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The Purpose and Use of Best Management Practices for Erosion Control

Kyle Hauschild
Spring 2013 Senior Thesis

Abstract

In today's world there has been a big push to make water that goes into streams and rivers as clean as possible, free of pollutants. Turbidity and soil are common contaminants in water bodies resulting from sediments carried off of construction projects in runoff caused by precipitation that doesn't infiltrate the soil and flows over unprotected dirt areas. My goal is to do a literature review of a few products that are widely used in the construction industry and find out what makes them better than the other products in terms of longevity and price. The three products that I choose to investigate were straw or hay mulch, erosion matting (double net), and Hydromulch™. I tried to evaluate each product and give examples where each product would be best suited for the situation and where the other products might not work as good.

Introduction

Although much soil erosion in North America is from nonconservation-based farming and agriculture practices, some is attributed to poor construction practices. For the sake of discussion, I am interested in construction storm water that runs off projects carrying sediment. According to the Environmental Protection Agency (EPA) storm water "discharges are caused when rainwater or snowmelt does not percolate through the soil flows over land or impervious surfaces such as paved streets, parking lots, and building rooftops. These discharges often contain pollutants in quantities that could adversely affect water quality. Most storm water discharges are considered point sources and require coverage by a National Pollutant Discharge Elimination System (NPDES) permit" (EPA, 2012). My goal is to investigate literature sources to find out

what some of the best ways to stop this erosion on construction sites from happening. My intention of this discussion is to help formulate simple Best Management Practices (BMP's) for construction sites to hold soils in place. There are many different types of BMP's that are on the market today; a few of the most common BMP's are silt fence, matting and mulch. I just want to look at the BMP's that are used to cover the soil to stop or slow the erosion caused by precipitation, these are called Erosion control BMPs. There is also Sediment control BMP's, that are used to catch sediment once it has been moved and is being carried by runoff.

Erosion control BMP's also have many different types of products that can be chosen. One type of BMP would be to use what is called mulch, this is basically straw or hay that is blown over the surface of the soil and then crimped in (see Figure 1a and b). Crimping is the act of using a disk-like piece of equipment that will push the straw or hay into the soil approximately 1-2 inches (Nebraska Department of Roads , 2010) so the straw it is more likely to stay in the area that it is applied and will not be blown away by the wind or washed away by rain.

Matting or blanket is also one of the BMP's that are included in the soil coverage category and can be made up of many different products. One thing that all of the matting has in common is that it must be anchored to the soil so it cannot be moved easily by wind or water (Figure 2).

A "double net blanket" has straw between two layers of biodegradable netting that is used to hold the straw in place (Figure 2 a and b). There is also an Excelsior blanket that is made in a similar fashion as the straw matting, but in exchange of the straw, wood fibers (Excelsior) are used.

Coir matting is the also a main type of matting that could be used for soil stabilization. Coir is basically just coconut fibers that have been made into small rope like strands and then knitted together like a scarf, making a thick and heavy coverage for the soil (Figure 3).

Hydraulically applied mulch is the last type of BMP that I will talk about, this type can be made of many different products. Some consist of ground up newspaper; some have straw; and some which are also called Bonded Fiber Matrix, and are made of wood mulch. The way this system works, is that these materials are mixed with water and an adhesive compound, or “tackifier” in a large tank usually on a truck or a trailer it is then sprayed out of the tank with a hose over the soil (Figure 4a and b). The tackifier is used to make this material stick to the soil making an armor coating over the soil so it is very difficult for water to cause splash erosion or cut channels through the soil during rain fall events. Once this product is mixed it is applied over the soil with a hose and comes out as a liquid; as the product dries it becomes a very tough barrier over the soil.

Literature review

The purpose of this literature review is to find out what previous BMP research has shown for the various types of BMP's. As stated in the introduction, there are various types of products that have been tested in labs or in the field. I intend to find what products worked best for the tests that were run on these BMPs.

Mulch

The first type of soil stabilization BMP evaluated in this review is straw or hay mulch. This product is applied by taking a bale, either square or round, and running it through a grinder and blowing it over the top of the soil, the coverage should be applied at 2 tons/acre according to the specifications set by the Nebraska Department of Roads. Several issues with using mulch as a BMP, and testing this material as a BMP, were uncovered in this review. One issue was the lack of a universal amount that is applied to the soil. Different soils, different areas, and different states all use different specs on how much mulch should be applied to an area. According to the NDOR manual, approximately 2 tons per acre should be used in some areas of the state while 2.5 tons per acre in other certain areas of the state. The difference in application rates was due to the soil make up in the different areas, the areas with higher sand content needs more mulch applied.

Another issue is the difficulty in determining whether a certain amount has been applied to any specific area. Basically the amount that is applied to the soil is very random and no set amount can be uniformly applied to the area. The Texas Institute of Transportation states, "organic erosion control measures vary by study simply because of variances in the test materials, application, experimental condition, and test protocol. Such variances make it difficult to standardize test results" (Jett McFalls, 2007). As stated before, there is variance in the application of mulch that makes it very difficult to test the validity and reliability of this method based on the variations in the application rate could be much different in each of the tests.

Another problem related to this erosion control method, is that crimping of the straw or hay can be negatively impacted if the areas of high clay where the soil becomes very hard which makes it hard to crimp and stay attached to the soil. The 2012 drought affected a large area of the U.S. and much less straw and hay was available for non-livestock purposes which made it very difficult to use this BMP. Drought and other production problems in a region can be an issue to getting this BMP for a project. The last thing with this product is that it only stays in place for a very short time, hay or straw mulch will only stick around until around the time vegetation starts to establish, by this time this mulch is mostly degraded.

Matting

Double net matting can be made of basically two types of materials: straw and excelsior mulch. This product is more labor intensive than mulch; this product must be applied manually. These “straw blankets” come in rolls and must be put down by hand, and in most cases cannot be applied by a machine. As alluded to previously this product is applied over the soil, and must be anchored to the soil with very large staples. The mat in this type of matting is made with polyurethane, which makes it synthetic (Sutton & Williams). However, the netting degrades over time, and is broken down by UV rays (American Excelsior Company, 2012). The benefit behind using matting compared to just plain mulch is that you get a longer life out of this BMP, compared to mulch; this product will last much longer and lessen the splash and runoff effects from precipitation. The life span of this BMP will depend on what blanket is used and what the designed life should be; some blankets will last one growing season, and others will last up to 2 or 3 years (Barr Engineering Co., 2001). In addition to an

increased period of effectiveness, and more uniform coverage, double net matting also can be applied on a steeper grade, which is the slope of the hill. By looking at Figure 5 one can see what the Nebraska Department of Roads recommends for what products that should be used in each situation.

Coir matting or blanket is a very heavy blanket made from coconut husks. Coconut husk is a very tough natural product that is not prone to degradation, mold or rot, making coir a very good as a BMP (Pillai & Vasudev, 2001). Coir is applied the same way as the double net matting; it comes in roll, in most cases cannot be applied with a machine, therefore it must be laid by hand and needs to be stapled down to prevent the mat from being washed away by water or blown away by wind. Coir matting is an all-natural product meaning that it contains no polyurethane, or plastic netting. Coir matting is made entirely of coir ropes that have been knitted together. The benefit of this product over the less thick double knit is that it is much heavier so it is better at slowing higher volumes of water. When coir does get wet it will hold water much longer giving the vegetation that is trying to establish more moisture to help it germinate and grow (Pillai & Vasudev, 2001).

Hydromulch

The last BMP evaluated here is Hydraulically Applied Mulch (Hydromulch). This product is very versatile and can be used in all the situations that were discussed in the previous paragraphs. In addition Hydromulch can be used in many other applications that the other products wouldn't be as effective as other BMPs. Hydromulch is applied from a tank that can be mounted on a truck or trailer. The ingredients are added to the tank mixed and then applied through a hose on to the soil. The materials that make up

is this mixture are water, mulch which can be ground up wood chips, ground newspaper, or ground straw/hay and a water soluble adhesive or “takifier”. Takifier is glue that holds the mulch in place; once it has dried it should no longer break down from applied water such as precipitation (West & Delgado-Fornue, 1995). One of the main benefits of using Hydromulch is the accessibility of using this system, in places that it would be very hard to get machinery in areas to put down seed and mulch, or an area that is difficult to blanket, Hydromulch is very efficient for this type of application. The issue that one can run into with this system is that if the product isn’t applied correctly it can break down very quickly and not serve the purpose that it was designed for or be worth the price that was paid for it.

The next section of this review will compare each of these BMPs against each other to see what works best and the differences in cost. For example, a flat area about 30 acres in size could be protected most inexpensively using hay much rather than blanket. I found that in most cases the longevity of the product that is being used has a lot to do with the price of the product (Texas Department of Transportation, 2010). In the case of a large flat area it would be much more cost effective to use straw mulch verses blankets or the Hydromulch. The issue of mulching the area is the large amount of equipment that is needed. A tractor will be needed in order to drill the seed into the soil; another tractor will be needed to pull a shredder so the bails can be shredded and applied to the soil, and something would be needed to move the bails into the shredder. In addition the bails will be need to be hauled to the area that they needed for application and a crimper would also need to be on the job so the mulch can be crimped after it is applied. In most cases I have seen this process carried out with two tractors

and a semi with a flatbed trailer. However there is some manual labor that goes into putting the different attachments onto the tractors meaning some man hours are put into this product application.

Now if this area was to be blanketed with matting a tractor with a drill would still be needed to plant the seed in the ground, but that is all that would be needed for machinery. A large trailer pulled by a pickup would be needed to haul the blankets to the jobsite and each blanket would need to be put down individually by means of manual labor and then secured with the staples. Finally if the same area was Hydro mulched, again this area would need to be drilled according to Nebraska Department of Roads specifications, but in some situations seed can actually be added to the mulch and blown out of the truck with the mulch. After the seed is drilled the Hydromulch truck can move along the area and spray the Hydromulch over the soil. It is advised that the area be sprayed from two different directions to prevent shadowing,. "Shadowing" is a term used to describe areas that are not covered by Hydromulch due to very uneven surfaces or vegetation that can catch mulch, causing a shadowing effect (Nebraska Department of Roads, 2012). Not having coverage with Hydromulch can be big problem because this leaves a weak spot for water to get under the mulch and create a channel; this is something that should never happen.

As stated before, the most durable BMP generally is the most expensive and in most cases the simplest method. To me it seems that Hydromulch is the easiest and fastest way to get this area covered, however it is not the cheapest. If one were looking to save money the cheapest, most efficient way of getting this soil covered would be to use the straw or hay mulch. We have found around the state of Nebraska the last few

years while in a drought that it is very hard to find straw or hay, which also makes it hard to make blankets because they are also made with straw so the cheapest way might be to Hydromulch, but this is a very rare occasion.

In the next section I will be evaluating the same area; however instead of the area being flat it would be on a 3:1 slope. This area could be mulched, but in most cases it would be very prone to erosion. So this would leave one with two choices: to use the double net blanket or Hydromulch. When doing research I was unable find exact prices for any products because, I think that it varies from area to area and the weather they are having in that area, such as if the area was in a drought. If one goes back to the ease of application and the amount of time the products are good for, I'd say that it would be much cheaper to use the double net blanket over the Hydromulch.

In the last situation we take a 30 acre with areas that are very cut up and steep, with slopes that are more like a 4:1 slope, this would made it hard for a tractor to spread mulch, and would also make it very hard to lay down the matting because there would be lots of cutting and moving around in order to get the area covered. In this cause it would be much easier for a Hydromulch truck to drive along and hit all of the areas that need to be covered to prevent erosion.

There are few situations where the coir blanket would be needed over large areas; the main area of usage would be in ditch bottoms. The reason that this product would be used in these areas is because they are very tough and very good at standing up to high volumes of water without allowing these areas to be washed out or eroded.

These are a few situations where each of these products would be used to the best of their abilities, and also the most cost effective way of using each.

Research Question

I had two questions that I wanted to try to answer as I was going through my research project. The first question that I asked was, what was the most efficient BMP at keeping the soil in place and prevent it being washed away during rain events or when snow melts. The second question that I wanted to look into was to find out what would be the most cost effective product for the specific situation used and the time needed to apply each product.

Materials and Methods

I didn't actually do any testing of products myself, but from the literature research that I conducted I found that in most cases that the lab tests were set up on very large tables. These tables are very sophisticated; they can be moved up and down to change the slope of the tables so the BMPs can be tested in many different situations. The labs that these are tested in are used strictly for this type of research. They are in very large buildings with rain fall simulators near the ceiling so the water is able to fall a long distance before it contacts the soil. This is a very close representation of rainfall. The first step to setting up these tables to get good soil for the test, it should be representative of the soils of the areas that the BMPs will be used. Next, soil is placed on the tables and compacted to a certain density. Usually this compaction is established by the state specifications as to how much compaction the soil on a jobsite would need. After the compaction, the BMP's that are to be tested are applied to the soil on the tables. The tables are then set to a particular slope that the test will be performed. There are many different ways that the BMPs are tested, in some tests the rain

simulator is run over the tables for 30 minutes at a rate of 2 inches/hr, and in some test rain will fall over the tables many times in an hour, not just one long duration. The variances in this test are to test the many different precipitation events that can happen in real life situations. These tests are designed to see how these products will perform in field situations.

Conclusion

I found that out that each of these BMP products have their positives and negatives depending on the situation. They are, how long they require the product to be in place, the amount of man hours that a person would want to put into the installation, and how much money that they would want to be save or spend all contribute to what product is chosen. I found that mulch is a very cheap product that requires ample amounts of time, a lot of machinery but very little physical labor. However mulch is a very short lived BMP that will only last for about one season, just long enough to get vegetation growing. Matting is more expensive, more labor intensive, but requires much less machinery than mulch. Matting can also be used in many more applications such as on slopes or areas that it is much harder for machinery to reach. This method also takes much longer to apply than mulch. Hydromulch is the most expensive of the three tested BMP's, Hydromulch goes down much faster and is in contrast, less labor intensive than matting. If this product is not applied correctly it could lead to many issues that may not be as obvious with the other two products. I would say that the biggest downfall for this product would be the higher price. However the higher price could be outweighed by the man hours that go into the matting, and the short life of the mulch.

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Figure 1a



Figure 1b



Figure 2a



Figure 2b



Figure 3 (Picture from IWT/Cargo Guard)



Figure 4a



Figure 4b

Figure 5

SLOPE EROSION CONTROL USAGE CHART									
TYPE OF EROSION CONTROL *	SLOPE STEEPNESS								
	6:1 or Flatter	4:1	3:1	2.5:1	2:1	1.5:1	1:1	1:1	1:1
	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+	SLOPE LENGTH 0-30' 30'-60' 60'+ 0-9M 9-18M 18M+
Seed with Properly Anchored Mulch
Sod
Slope Protection (Mulch)
Type 1A Slope Protection Netting
Type 1B Lt. Wt. Quick Degrading Erosion Control Blanket
Type 1C Lt. Wt. Single Net Erosion Control Blanket
Type 1D Lt. Wt. Double Net Erosion Control Blanket
Type 1E Med. Wt. Double Net Erosion Control Blanket
Type 1F Heavy Duty Erosion Control Blanket

* For a description of the physical properties, see Exhibit 2.7.

..... Designates instances where a particular Erosion Control Type will be used
 Designates instances where a particular Erosion Control Type may be used

Rill and gully erosion on side slopes is the primary concern when designing slope erosion control. When unprotected, the slopes will erode. Rills and gullies provide channels that further concentrate runoff and greatly increase the rate at which sediment is removed from the slopes. Once formed, they can become costly to correct and dangerous for our maintenance crews. Seeding and Mulching is the primary method of slope erosion control. However, Rolled Erosion Control Products (RECP's) are used based on aesthetic considerations, severity of the slopes, and soil types as well as cost.