TEMPORARY SLOPE PROTECTION: COST VS. EFFECTIVENESS

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ABSTRACT

Soil stabilization is a key concept in the realm of erosion control. As many construction sites are in the grading phase, slopes become exposed requiring temporary stabilization protection before homes, permanent landscaping or other enhancements are established to maintain compliance with the NPDES permit. Several products on the market provide sufficient coverage and protection. Performance correlates with the costs, as shown in a study conducted by Landscape Development, Inc. Varying products were shown to reduce the amount of soil lost on a typical 2:1 slope. However, performance is also dependant upon the area that needs protection, the type of soil, and the amount of time the protection is needed.

Landscape Development, Inc. conducted a study in Santa Clarita, CA. Eight products and applications were tested on 92.9 square meters (1000 square foot), 2:1 slope panels during the heavy rain season of 2004-2005. The rains in this area accumulated to over 101.6 cm (40 inches) between October and May. The products and applications tested include straw blanket, blown straw with organic binder-tackifier, straw/coco blanket, coconut blanket, jute netting, wood fiber mulch and organic binder, a preblended stabilized fiber matrix (SFM) with two stabilizer components (a tackifier and cross link binder), and another stabilized fiber matrix (SFM) with one stabilizing component consisting of wood fiber mulch with polyacrylimide stabilizer.

Four soil loss samples were taken over the course of the study. The weight of the soil lost was accumulated and used in comparing the performance of the varying products and applications. The blanket products performed better, overall, for retaining the soil on the slope face when compared for amount of soil lost per inch of rainfall. The cost comparison for all the products and applications showed comparable pricing when extended over the duration of the product/application’s effective lifeline.

Keywords: erosion control, slope protection, cost-effectiveness

1.0 WHY IS SOIL STABILIZATION IMPORTANT?

As a builder looks to begin a new project, there is the onerous task of essentially “moving mountains”. In the Southern California region, land suitable for homes and buildings in appealing areas is becoming scarce. The solution many builders utilize is to change the geography of the land by cutting down mountains to build new development sites; rearranging the land to fulfill the needs of the ever-growing demand.

Hundreds of millions of dollars are spent on moving dirt to create more suitable land usage. With this comes exposed soil, new unprotected slopes, and with rainfall the potential for soil erosion and damage to the newly graded areas and discharges of unacceptable levels of soil in the run off waters. Facing a rainy season after countless hours and dollars were expended to create a useful, appealing building space heightens the importance of soil stabilization. Keeping soil in its original place is an obvious cost reducer, but compliance to NPDES regulations is required and the need for effective soil stabilization becomes more important.

2.0 SEDIMENT VS. EROSION CONTROL

What is the difference between sediment and erosion control? Essentially one occurs after the other has failed. With new technology and a better understanding of the erosion control industry, sediment control as the primary method of controlling erosion on construction sites is a thought of the past. Sediment control is virtually managing the displaced soil and sediment being washed away in a rain event or by irrigation. This sediment along with its pollutants cannot leave the site in order to maintain compliance with the NPDES permit. With the typical amount of storm water runoff associated with projects, water is flowing steadily and needs to drain offsite. This is where erosion control and proper planning comes into play. Erosion control is preventing soil from being dislodged and the resulting sediment from traveling with the runoff down slopes and roads toward the outlets of the site. Soil stabilization is a key part of the erosion control plan in creating a more manageable project and reducing flow of water with sediment and pollutants. Keeping the soil in place by way of erosion control is a more effective way of managing a storm water pollution plan than sediment control alone. An effective plan will utilize a combination of both erosion and sediment control.

3.0 BACKGROUND SITE CONDITIONS

The Santa Clarita Valley in Southern California was the location where nine panels were created to test various soil stabilizing products. These compartmentalized panels were 92.9 square meter (1000 s.f) in area and built on a 2:1 slope. The soil type was classified as loamy sand. At the toe of each slope, within each of the compartments, an area of poly sheeting was installed to capture all the soil lost throughout the study. The displaced soil was collected four times over the course of the study. Soil was taken to the lab where weight and soil composition was measured. Rainfall data from the National Weather Service for that area was used in the calculations of this study.

There were a total of nine panels for this study. The first panel was a control panel in which no soil-stabilizing product was installed. Another panel consisted of a straw blanket made of 100% California straw with poly type biodegradable stitched netting on both sides. A third panel was applied with straw blown on the slope at a rate of 1.8 metric tons (2 tons) per 0.4 hectares (1 acre) with 90.7 kg (200 pound) per acre of organic binder tackifier and 680.4 kg (1500 pound) per 0.4 hectares (1 acre) of wood fiber mulch applied hydraulically. The fourth panel was protected with a blanket consisting of 30% coir fiber and 70% California straw with a poly type biodegradable stitched netting on both sides. On the next panel, a pre-blended Stabilized Fiber Matrix was hydraulically applied at 1134 kg (2500 pound) per 0.4 hectares (1 acre). The sixth panel had a 100% coir fiber with a poly type biodegradable stitched netting on both sides. The seventh panel was covered with 100% natural hemp fiber jute netting that had not been treated with non-smolder resistant chemicals. The next panel was protected with a polymer that was applied at the rate of 30.3 liters (8 gallons) per 0.4 hectares (1 acre) in conjunction with 1134 kg

(2500 pound) of wood fiber mulch per 0.4 hectre (1 acre). The final panel was hydraulically sprayed with 90.7 kg (200 pound) per 0.4 hectare (1 acre) of organic binder tackifier with 1134 kg (2500 pound) per 0.4 hectare (1 acre) of wood fiber mulch.

4.0 RESULTS

The study was conducted from October 2004 to May 2005. Soil collections were made on 11/23/04, 2/4/05, 4/13/05, 5/19/05. Weight of the soil collection is depicted in Table 1. The amount of rainfall for this study is detailed in Table 2.

Table 1. Soil loss collection in kilograms (pounds)

Material/Date	11/23/04	2/4/05	4/13/05	5/19/05	Total Loss
Natural	10.1 (22.3)	49.6 (109.28)	36.5 (80.53)	1.89 (4.18)	98.09 (216.25)
Straw blanket	0.3 (0.6)	1.35 (2.984)	0.38 (0.853)	0.19 (0.423)	2.22 (4.897)
Blown straw w/Tackifier	0.2 (0.43)	1.29 (2.839)	0.36 (0.8)	0.11 (0.253)	1.96 (4.32)
Coco/Straw blanket	0.03 (0.064)	0.96 (2.129)	0.139 (0.306)	0.012 (0.026)	1.14 (2.525)
Coconut blanket	0.036 (0.079)	0.92 (1.988)	0.187 (0.414)	0.008 (0.018)	1.15 (2.499)
Jute netting	1.46 (3.23)	15.7 (34.61)	1.8 (3.96)	0.302 (0.666)	19.26 (42.469)
Wood fiber mulch w/binder	0.98 (2.16)	20.2 (44.6)	14.7 (32.5)	1.34 (2.949)	37.22 (82.209)
Preblended SFM	1.06 (2.33)	14.95 (32.96)	12.75 (28.1)	1.33 (2.925)	30.09 (66.313)
Polymer w/wood fiber mulch	1.2 (2.65)	17.6 (38.82)	12.65 (27.88)	1.16 (2.555)	32.61 (71.907)

Table 2. Rainfall per month

Month	Rainfall cm (inches)
October	12. 6 (4.96)
November	0.59 (0.231)
December	12.4 (4.882)
January	39.57 (15.581)
February	29.1 (11.47)
March	5.1 (2.01)
April	1.8 (0.713)
May	0.42 (0.167)

5.0 DISCUSSION

Rainfall is a major cause of erosion on slopes. The impact of a raindrop is the primary step in erosion development. Subsequent runoff begins the process of soil transfer. These two components are often the cause of much damage to slopes and generate a multitude of costs associated with handling the sediment loss and repairing damaged slopes. Therefore, it is common sense and of utmost importance to protect the exposed slopes by creating a barrier of direct contract of raindrop and soil and stabilizing against runoff.

The amount of soil lost in comparison of each inch of rainfall is shown in Figure 1. Overall, the blanket stabilizers performed better than the spray on applications. These results also show a direct relation with cost as seen in Figure 2.

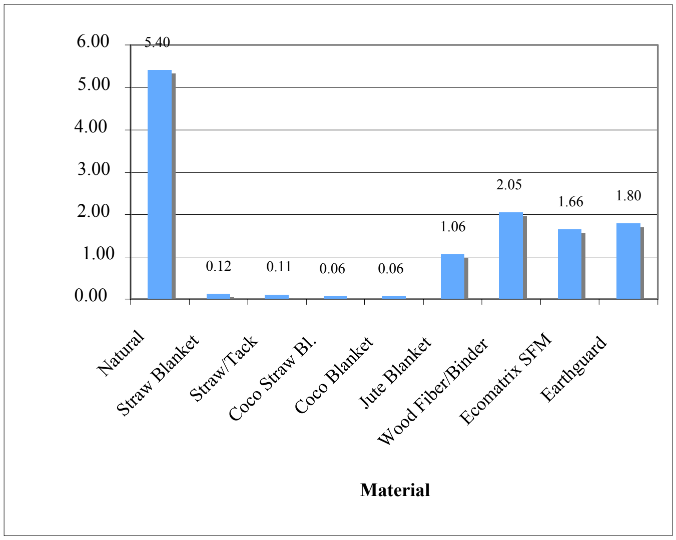

Figure 1. Pounds of soil lost for each type of material per inch of rainfall.

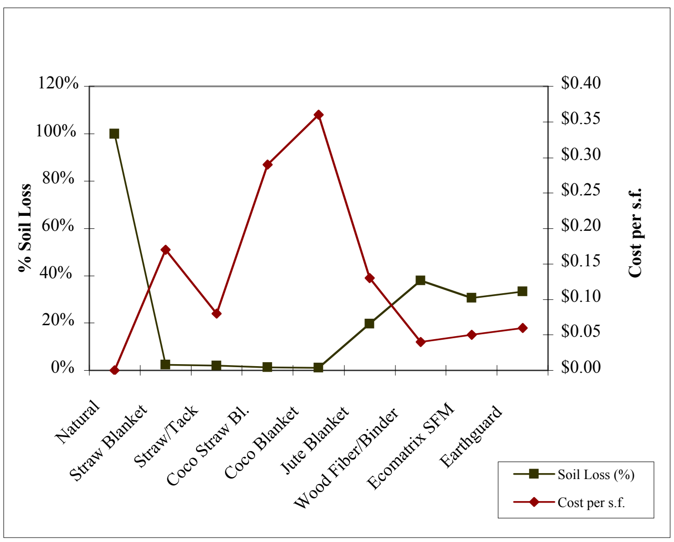

Figure 2. Cost comparison of each material to the percentage of soil lost.

Each type of application has a different lifespan. Taken into consideration, the overall cost versus effectiveness becomes a more level playing field. Table 3 shows the comparison of the various products in relation to their effectiveness and cost.

Table 3. Cost comparison for the various applications in regards to lifespan and price per square foot.

Material	Soil loss (lb.)	Price per s.f. ($)	Lifespan (months)	Cost/s.f./month
Natural	216.25	$0.00	0	$0.000
Straw blanket	4.897	$0.18	9	$0.02
Blown straw w/tackifier	4.32	$0.085	6	$0.014
Coco/Straw blanket	2.525	$0.24	24	$0.010
Coconut blanket	2.499	$0.30	36	$0.0083
Jute netting	42.469	$0.15	18	$0.0083
Wood fiber mulch w/binder	82.209	$0.04	6	$0.007
Preblended SFM	66.313	$0.05	6	$0.008
Polymer w/wood fiber mulch	71.907	$0.06	6	$0.010

It can be seen that cost is directly correlated with the lifespan of the application as well as the effectiveness in minimizing soil loss. For example, coconut blanket is the most expensive of the materials, on a per square foot basis, and it lost the least amount of soil. However, taken over the lifespan of the product, the cost is comparable to that of the hydraulically applied stabilizers that lost almost 30 times more soil.

The key to choosing a cost effective soil stabilizer is planning and determining the length of time the temporary erosion control is needed. Obviously, if changes will be made to the exposed area in a short amount of time, a material lasting 36 months is not necessary. Any of the listed applications is a better option than doing nothing at all. Although there was a loss of 82 pounds of soil from the wood fiber mulch and binder application, it is protecting at an improved rate 65% better than no protection as indicated. This most basic of methods reduces soil being lost during the rainy season at a lower cost than all the repairs that will be required to bring the areas back into compliance and be useable for further improvements.

6.0 CONCLUSION

Blankets provide better soil stabilization on the slope areas than spray-on applications. In relation to cost, determining the lifespan requirements of the application is imperative in making the decision on which to use and creating a more successful erosion control program. Each of the applications has it applicable use. Proper planning and use of any type of stabilization is better than having no protection and leaving the soil areas exposed. Extrapolating the numbers, it is easy to see the great amount of soil loss potential on unprotected slopes or un-stabilized soils on any project. Soil loss calculations using RUSLE will further substantiate the claim that any type of stabilization will have a positive impact on soil loss reduction.