FILTREXX®
Advanced Tubular Filters

TechLink Research Summary #3333

Performance of Seven Sediment Control Barriers Under Large-Scale Testing

Performance of sediment control barriers is of increasing concern to designers, regulators, and contractors. Whether staying in compliance with state and federal permits, protecting sensitive water bodies, or simply demanding high-performing practices on job sites, knowing how sediment control barriers perform and compare to one another has become of critical importance. In order to evaluate the sediment control performance between various sediment control barriers, these practices must be subject to the same standardized testing procedure or evaluated in controlled side-by-side testing. This testing project does both.

OBJECTIVES

The primary objective of this study was to evaluate the performance of the following sediment control barriers: 9-in Filtrexx® SiltSoxx™, 12-in Filtrexx® SiltSoxx™, 12-in Compost Tube, 9-in Straw Wattle, 20-in Straw Wattle, 9.5-in Tire Chip Filled Wattle, and 10-in Triangular Silt Dike. The secondary objective of this study was to determine any sediment removal performance differences between compost filter socks meeting all federal/state specifications (Filtrexx® SiltSoxx™) versus those that do not comply (Compost Tube). It has been hypothesized that compost filter socks/tubes containing predominantly fine particle-size filler material (> 50% passing 3/8-in) and/or a containment system with mesh apertures smaller than 1/8-in do not allow adequate hydraulic flow through, and thereby overtop faster, leading to increased sediment loss; or the increased hydraulic pressure behind the barrier leads to undermining and even greater loss of sediment. These same characteristics may also have a similar effect on performance of wattle/tube devices using filler material other than compost filter media.

MATERIALS & METHODS

The large-scale testing reported herein was performed in accordance with ASTM WI 11340 modified as necessary to accommodate the selected products, on 3:1 slopes using sandy clay test plots measuring 27-ft long x 8-ft wide. Simulated rainfall was produced by "rain trees" arranged around the perimeter of each test slope. Each rain tree had four sprinkler heads atop a 15-ft riser pipe. The rainfall system was calibrated prior to testing to determine the number of sprinkler heads and associated pressure settings necessary to achieve target rainfall intensities and drop sizes. The target rainfall intensities were 2, 4, and 6-in/hr and were applied in sequence for 20 minutes each. Three replicate test slopes with the perimeter sediment control barriers (SCBs) installed at the bottom were tested. The sediment retention provided by the product tested was obtained by comparing the protected slope results to control (bare soil) results.

The initial slope soil veneer was 12-in thick and was placed and compacted on the slope prior to each run. Compaction was verified to be 90% (± 3%) of Proctor standard density using ASTM D2937 (drive cylinder method). Subsequently, the test slopes underwent a "standard" preparation procedure prior to each slope test. First, any rills or depressions resulting from previous testing were filled in with test soil and subject to heavy compaction. The entire test plot was then tilled to a depth not less than four inches. The test slope was then raked to create a slope that was smooth both side-to-side and top-to-bottom. Finally, a steel drum roller was rolled down-and-up the slope three times proceeding from one side of the plot to the other. The submitted erosion control product was then installed using the technique acceptable to/ recommended by the manufacturer. For this testing, sediment control barriers were installed on the slope as follows:

1. Compost Socks/Tubes installed with wood stakes @ 2-ft centers.
2. Straw Wattles installed with wood stakes @ 2-ft centers.
3. Erosion Eel installed with 5-ft Steel T-Posts (downstream) @ 2-ft centers.
4. Triangular Silt Dike installed with apron in upslope anchor trench and 6-in staples through the apron.


Fig. 1: Test Plot Set-Up Prior to Treatment Installation.

Immediately prior to testing, rain gauges were placed at the quarter points (i.e. 6.75, 13.5, 20.25-ft) on the slope. The slope was then exposed to sequential 20-minute rainfalls having target intensities of 2, 4, and 6 inches per hour. All runoff was collected during the testing. Additionally, periodic sediment concentration grab samples were taken and runoff rate measurements were made. Between rainfall intensities, the rainfall was stopped and rainfall depth was recorded from the six rain gauges, valves are adjusted to facilitate the subsequent rainfall intensity, and empty collection vessels were positioned to collect subsequent runoff. After allowing for sediments to settle, water was decanted from the collected runoff. The remaining sediments were collected and dried to determine total soil loss.

The Practice Management (P) Factor from the Revised Universal Soil Loss Equation (RUSLE) of the USDA-ARS Agricultural Handbook 703 was the reported performance measure for slopes determined from this testing. The A-Factor, R-Factor, and P-Factor reported herein are related through RUSLE by the following relationship:

A = R x K x LS x C x P

where:

A = the computed soil loss in tons per acre (measured/calculated from test);
R = the rainfall erosion index (measured/calculated from test);
K = the erodibility of the soil (calculated from control tests);
LS = the topographic factor (2.02 for 8 x 27 ft slope);
C = the cover factor = (1.0 for all test slopes); and
P = the practice factor = ratio of treated slope sediment loss (via the sum of sediment moving through, over, or under a SCB) to control slope sediment loss (via sediment without SCB).

Note: P = 1.0 for the control slope.

Total sediment loss and the associated rainfall depth measured during the testing are the principle data used to determine the P-Factor. The P-Factor thus calculated is the reported performance value. This facilitates product-to-product comparison of test results at a common point of the storm event.

RESULTS

Results from measured design criteria and performance testing are reported in Table 1 for each individual sediment control barrier. Performance test results are based on means for all three tested replications.

Table 1: Design Characteristics and Performance of Sediment Control Barriers.

Sediment Control Barrier (SCB)	Design Dia/ Height (in)	Density/Weight (lbs/linear ft)	Undermined[‡]/ Overtopped (min)	Sediment Loss (tons/acre)	P Factor	Removal Efficiency (%)
Filtrexx® SiltSoxx™	8	10.4	28	2.6	0.18	82
Filtrexx® SiltSoxx™	12	25	NA	0.4	0.03	97
Straw Wattle	9	2.2	43[‡]	2.8	0.21	79
Straw wattle	20	2.7	33[‡]	4.1	0.30	70
Off-spec compost sock	12	14.7	26	4.6	0.34	66
Tire-chip wattle	9.5	16.6	23[‡]	4.4	0.31	69
Triangular Silt Dike	10	0.5	34	0.9	0.07	93
Bare soil (control)	NA	NA	NA	14.5	1.0	0

SUMMARY & CONCLUSIONS

The main objective of this study was to evaluate the sediment control performance of seven different sediment control barriers under a standardized testing procedure. Based on the testing methods described above, the sediment control barrier characteristics that most affected sediment removal performance included staking, degree of level surface, and particle size of filler media. All sediment barriers experienced overtopping for all replicates due to the amount of runoff and sediment generated under this test method. Overtopping increased at low points in the sediment control barrier, due to depressions from staking or uneven fill material. Because of this phenomenon, practices with extremely level surfaces are able to maintain sheet flow during overtopping (rather than localized concentrated flow) thereby reducing sediment loads flowing over the practice. Those practices that utilize finer particle-size materials for filler media (straw wattles, off-spec compost tube) appeared to overtop or undermine faster, due to the increased rate of runoff accumulation (ponding) and/or hydraulic pressure behind the barrier. Additionally, these sediment control barriers were most likely to undermine, thereby releasing the most sediment. It should be noted that overtopping typically releases much less sediment, relative to undermining, as the former still allows sediment deposition and filtration to continue, while the latter often results in mass failure if left unchecked.

In sum, those practices that could convey runoff through the barrier while preventing undermining were the best performing practices – these included both SiltSoxx™ and Triangular Silt Dike. It should be noted that the tire-chip wattle has both high density and apparent high hydraulic-flow through rate characteristics, but because the practice cannot be staked (secured to the ground), this practice experienced more undermining than any other.

The secondary objective of this study was to evaluate any sediment control performance difference between compost filter socks adhering to federal and state specifications versus those that do not meet these specifications. While the quantitative difference between these two practices is quite substantial, it is interesting to note that the 8-in SiltSoxx™ performed better than the 12-in off-spec compost tube, generating 43% less tons/acre of sediment, underscoring the importance of specification compliance in the performance of these practices. Furthermore, although the 8-in SiltSoxx™ was the smallest diameter sediment control barrier, it performed better than any other tubular sediment control barrier in the study. And finally, likely due to the combination of high density, high hydraulic flow through, staking ability, and filtration, the 12-in SiltSoxx™ did not undermine, resulting in 91% less tons/acre of sediment relative to the off-spec compost tube, and earning the highest sediment removal efficiency and designation of best performing sediment control barrier in this study.

Fig. 2-6: Testing Photos from TRI Environmental

Fig. 2: 12" SiltSoxx™
(97% Removal Efficiency)

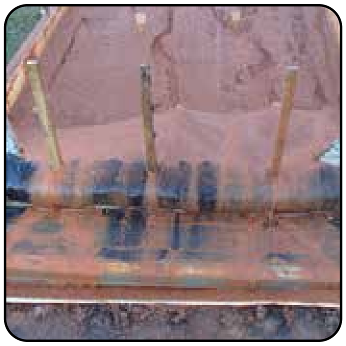

Fig. 3: 12" Off-Spec Compost Sock
(66% Removal Efficiency)

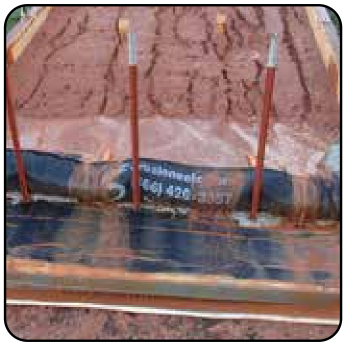

Fig. 4: 9.5" Tire-Chip Wattle
(69% Removal Efficiency)

Fig. 5: 10" Triangular Silt Dike
(93% Removal Efficiency)

Fig. 6: 20" Straw Wattle
(70% Removal Efficiency)

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