GARDEN RETAINING WALL WITH THE USE OF VETIVER IN ENVIRONMENTAL CONSERVATION AREA

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Abstract

The wall green combines innovative techniques and methods of natural engineering involving knowledge of vegetation in constructive interventions with low environmental impact. Thus, besides reducing intervention in the environment goes along with the reality of environmental preservation areas.

This case, reports the work performed on Santana do Parnaíba-SP/Brasil in an environmental protected area with approximately 1100 m² of front and 25 meters tall.
The technique consists in the formation of containment systems using geogrids, soil and vegetation. The role of geogrids is to strengthen the mass of compacted soil while the vegetation plays a fundamental role in the control of superficial erosion and aggregation of organic soil.

The walls are executed by compacting layers of a landfill by 20 cm (7.87 inches), interspersed with high strength and high modulus geogrids. The entire landfill plus the geogrids result in a stable soil mass which acts as a wall of weight. In the front are used biodegradable bags that are undergoing biological transformation of organic waste into humic substances, which form an organic layer coated with a biodegradable geotextile with aggregator function of the soil until there is a growth of Vetiver grass, *Vetiveria zizanioides* species, in the entire length of the wall.

We use a technique like bioengineering to stabilize the front of the green wall of containment, thereby preventing surface erosion and protecting the environment. The Vetiver was planted in rows to form a cover on which is very effective in slowing and spreading water runoff, reducing soil erosion, conserving soil moisture and promoting the accumulation of nutrients by improving their microenvironment in order to have other native sown plants or volunteer plants to establish themselves later.

The roots of vetiver play a fundamental role for the success of the wall, because its depth and its generous amount of root aggregated to the soil, it turns to be very difficult to occur a breakdown of the soil mass under the water flows at high speed. This very deep roots' system, and rapid growth also makes the vetiver system to become very drought tolerant and highly suitable for stabilizing the wall.

Traditionally the projects of containment of embankments and slopes use cement-based materials. The green system of containment has an innovative proposal with efficiency and low cost compared to the traditional engineering systems. It uses an advanced natural engineering technology with geosynthetics and the application of the vetiver system on its front, since it is a clean, fast and highly ecological work.

Keywords: green wall, containment, geogrids, bioengineering, low cost.

Introduction

The project was installed in a region of very uneven topography and difficult access. The project predicted in addition to access roads, the establishment of thresholds for the construction of houses, requiring major earthworks.

It is important to notify that this is an extensive area of environmental conservation with the presence of native forests and springs that could not be invaded by houses or streets during the above mentioned drives.

Environmental Preservation Area

The solution necessarily involved the implementation of retaining walls, mainly to restrain the skirts of landfill in sites close to areas of environmental preservation. The traditional techniques of containment structures involving the use of concrete and / or stone did not seem appropriate from the environmental and economic standpoint. Moreover, it is worth noting the concern for the search of less intervention in the environment and a solution to soil drain in the front of the wall made through research to arrive at a definitive solution which is the use of vetiver plantlets between compacted layers and around the alignment of the wall.

The ideal situation is not to choose only one method or another for recovery, rather, it is necessary to use and harmonize civil techniques of containment and biological measures, in order to obtain satisfactory results (Einloft, 2009).

To meet the structural and environmental needs of the project, the retaining walls should be performed guided by an aesthetic ideal that suited to the green areas of the enterprise, the access difficulties should be considered and therefore the solution should use the minimum materials brought in from outside the site.

The green wall responded to these needs because they have the front covered by vegetation that completely integrates with the environment, and minimizes the imported materials.

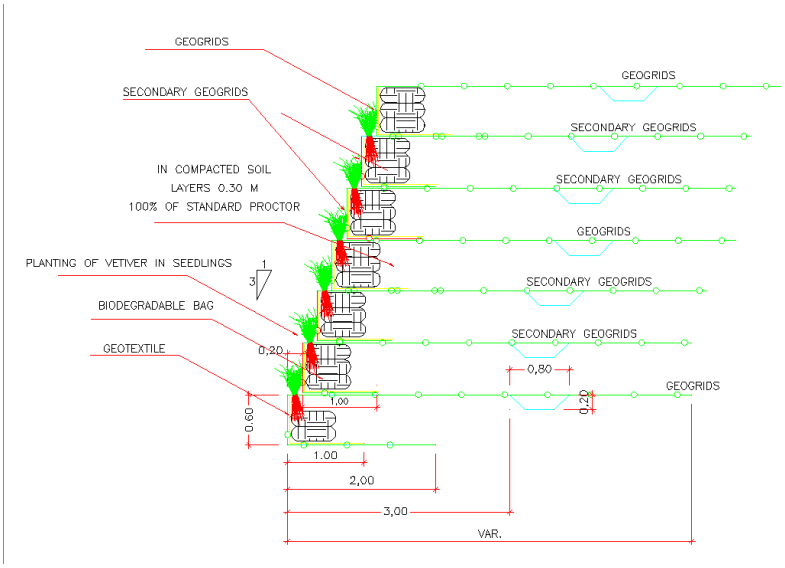
Materials and Methods

To implement the wall is used local soil, geogrids, geotextile, biodegradable bags and vetiver, all materials which are very light and easy to carry on the work.

The green wall is a retaining wall used to enable the implementation of infrastructure development in rugged topography area with low environmental impact and using local soil as a building material of the wall.

The wall runs through the compression of a landfill in layers, interspersed (reinforced) with geogrids of high strength and high modulus. The entire landfill plus geogrids result in a mass of stable soil that acts as a wall of weight. In the front are used biodegradable bags filled with soil, geotextile and vetiver that are placed between the bags and geogrids as the cross section below.

Side view of the green wall



Cross section

Executive Method

Introduction

Constructive sequence of retaining walls on reinforced soil with green polyester geogrids.

Team composition:

To a great productivity will be required a team for the work front formed by an overseer, a bricklayer and five servants.

The hiring of workers shall be exclusively in the city where the work will be performed, thus offering opportunities to local workers and contributing to social integration locally.

Equipments, materials and facilities involved:

The inputs are basically the local soil, the geogrids used for reinforcement, the biodegradable bags used for the stability of the front, the geotextile for erosive protection in early process, and vetiver grass to stabilize the face of the wall.

Filling site with soil

For the implementation of the wall are used primarily earth moving equipment (trucks for transportation of soil, wheel loader, backhoe, roller and manual compactor).

Calculation Method Dimensional Calculations

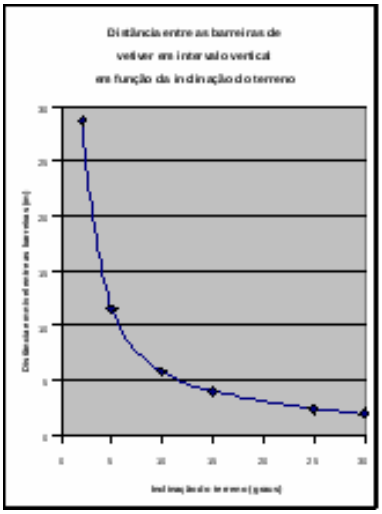
The dimensions of the walls were made from the dimensioning method of Ehrlich (1999) considering the relative stiffness between the compacted soil and reinforcement and the influence of stress induced compaction. For the sizing of the reinforcements, the reduction factors adopted all consider the effects of creep and installation conditions for long-term (lifetime of 60 years) certified for geogrids.

Importance of the root of vetiver grass to the green wall.

Analyzing the Vetiver grass, it appears that its application in the field of physics is through its tensile strength and shear strength as shown below.

According to Technical Bulletin effects of vegetation on slope stability: The increase in shear strength of soil is directly linked to the direct transfer of shear stress to the roots resistance to stress. This transfer leads to significant increases in the shear strength of soils, reducing soil erodibility, and increase soil stability. (PEREIRA, 2006).

Besides the shear strength which is between 6 to 10KPa per kilogram of root per cubic meters of soil, and be resistant to shear the soil loss by runoff is very low as shown in the following chart.



Source: Word Bank (1993)

As the chart indicates any degree of the slope, since it is inside the set for the planting of Vetiver, it is more efficient than other species. It also defines that the steeper the terrain the distance will be smaller between the barrier levels.

Tilting the green wall

Also according to Hengchaovanich (1998) cited technical bulletin, the average tensile strength of roots of Vetiver is 75MPa corresponding to 1 / 6 of mild steel, with roots ranging between 0.7 and 0.8 mm diâmetro. Source: Hengchaovanich (1997).

Resistance and strength of the roots.

The wall has a high level of resistance by the use of geogrids on the inside, depending on the cohesion (the ability of particles to attract and hold each other together) and internal friction (friction between the grains within a material) that preclude driving forces.

The relationship of strength to resist the driving force is the safety factor (SF). If SF> 1, the slope is stable. Otherwise, it is unstable. Typically, an SF of 1.2 to 1.3 is an acceptable margin. In the green wall, the slope is very high, so the use of geogrids on the inside along with the vetiver on the external surface results in an optimal stabilization of the soil mass. The stability of the wall is a function of soil type, its strength, slope geometry (height, angle), vegetation, climate and weather. Each of these factors may play a significant role in controlling the driving or resisting forces.

The characteristics of vetiver allow an adequate stabilization of the front of the wall because they have unique attributes that ensure the proper preservation of the system and it is actually a very effective tool in bioengineering:

Vetiver in the face of the green wall

- Although, it is technically a grass, the vetiver plants are used in applications to stabilize the earth behave more like fast-growing trees or shrubs. The roots of Vetiver are, per unit area, stronger and deeper than the roots of trees.
- The roots of Vetiver are very deep and massive, finely structured and may extend up to 2.3 meters (six to nine feet) in the first year. Its root is long and thick that turns on the ground, making it very difficult to dislodge, and extremely drought tolerant.
- As strong as or stronger than those of many species of hard wood, the vetiver roots have high tensile strength that has been proven to strengthen positive root on steep slopes.
- The roots have an average tested tensile strength of about 75 Mega Pascal (MPa), equivalent to 1 / 6 of steel reinforcement and a slight increase in shear strength of 39% at a depth of 0.5 m (1.5 feet).

- The roots can penetrate a compacted soil profile that has facilitated its use in the green wall, providing a good anchor to fill and soil.
- The plants were planted together and will form dense hedges that reduce the velocity of the flow and divert the runoff water, and create a very effective filter that controls erosion.
- Acting as a very effective filter, the vetiver helps reducing the turbidity of the runoff, its new roots tailors through us, when buried by sediment trapped.

Obtained Results

The deployment of the green walls of containment was important symbiosis x environment construction for the following reasons:

- The work of the resistance of polyester geogrids and the roots of vetiver form a perfect symbiosis to stabilize large soils.
- Reduced environmental impact on fauna and flora.
- The use of vetiver grass in the external front of the walls has two functions: Add, reduce the risk of erosion and conserve moisture for the development of root system in the stabilization of the landfill front.
- The possibility of a consortium of local plant species into the front of the wall enriching local biodiversity.
- Better cosmetic result compared to the other retaining walls reinforced with cement or concrete.
- Reduced costs for transportation of materials, whereas access is difficult and the land used is the same place of execution.
- The use of unskilled labor (production assistants) allows the hiring of employees in the region of the work, thus creating new opportunities for local people.

It is considered therefore that this system provides minimal transformation by man to the environment, qualifying it for use in various situations where there is a need for environmentally viable solutions.

Aplication Areas in the Organization

The application of green walls of containment may be in areas that require the need for reinforced embankments of varying heights on which it intends to preserve the local sustainability and protect local biodiversity.

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Curriculum

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Note

“Usually the walls are green toward environmental preservation area of contention is the proposal meet with an important concern, but only recently started to be debated by all means: the issue of sustainability. Using this system will replace concrete walls by walls of vegetation that contribute to the microclimate of the regions where we work, thus promoting local fauna and flora.”