

ECO-MORTAR VETIVER TECHNOLOGY INTERACTION.

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Abstract.

Since 2000 we have been working with a technology for infrastructure protection and environmental protection that we have called Bio-structures that is the combination of plants and building materials. Using the Ecological Mortar, which is a mixture of cement, sand and left-over material from the paper industries rich in cellulose (Paper Mulch) in combination with Vetiver Technology, which is based on the applications of Vetiver Grass (*Chrysopogon zizanioides* L). We have recovered extends eroded areas in the Andean Region of Colombia.

Vetiver System is also being tested as agricultural improvement in coffee, cane sugar and fruits plantations between 1,200 m. s. n. m. and 1,800 m. s. n. m.

Keys words: Ecological mortar, bio-structures, vetiver,

1.0 INTRODUCTION:

Vetiver System Technology (VST) is being used in Colombia mainly as a tool for erosion control and infrastructure protection projects; this paper will present how VST is being used in Colombia for infrastructure protection, the interaction between VST and Meceta , the development of Ecological Mortar to Control Erosion and stabilization of steep slopes and some other agricultural uses that are being tested at the moment in local farms.

We are manly working in the Andes region in Antioquia State, Colombia. It is well known as the coffee area; it is a high mountain area with predominantly an abrupt and steep topography and a wide range of soil types such as: sands, clays, silts and volcanic substrates.

Since 2000, we have been working with a technology that we called Bio-Structures, that is the combination of plants and building materials. From recycling left-over from the paper industries, we have developed an ecological mortar which is a substrate where the vegetation can grow and be established, being environmental friendly. These elements are working together in controlling and correcting physical degradation processes, manmade or natural phenomena.

The Ecological Mortar is a mixture of cement, sand and left-over material from the paper industries which are rich in cellulose (Paper Mulch). It quickly presents a stable surface which is resistant to erosive agents, especially against the rain and run-off water, wind and sun.

In addition to its ecological properties, it has special physical properties like: humidity control and absorption, high adhesion to any surface or material, low density, quick drying,

plasticity; follows the consolidation movements of the area, gives nutrients and regulates the acidity in the soils.

MECETA has helped to recover areas in different areas of the country in both public and private sectors working with the best professional staff and receiving acknowledgement and awards from government institutes.

VST is being tested as an agricultural field's improvement technique, in coffee, sugar cane and fruit plantations. It is being planted between 1200- 1800 m.a.s.l. as a barrier against erosion and soil loss, soil nutrients improvement, groundwater recharge and soil moisture improvement.

VST is being implemented at Abejorral – Antioquia, on a coffee, sugar cane and fruit plantation .We hope to present the results of this research program in less than two years time and we already know they are going to be excellent.

2.0 ECOLOGICAL MORTAR

The Meceta's Eco Mortar is a mixture of Portland cement, sand and left-over material from the paper industries which are rich in cellulose (Paper Mulch). It quickly provides a stable surface which is resistant to erosive agents, especially against the rain and run-off water, wind and sun.

2.1 Uses and Characteristics.



*Ecological Mortar- Vetiver- Creeping Forage Penaut
Mountain Highway “Las Palmas” Km1+500 - Medellin. Antioquia*

The eco mortar is a superficial protective layer on the steep slopes of hillside surface, it regulates water infiltrations controlling and balancing the humidity of the area, it avoids; soil saturations, weight increases, soil loss and the alteration of the aeromechanic properties of the

soil. It is used in combination with Vetiver Technology and some other suitable plants for the stabilization of steep road batter and river banks, control erosion and soil improvement in areas that have lost the organic content, by manmade or natural phenomena.

2.2 Principal Characteristics

- Quick drying; it quickly provides a stable surface which is resistant to erosive agents, especially against the rainfall water, wind and sun.
- High adhesive capacity to all surfaces; particularly sandy soils, and in general, it amalgamates them, giving them superficial protection avoiding its displacement.
- Low density; for it does not increase the weight on the hillside.
- It is hygroscopic: It means that it absorbs and regulates the humidity in the interior of the material. Avoids soil saturation, increases weight and avoids the loss of internal friction.
- The ecological mortar immediately protects the damaged and vulnerable surface against the principal erosive agents: the rain and of run-off water, the wind and the sun light. When it integrates with the soil, it controls the dampness (water content), it improves the geo-mechanical properties and induces the consolidation.

It is environmentally friendly; it helps the regeneration of the ecosystem and promotes the return of Native Vegetation, which spontaneously starts to germinate over the mortar after the area is stabilized.

3.0 APPLICATION OF ECOLOGICAL MORTAR

3.1 Surface Preparation

The surface pre-treatment is minimal in the area. If there are some large and unstable rocks, they should be removed and placed in a safe position, It is not necessary to remove any native plants from the area.



*Ecological Mortar- Vetiver- Creeping Forage Peanut (Arachis pintoi)
Mountain Highway "Las Palmas" Km1+500 - Medellin. Antioquia*

The terrain must be prepared with some superficial manual compaction and rows must be made in the hillside for the easiest application possible.

3.2 Preparation and Installation.

The mixture should be prepared in a similar way that concrete is made. When the mortar has optimal malleability, it is manually installed over the area, covering all the surfaces; meaning that all of the area should be covered with an approximated 2 cm thick layer. When the area is covered, it is immediately protected from erosive agents and the consolidation process begins.

The projects are completely being done with manual-labour and qualified staff is not required, so the workers are local to the area influenced by project, generating employment and given benefits for local communities. It also provides a sense of ownership of the project to the local community and they will look after it.

TECHNICAL SPECIFICATIONS

Characteristics	Description
Color	Gray
Mixture time to dry	2 hours, After preparation.
Application temperature	5°C - 38°C
Minimum thickness	10 mm
Maximum thickness	30 mm
Resístanse (f'c)	1150 kPA
Density	18,5 kN/m3
Absorption	22%
Adherence resistant	45 Pa

3.3 Application:

The manual-labour installation of the mortar must be with care and love, the aim is to get the mortar in perfect contact with the surface that is being treated. The use of concrete guns (pump) is not recommendable, this technique could allow air pockets between the mixture and the hillside surface which could become water traps and increase the instability of the site.

4.0 VETIVER SYSTEM

After the Eco mortar was developed and field trials started the main objective was to find a plant that would be a perfect complement on erosion control activities, at that time we were looking special characteristics, such as

- **Low maintenance:** For the nature of the projects, once works are finished and the erosion has been stopped fulfilling the functions for which they were executed, the sites are practically abandoned to allow the return of wild vegetation.
- **Adverse soil conditions tolerant:** A plant tolerant to adverse soil conditions, the

slopes that had been affected for erosion present diverse qualities of soils sometimes without organics layers and very low amount of nutrients.

- **Good root capacity:** The slopes are in a growing state of degradation, geotechnical properties are altered, so therefore will need deep and strong roots system to act as anchors (pins), binding the soil, acting as retaining "living structures" and avoiding the collapse of the slope.

Vetiver was researched on informal consultations with agronomists and after some trials we proved that vetiver grass grows quickly, becomes established under hostile conditions, and its very deep and extensive root system provides structural strength in a relatively short period of time, fulfilling all the requirements that we were looking for.

Other interesting findings were made where the Vetiver has been planted on a hillside with rock fragments of different sizes, showing its extraordinary characteristics to grow in adverse conditions; we also tried on array sandy silt and silt clay. These are typical geological conditions of Antioquia batholiths



With these good results, the perfect interaction between Vetiver and the Eco Mortar was demonstrated in different soil conditions. The Eco mortar working on the steep slopes of hillside controlling surface erosion and water infiltrations and Vetiver System working from inside the soil giving strength and binding soils. More than 50.000 m² of eroded area has been recovered in a wide range of climatic conditions and different altitudes from sea levels to 2,800 m above sea level

Water management is a basic preliminary activity in all Bio-structures intervention; drainage structures such as canals, ditches and rounds of coronation must be done. To allow construction temporary drain facilities should be made.

The walls of drainage structures are made with Eco mortar. The bottom of channels and grooves is protected with Eco concrete (Eco Mortar + aggregate ½" ÷ ¾"). The structures should be done where the natural waterways are, without changing any water courses.

Drain must be shaped in the same way that natural channels are. On steep slopes the water energy should be mitigate overlying water stone on the bottom of the channels protected with Eco-mortar.

All hydraulic structure is protected with Vetiver rows. Vetiver would provide better soil conditions and it will also help water control.



Vetiver. Road: Angelópolis – Amagá K 4+100 “Curva del Chocho”

Vetiver efficiency was tested as an anchor and moisture regulator on a unstable slope in a park located in the city of Medellin. Rows were planted, 0.15 m. apart, without removing the existing grass.

In Esteban Jaramillo’s experimental Farm, from The Coffee Federation, located in the municipality of Venice Department of Antioquia Vetiver is been used as a barrier against erosion and to retain nutrients within the coffee plantations and in the lower perimeter to prevent the collapse of escarpment. Coffee plantations are located in the coffee belt, between 1,200 m. s. n. m. and 1,800 m. s. n. m.



From the observations and analysis of our project and in particular of the interventions that had been done, we concluded that Vetiver is ideal to be associated on high mountains coffee plantations, due to its characteristics to control soil erosion and keeping the nutrients in the soil. In the municipality of Abejorral - Antioquia, a research is on, carrying out a massive Vetiver plantation around coffee trees, livestock pastures and sugar cane fields. We hope in two years to inform them of the results that no doubt will be excellent.

Preparation of Vetiver planting materials:

- We transport the bare roots in bags of polypropylene fiber from the seed bank to the temporal site (250 Bare roots per bag approx.)
- Introducing the bare roots in a solution of Hormonagro N ° 1 - Rooting (50 gr in 20 liters of water), until they are planted in plastic bag. At the moment trial are being made changing the Hormonagro for Aloe Vera Crystal, The bare roots are placed in a container with water and crystals.
- The soil for the poly-bags is being treated to improve its qualities and fast growing of Vetiver plants. To black soil mycorrhiza, phosphate rocks and dolomite lime are being added.
- Mycorrhiza:
 - Content of infective propagules per gram at least 40-230.
 - Content of viable spores per gram at least 40-230
 - Content of mycorrhizal roots at least 40% -70%
 - Minimum content of roots per kilogram 1 gram
 - Moisture content. Gravimetric than 20%.
- Phosphate Rocks:
 - Phosphorus 26%:

- Calcium 10%
 - Fluor (F) up 4%
 - Maximum humidity 5%
- Dolomitic lime.
 - Total phosphorus (P₂O₅) 1.0%. This match is slow uptake.
 - Calcium oxide (CaO) 40.0%
 - Magnesia oxide (MgO) 12.0%
 - Dosing volume:
 - Black Soil: A bag (0.04 m³)
 - Mycorrhizae: Three cups
 - Phosphate Rock: A cup
 - Dolomitic lime: A cup



Once planted in poly bags were placed in easily accessible area for manipulation, watered daily and after about three weeks they are able to be transplanted to the final location.

Empirical verification before plantation is test whether the plant supports without being lifted off and see the bag to see if the roots and emerge from the bottom. Given these conditions, the seed is completely reliable to be planted

When plantation is being made fertilizer is applied, the use of caprinaza (goat's manure) has given excellent results.

The Vetiver internal transpiration acts effectively and is of vital importance for the improvement and maintenance of the stability conditions of the slope. At the surface level, it hydrates and oxygenates the ecosystem, providing beneficial elements for plant and animal life, thus helping the protection, restoration and conservation of the environment.

When we are establishing Bio-structures we provide the eroded and unstable area, instant protection and vegetation. Best conditions for the consolidation process and to recover in a natural way and wild vegetation will spontaneously appear.

“BIO-INGENIERIA PARA LA PROTECCION, RECUPERACION Y DESARROLLO DE LA MADRE TIERRA”

“BIO-ENGINEERING FOR THE PROTECTION, RECUPERATION AND DEVELOPMENT OF MOTHER NATURE”





Ecological Mortar- Vetiver- Creeping Forage Peanut (Arachis pinto)
Mountain Highway "Las Palmas" Sector Los Balsos- Medellin. Antioquia

A brief Introduction to the first author.

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