

COMBINATION OF THE VETIVER SYSTEM AND GEOMATS AS A BIOENGINEERING TECHNOLOGY

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Abstract

Geo Mat: Synthetic or biodegradable membrane used for erosion control on slopes.

Geo Mesh: Synthetic membrane with openings of varied shapes used to provide resistance to the slope and thus contribute to its stability.

During the last decade there has been an increase in the use of Vetiver System (VS) to contribute to slope stability and erosion control. The efficiency and low cost have contributed to its growing acceptance. Both fill and cut slopes have been treated effectively with this impressive system. The list of its advantages of the vetiver system is interesting to mention. However, the research topic leads us to discuss one of its major disadvantages, the establishment period which the system requires to begin providing a significant level of protection on the batter/slope. Recall that the VS is based on the use of a plant which takes time to establish itself after which point significant protection begins to be provided. The time needed for establishment varies by site. In our experience we have been able to achieve an acceptable degree of protection after four months and final establishment after eight months, under ideal conditions. During this establishment period of the VS, the ground surface has a large area which is vulnerable. Currently there is no definitive solution to combat this deficiency in the VS. There is no way to speed up the process to reduce or eliminate this vulnerability phase.

That is what has lead to the idea of using a blanket or mesh to cover the surface of interest and thus control erosion immediately of the exposed surface, or to contribute to the slope stability, as applicable. These blankets are called geo blankets or erosion control blankets. In cases where the stability of the slope is a significant concern, geo synthetic meshes are used.

In both cases, using geo blankets and meshes provides an immediate function of complimenting the VS during its vulnerable establishment phase, which is very effective to stabilize the slope and/or control erosion over the short to medium term.

The geo mesh and geo mat systems have been developed using good techniques for erosion control and soil stability and can now be very effective and low cost. Combined with the VS they provide the best combination for proper management of slopes.

Resumen

Geo Manta: Membrana sintética o biodegradable utilizada para control de erosión en taludes.

Geo Malla: Membrana sintética con aperturas y formas variables utilizada para aportar resistencia al talud y así contribuir a su estabilidad.

En la última década se ha evidenciado un incremento en el uso del Sistema Vetiver -SV- para contribuir a la estabilidad de taludes y el control de la erosión. La eficiencia y bajo costo han contribuido a su aceptación cada vez mayor. Taludes de relleno y de corte han sido tratados eficientemente con este formidable sistema. Una lista de sus ventajas sería muy interesante mencionar. Sin embargo, el tema de investigación nos lleva a discutir una de sus mayores desventajas; el tiempo de establecimiento para que el sistema alcance un nivel considerable de protección en el talud. Recordemos que el SV descansa en el uso de una planta la cual necesita de un tiempo para establecerse exitosamente y entonces brindar la protección deseada. El periodo necesario para establecerse varía según las características agroclimáticas del lugar. En nuestra experiencia hemos visto alcanzar un grado aceptable de protección a partir del cuarto mes y alcanzando su establecimiento definitivo en ocho meses en condiciones ideales. Cualquiera que sea este periodo, dejará vulnerable la superficie mientras el SV logre establecerse definitivamente. Actualmente no existe una solución para evitar esta deficiencia del SV. No existe forma de acelerar el proceso para reducir o eliminar dicha vulnerabilidad.

Es por ello que surge la idea de utilizar una manta o malla para cubrir la superficie de interés y así controlar la erosión de forma inmediata o dar algún aporte de estabilidad al talud según sea el caso. Dichas mantas son llamadas geo mantas o mantas para control de erosión. En casos donde la estabilidad del talud es significativa se utilizan geo mallas sintéticas.

En ambos casos en el uso de geo mantas y el uso de geo mallas su función es brindar un aporte inmediato para complementar la función del SV el cual será muy efectivo para estabilizar el talud o controlar la erosión empero a mediano plazo.

Las geo mantas y geo mallas han revolucionado las técnicas para control de erosión y estabilidad de suelos de forma muy efectiva y a un bajo costo. Combinadas con el SV han dado lugar a la mejor combinación en manejo apropiado de taludes.

Palabras claves: geomantos, escorrentía, control de erosión.

INTRODUCTION

Using the Vetiver System as a bioengineering tool to resolve distinct environmental problems is excellent when it is necessary to reduce costs of the mitigation methods.

This system entails a series of inherent uses to provide diverse environmental solutions which include among others the ecological stabilization of slopes and control of erosion and sediments. Its impressive low cost of implementation, compared to hard engineering solutions, makes it very viable to add as an item when in the budget planning phase.

However, initially and during its establishment phase, the Vetiver System presents a risk of failure during high rainfall events, of slope instability depending on several factors such as the slope gradient and soil type. For this reason, the use of materials is required to protect the fertile soil and assist in controlling erosion and the establishment of the vetiver system. In reality, apart from the vetiver system there also exist other practices and products which serve to protect against erosion. This is where geomats come in; for erosion control.

In this document we will analyse how to combine these two tools to assure slope stabilization without ignoring the erosion problem. We will therefore start by describing the geomats and after we will discuss several cases where the combination of geomats and the vetiver system has been used successfully.

METHODS:

Combination of the Vetiver System and Geomats for Erosion Control and Slope Stabilization

The implementation of the Vetiver System or revegetation on inclined land; be it cut or fill slopes; with scarce organic matter or loose soils, requires the use of materials that protect the fertile soil and provide erosion protection, and support the establishment of the vetiver system. Currently there exist practices and products which serve to control erosion caused during rainfall, storm events, wind and gravity. One of these solutions are rolled products for erosion control called in Spanish PECE (Productos Enrollables para el Control de Erosión), among other erosion control geo mats.

What are geomats?

Geomats are flat canvases used to cover bare land exposed to erosion. Their principal function is to protect the land from the effects of rainfall surface runoff, avoiding in this manner the loss of soil and destruction of the slopes and benches.

They are materials fabricated especially for use over the surface of soil in a temporary manner (biodegradable or natural fibers), or permanent (synthetic fibres).

TYPES OF GEOMAT

Based on material type: Can be biodegradable and photodegradable (Synthetics).

Based on thickness: Can be flat or 3D.



Photo 1: Biodegradable Geomat installed. Guatemala, May 2010.



Photo 2: Synthetic Geomat installed. Concepción, February 2013.

Biodegradable Geomats:

This is a geomat which has been fabricated using natural fibres generally held together between two very widely spaced synthetic mats. It is known for its excellent ability to resist erosive forces while biodegrading over a period of time returning to the soil.

This geomat is special because it permits the passing of some sunlight through it, facilitating any germination and growth of plant life beneath. Furthermore, it has the ability to retain and release humidity, generating a microclimate between the soil and the geomat, also facilitating plant growth.



Photo 3: Biodegradable geomat and the Vetiver System. Cobán. 2013

Photodegradable and Synthetic Geomats

This is a synthetic mat which appears natural, green in colour, and that protects the soil surface from erosion during natural events such as rainfall and wind, offering some partial shading and heat storage, once again creating microclimate for the development of vegetation beneath. This geomats has been designed to keep organic soil in place, until the vegetation beneath has been established.



Photo 4: Synthetic Geomat Installed. Guatemala, 2012

BENEFITS AND ADVANTAGES OF GEOMATS

A slope protected correctly with geomat reduces highly the risk of surface damage.

List of the benefits and advantages:

- Low cost
- Roll up presentation and fast instalation
- In absence of vegetation Geomats gives immediate protection after installation
- High resistance to hydrodynamic forces in water channel and on slopes
- Breaks down erosive forces of raindrops when they would usually hit the soil
- Eliminates abrasion of erosive agents on the soil
- Control of the runoff, reducing the speed of water flow.
- Prevent landslides of the surficial soil mass.



Photo 5: Germano synthetic installation, Fraijanes, February 2013

METHODS:

Geomat Installation and the Vetiver System

a) Geomat installation

To assure the success using the geomat, it is important to notice some installation indications, which are simple, do not require qualified technicians, no specialized equipment and tools. The key is “to establish and maintain intimate contact with the ground surface”.

Ground preparation

- Remove all rocks, roots, vegetation or any obstacle between the geomat and the ground surface.
- Compact the area
- It is necessary diversion ditches on the crest of the slopes to reduce greatly quantity of water flowing down slope faces

Anchoring of the geomat:

- On the slope, make a ditch 30 x 15 cm. along the crest of the slope to fix the geomat, as shown on figure 1.
- Placed the geomat inside the ditch and anchor (step 1) with prefabricated stakes made with construction iron, put backfill over the geomat with soil to refill the ditch and compact (step 2).
- Unroll the geomat over the slope all the way down, anchor to keep it firm to the surface and distribute the anchoring in a uniform way, approximately one every 60 cm.

Figure 1: Anchoring of the Geomat.
Source: PAVCO

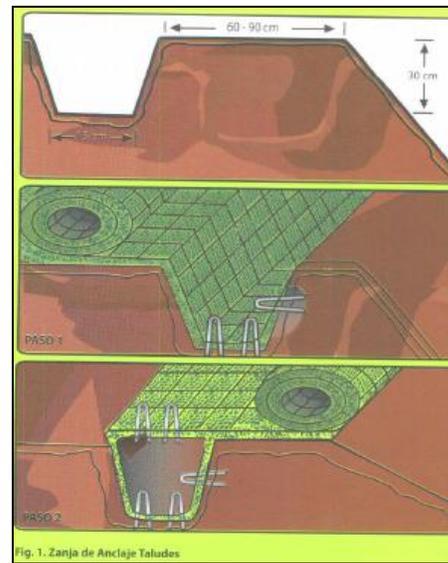


Photo 6: Anchoring ditch for the geomat. Quetzaltenango, December 2010



Photo 7: Synthetic geomat anchored to the slop. Antigua, July 2011

b) Vetiver System installation

The way to stablish the Vetiver System is planting several rows of Vetiver grass at right angles to the slope in the way that all sediments running down the slope will be trapped behind the established vetiver barrier.

To protect agains the risk of slides on the slopes, the following is used a general rule. Plant Vetiver lines 1 m apart, each plant in the line being approximately 15 cm apart. Where geomats is implimented, the distance between plants can be increased.



Photo 8: Installation of the Vetiver System. Cobán, June 2013



Image 9: Installation of the Vetiver System. Fraijanes, May 2013.

RESULTS:

Vetiver System and Geomats combination

The slopes can fail for two reasons: erosion and instability
Vetiver System has the ability to protect and stabilize the surface of the slopes, increasing the resistance slippage. However, during the first stage and the time for establishment of the system, failure could occur due to slope instability and heavy rainfall runoff.

Doing this combination does not represent a significant increased in costs when considering the increased security that the geomat brings during the time for establishment of the vetiver system.

For this reason it is recommended to combine the fabulous Vetiver System with Geomats to control erosion and stabilization.

Slopes can fail due to 2 reasons: erosion and instability.



Photo 10: Slopes without protection, Concepción, May 2012.



Photo 11: Slopes protected with geomats and the vetiver system. Concepción, June 2013



Photo 12: Protection of a slope at a private residence. Carchá, April 2013.



Photo 13: River bank protection. Boca del monte, August 2011.

CONCLUSIONS

- Geomat used on slopes bring protection to reduce probabilities of failure of the Vetiver System.
- Bio engineering techniques increase the probabilities of success on a slope.
- The cost with the combination of Geomats and Vetiver System are less than the traditional systems.
- The Vetiver System is a highlight among the current bio engineering techniques due to the surface erosion protection it provides slopes along with significant improvement in overall slope stability.

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