical response of samples during and after testing can also be evaluated in various ways, including: visual observation and video documentation, pre-/ post-test weight comparisons, or estimating clay loss based on typical, pretest AquaBlok™ compositions (Hull et al., 1998).

Results and Observations

Results of multiple flume tests indicate that relatively insignificant AquaBlok erosion occurs at flow velocities as high as 5 to 6 ft/sec, and for continuous flow durations for up to several days. Photograph 3 illustrates typical AquaBlok sample response to flume testing.



Photograph 1. Typical plan-view appearance of AquaBlok sample after testing (red ribbons are flow indicators)

In contrast to AquaBlok's relative resistance to shear stresses under relatively high-flow conditions, erodibility is typically high for sand and unconsolidated, fine-grained sediments at flow velocities of approximately 2 ft/sec or less, and for flow periods of as short as 10 to 20 minutes. Such unconsolidated saturated materials can display 90 percent mass loss under these relatively passive flow conditions.

In a related note, results of laboratory flume tests conducted by others (e.g. Gailani et al., 2001) indicate that adding even small amounts of bentonite (a principal component of typical freshwater AquaBlok formulations) to relatively non cohesive topsoil and sand materials can greatly reduce material erosion rates, thus enhancing the stability of these materials for sediment capping.

Conclusions

Laboratory study of relative resistance of typical freshwater AquaBlok to shear stresses invoked under various testing conditions indicates that AquaBlok is relatively resistant to considerable – and sustained - fluvial-like erosive forces. Consequently, sediments occurring in fluvial environments and overlain by AquaBlok or AquaBlok-based capping systems could remain in place and physically stabilized during relatively high-flow events (e.g. a 100-year flow event). Depending on site conditions, AquaBlok-based cap designs could include a surficial armoring component, if relatively higher flows are expected.

In contrast, other materials such as less-cohesive sediments and sands prove less resistant to erosive forces. Depending on a site's hydrologic/hydraulic conditions, capping of sediments with less shear resistant materials like sand may not offer the same degree of sediment stabilization as can AquaBlok-based capping, or could require excessive thicknesses of sand that could interfere with waterway navigation.

References

Hull, J.H., J.M. Jersak, and B.J. McDonald, 1998. Examination of a new remedial technology for capping contaminated sediments: large-scale laboratory evaluation of sediment mixing and cap resistance to erosive forces. Remediation, Summer 1998 issue: pp 37-58.

Gailani, J.Z., Jin, L., McNeil, J., and Lick, W. (2001). "Effects of bentonite on sediment erosion rates," *DOER Technical Notes Collection* (ERDC TN-DOER-N9), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/dots/doer*

Palermo, M., S. Maynord, J. Miller, and D. Reible. 1998. "Guidance for In Situ Subaqueous Capping of Contaminated Sediments," EPA 905 B96-004, Great Lakes National Program Office, Chicago, IL.

AquaBlok® Composite Particle System

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