COMPARISON OF EROSION CONTROL TECHNOLOGIES: “BLOWN STRAW VS EROSION CONTROL BLANKET, QUANTIFICATION OF PERFORMANCE AND VALUE

EROSION CONTROL TECHNOLOGY COUCIL

Greater societal awareness of the costs of pollution and regulatory emphasis on maintaining clean, beneficial waterways have resulted in a need for quantifiable performance in erosion and sediment control practices. As lands are disturbed, erosion and sediment control professionals are demanding Best Management Practices (BMPs) that can be specified, installed, and inspected with confidence. To that end, manufactures of Rolled Erosion Control Products (RECPs) and various other stakeholders within the erosion control community formed the Erosion Control Technology Council (ECTC). ECTC endeavors to develop testing protocols, installation guidelines, and application specifications from a non-biased industry perspective. Further, ECTC provides distributors, contractors and specifiers technical information and product application information as to the state of the practice of RECPs.

Challenges in providing adequate erosion control in the field require a diverse toolbox of solutions. BMPs refer to the individual tools available to the erosion control professional in stabilizing and minimizing soil erosion. Included in any standard toolbox of BMPs should be solutions intended to provide varying levels of performance and economy. Determining the overall most beneficial solution to any particular field challenge, an understanding of the expected performance and overall value of alternative practices must be obtained. ECTC has conducted research for a series of BMPs to evaluate common technologies. Within the framework of a dedicated study, the practice typically referred to as “Blown Straw” and a typical RECP were compared. This article presents the results of the comparison.

Erosion Control Practices, Materials and Products

The United States Environmental Protection Agency (USEPA) defines a BMP as “A practice used to reduce impacts from a particular land use.” BMPs may consist of a practice applied in the field, application of material, or installation of a manufactured product. Of the three methodologies, expense and performance increase with the level of effort and as confidence in results increases. Field practices, including traversing bare slopes with tracked machinery to interrupt flow, represent the least expensive and least reliable form of erosion control. An application of a natural mulch or hydraulically applied manufactured cover represents an upgraded level of performance. Finally, manufactured and performance verified products like RECPs provide the highest level of erosion protection and confidence.

The advantage of manufactured erosion control products is the level of confidence in the quality, consistency and performance. Manufactured products are held to the highest standard of evaluation and regulation. Thus, manufactured products tend to be the most costly, however, most reliable tool in the toolbox. Further, manufactured products are designed and produced from various materials to meet the varying requirements and challenges found in the field. RECPs are available in a variety of configurations to provide maximum erosion protection, increased infiltration, and/or enhance mulching capability. Further, RECPs are designed to have expected longevities ranging from 45 days to over three years. Thus, an erosion control professional will virtually always have an acceptable solution to nearly every design challenge. Figures 1 through 4 present photographs of Blown Straw and RECPs in action.

Quantifying Costs

Erosion Control Technology Council

Figure 1. Temporary ECB on Slope

Figure 2. Blown Straw in Detention Pond

Figure 3. Temporary ECB on Slope

Figure 4. Blown Straw on Slope

Regulations require appropriate technologies be applied to ensure performance within an acceptable tolerance of risk. It is of critical importance to ascertain the overall cost and performance of each methodology to determine the value of the practice. All erosion control practices and products require monitoring and maintenance after installation. Practices that are initially inexpensive may incur additional expense in maintenance which could potentially exceed the initial savings. In quantifying the total cost of an erosion control plan, the expected performance of the specified treatment must be considered. Costs of manufactured products, whether hydraulically applied or rolled on the soil surface, can vary depending on scope, product and location. However, manufactured products are typically required to be evaluated in laboratory or field trials. Quantification of the expected level of performance, coupled with monitored quality control in manufacturing decreases the risk and maintenance of any given installation.

Quantifying Performance

In order to develop confidence in expected results, erosion control practices must be tested. Testing procedures are developed to quantify parameters critical to performance that can not be theoretically derived. Over the course of time, BMPs were identified, developed and tested. However, testing methodologies have not remained constant. Technologies and practices were evaluated as per the state of the practice at the time.

In the case of RECPs, a very rigorous series of evaluations has been developed and implemented. Testing and research that the RECP industry utilizes have proven to be major catalysts in the overall increase in confidence and use of the technology. Detailed testing has been conducted on virtually hundreds of products under various conditions and protocols. Testing for slope installations has focused on the ability of the RECP to mitigate the forces of detachments from rainfall and rainsplash while maintaining soil in place. Several facilities throughout the country are configured and utilized for testing. ASTM International maintains a refereed standard (D6459) for the large-scale evaluation of RECPs performance in a rainfall scenario. The ASTM standard requires the product to be tested on a 3:1 (H:V) slope and be subjected to a series of controlled rainfall events while monitoring sediment migration and runoff. The ASTM standard provides a consistent methodology for testing and a means of comparison to evaluate competing products and technologies. In addition to the ASTM standard, implementation of approved product programs on the state and federal level typically requires testing by alternate protocols.

Conversely, practices utilizing non-manufactured material or in-field techniques have not been evaluated under the same scrutiny. Many states do not require testing of non-manufactured techniques, nor associate any performance limits to the practice. However, over the course of the development of erosion control techniques, many practices have been evaluated by field trials or simulated conditions applied to field installations. Testing of many practices were conducted on available plots of land, subjected to whatever storms nature provided. In the case of Blown Straw, values for the performance of the technique have been published by the Center for Watershed Protection, referenced from Harding (1990) and Horner (1990). According to the research conducted, Blown Straw reduced erosion up to 93.2%. Two specific evaluations were cited utilizing differing evaluation methods. Performance of an erosion control practice on a slope typically is dependent on the rainfall energy, slope grade, slope length and the soil type utilized for testing. Further, performance may vary if the application was exposed to little rainfall or little wind.

Direct comparison of Blown Straw to RECPs can be conducted by evaluating the Cover Factor utilized within the Revised Universal Soil Loss Equation (RUSLE). A value for Cover Factor may be derived from testing as the ratio of sediment yield in the protected condition to sediment yield of the unprotected condition. Lower Cover Factor values indicate improved performance. Table 1 presents a summary of testing parameters typically used for RECPs, Blown Straw testing reported by Harding and Horner, and Blown Straw testing reported by Clopper et al. Table 2 presents a summary of values reported by Harding compared with typical values published for RECPs.

Table 1. Critical Testing Parameter Used in Comparative Testing

Parameter	Blown Straw Testing as Reported by Harding		Blown Straw as Reported by Clopper et. al. (ASTM D6459)	Temporary ECB (ASTM D6459)
Application Rate	1.25 T/ac	2.0 T/ac	2.50 T/ac	Single Blanket Installed per Manufacturer
Slope Steepness	24 %	9 %	3:1 (H:V) (33 %)	3:1 (H:V) (33 %)
Slope Length	No slope length noted in report	No slope length noted in report	40 feet	40 feet
Rainfall Intensities	Variable—13 storms over 2 seasons	106.6 mm/hr (4.2 in / hr) 147.3 mm / hr (5.8 in / hr)	51, 102, 154 mm / hr (2, 4, 6 in / hr)	51, 102, 154 mm / hr (2, 4, 6 in / hr)
Rainfall Drop Height	Field Installation	Unknown	14 feet	14 feet
Test Duration	13 storms over 2 seasons	2 tests one hour duration	20 minutes	20 minutes
Soil Type	Gravelly Sand Loam	Silt Loam	Sand, Loam, Clay	Sand, Loam, Clay

Table 2. Comparison of Cover Factors

Cover Factor (1)			
Practice Longevity	Blown Straw Testing as Reported by CWP (2)		Typical RECP Values
	Test Series A	Test Series B	
Temporary	0.068	0.107	0.001—0.100
Extended Term	N/A	N/A	0.050—0.150
Permanent	N/A	N/A	0.010—0.250

(1) Cover Factor express as the ration of sediment yield in the protected condition to unprotected (normalized with respect to measured rainfall.)

(2) CWP 2000

Evaluation of Table 2 shows the Blown Straw techniques compare favorably with RECPs. However, given the limitations of the testing methodologies employed (e.g. minimal slope gradient), a comparison under identical conditions is necessary to strictly evaluate the benefits and potential performance of each practice with respect to the overall cost of implementation.

A study was conducted to evaluate the performance of Blown straw versus a typical RECP, utilizing identical testing methods. In order to determine the potential for Blown Straw to be used as a replacement for RECPs, the RECP testing protocol, ASTM D6459 was employed.

Blown Straw was applied to the test plot at a rate of 2,837 kg/Ha (2,500 pounds per acre). An RECP consisting of a single netted, temporary Erosion Control Blanket (ECB) was utilized for the comparison. The unit weight of straw in the ECB effectively resulted in approximately 2,746 kg/Ha (2,420 pounds per acre or 0.5 pounds per square yard) rate of straw applied to a site. The ECB was rolled onto the plot and secured to the ground surface using metal U-staples. Staples were positioned in accordance with the manufacturer's guidelines. Each practice was evaluated under identical conditions, on three soil types. Simulated rainfall was produced at three intensities 51, 102 and 154 mm/hr (2, 4 and 6 inches per hour). Each installation was exposed to increasing rainfall intensities to allow for the quantification of performance. Figures 5 through 8 present photographs from the comparative testing conducted.

Figure 5. RECP Installed for Testing

Figure 6. Blown Straw Installed for Testing

Figure 7. RECP During Testing

Figure 8. Blown Straw During Testing

As each simulated rainfall event was generated, runoff from each test plot was collected. Runoff was evaluated to determine the total sediment yield and water volume from each plot. Unprotected plots were tested identically as a reference. Sediment yield from each protected plot was compared to the reference plot of the same soil type to determine the percentage sediment yield reduction. Sediment yield reduction was normalized with respect to the actual recorded volume and duration of the simulated rainfall event for each plot. Table 3 presents a summary of the results as presented by Clopper et al compared with values reported by Harding and Horner.

Table 3. Summary of Blown Straw versus RECP Testing Results

Cover Factor (1)				
Soil Type	**Blown Straw Testing as Reported Harding (2)**		**Blown Straw as Reported by Clopper et. Al. (ASTM D6459)(3)**	**Temporary ECB (ASTM D6459) (3)**
	Test Series A	**Test Series B**		
Sand	N/A	N/A	0.003	0.010
Loam	0.068	0.107	0.810	0.018
Clay	N/A	N/A	1.000	0.222

(1) Cover Factor express as the ration of sediment yield in the protected condition to unprotected (normalized with respect to measured rainfall.)

(2) CWP 2000

(3) Clopper et. al. 2001

Evaluation of Table 3 reveals a distinct difference in the sediment yield produced by the test plots protected by blown straw and the RECP. The results are provided in Figure 9 graphically for visualization.

The dramatic difference in performance of the two systems is evident in Figure 9. Blown Straw was effective on the sand soil and on shallow slopes with loam soil. However, Blown Straw provided little benefit on the steep slopes, and no measurable benefit on clay soil. In contrast, the RECP was over 98% effective on both the sand and loam plots and reduced erosion on the clay plot by nearly 80%. As RECPs are a technology that is developed from intelligence in engineering and consistency in quality, the benefits realized where the raindrops meet the slope were not surprising. However, the overall lack of utility on slopes without the potential to freely drain, was contradictory to other work. Comparing the results from testing of the two methodologies, it becomes evident that the field usefulness of Blown Straw is restricted to shallow slope, low risk environments. Applied to steeper slopes and exposed to significant rainfall, Blown Straw provides minimal benefit as an erosion control practice. The intelligence in engineering, diligence in quality, and confidence in verified performance make RECPs ideal for the demanding applications for steeper slopes and other challenging field conditions.

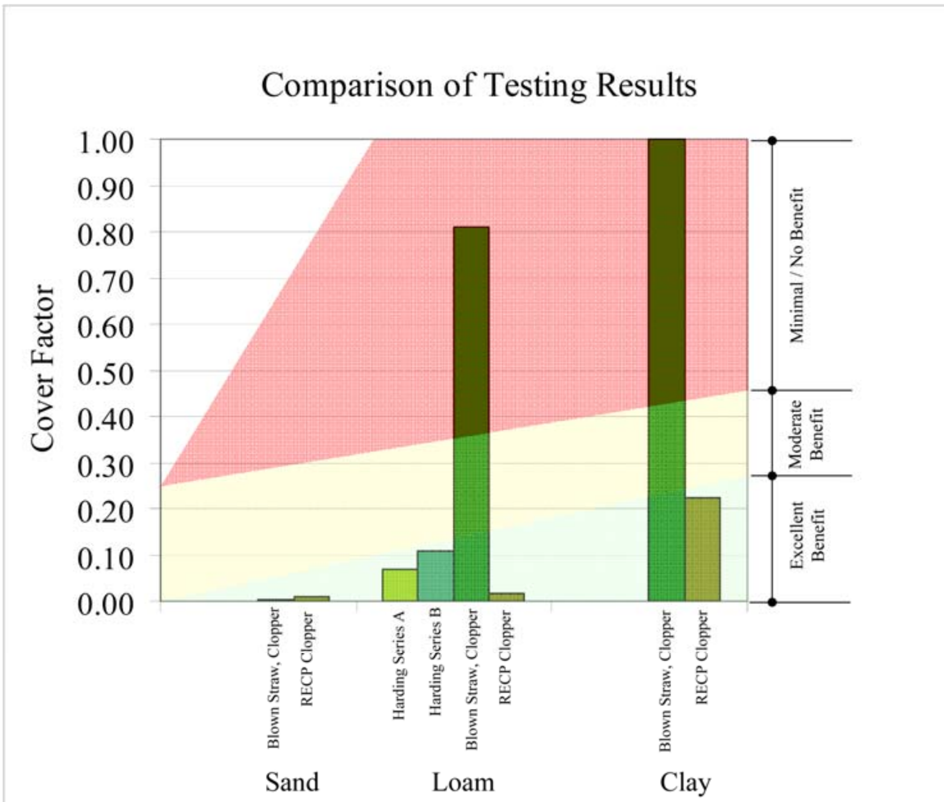

Figure 9. Graphical Presentation of Test Results

Conclusion

It is often difficult for designers and specifiers to distinguish between erosion control technologies. It is also difficult to make informed choices with the variety of information available and the ever-evolving state of standards and testing. Direct comparison of technologies under identical conditions and utilizing state of the practice methods, provides the single best means of delineating the performance of competing technologies. As RECPs are many times utilized in extremely demanding field conditions, RECPs are subjected to the scrutiny of testing, evaluation and regulatory compliance of engineered products.

Environmental stewardship requires diligence in maintaining the integrity of erosion control applications. Economic feasibility requires the use of appropriate technologies for field conditions. Selection of technologies based on expected performance, field conditions and consideration of risk yields erosion control solutions that provide environmental stewardship.

References

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