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ENVIRONMENTAL BENEFITS OF APPLYING THE NATURAL MATERIALS IN GEOGRIDS

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Abstract

Considering the geogrids, as one of the types of geosynthetics, the two basic types are distinguished. There are the geogrids made of synthetic materials and the geogrids made of natural materials. This paper deals with the type of geogrids made of natural (organic) materials. Geogrids and geotextiles made of natural material (coconut, jute) are a natural and 100% biodegradable solution for erosion control using the geogrids or geotextile mats made of coconut fibers. A geogrid or permeable geotextile provides a natural support system (improvement of characteristics) to the soil (soil, landfill...) and vegetation.

Keywords: *geogrid, geotextile, natural (organic) materials, mining, natural vegetation, environmental protection.*

1. INTRODUCTION

A special part of the field of application the geomaterials is represented by the geogrids, made of natural materials, which is the main topic of this paper. The organic geogrids have the unique characteristics consisting of biologically and chemically degradable natural fibers. They are designed to hold the soil in place until the natural vegetation is established. On the other hand, the geogrids and geotextiles, made of synthetic materials, have much greater strength, elasticity and durability. [1–4]

The geogrids provide tensioning: various types of landfills, foundations and foundations of railways and roads, covering trenches and landslides, etc. The geogrids are excellent reinforcement elements, as they withstand the high tensile loads with very little elongation.

Engineering solutions that include the use of geogrids can contribute to the preservation of natural vegetation and environmental protection, as well as significantly help stabilization of the steep slopes and embankments.

Due to the large number of factors that directly affect the negative effects of mining or construction works, a special review should be made, not only on the application of geogrids and other types of geosynthetics, but also on application and selection the new materials and technologies in that area. [3,4]

2. RESULTS AND DISCUSSION

2.1 Geogrids - Materials, Differences and Types

The geogrids (Figure 1) are made of polymer materials such as polyethylene, polyester and polypropylene and are characterized by a high tensile strength. The original geogrids were made by drilling the holes in a sheet of material. Today, such geogrids are made by the so-called extrusion process. Many continuous fibers are combined into a thread that is then woven into the longitudinal and transverse directions with a certain distance between the ribs, and the pleats are additionally strengthened, and then the fibers are coated. In addition to stabilizing and strengthening a weakly load-bearing soil, the geogrids are also used to reinforce asphalt by placing them between the layers of asphalt or between the soil and asphalt. The geogrid absorbs the forces and prevents creation the cracks on the newly laid asphalt layer. The third important purpose of geogrids is protection against the soil erosion. For this purpose, there are two-dimensional geogrids that have small mesh openings and three-dimensional geogrids. The primary function and mode of operation of the geogrids is the same:

- absorb the kinetic energy of erosive elements (rain, wind) and stabilize the soil surface creating numerous micro dams over it,
- holds seeds and hydroseeding materials in place, even on the steep soil slopes, resulting in successful seed germination,
- helps water penetration into the soil and retain moisture, leading to the better seed germination and grass growth.

The use of anti-erosion geotextiles can increase and support the effect of erosion control in the areas with particularly steep slopes or in substrates subject to erosion [1,3,5].

2.1.1 Natural Geogrids

The greatest role - the purpose of vegetation in protecting the slopes from erosion and its stabilization (Figure 1) is provided when its surface enables the establishment of a given vegetation and allows water to flow at a certain speed and intensity on the surface and thus prevents deterioration of a vegetative cover. The natural (organic) geogrids have the unique characteristics consisting of biologically and chemically photodegradable natural fibers. They are designed to hold the soil in place until vegetation is established. The natural geogrid has the following roles: to absorb the kinetic energy of erosive elements (rain, wind); to facilitate the penetration of rain into the ground; to retain moisture from rain: In addition to being environmentally friendly, the water is approximately five times greater than its dry weight; it allows to avoid loss or dispersal of seeds needed for renewal • Enables the radical establishment of plant species; enables control of soil temperature mitigating its natural oscillations: so they can moderate the extreme temperatures and create a pleasant - climate for vegetation growth; allows reduction of the soil moisture loss.

The ability of natural geogrids to make a direct contact between the fibers and soil and allow a bond to develop between them allows soil loss to be reduced by 90% or more. In addition to the above, the natural geogrids act as “mulch” and thus improve the establishment of vegetation. They do not leave toxic material after decomposition [4,5].

The geogrid made of jute - annual plant that requires a very warm climate and a lot of moisture. The jute geogrids is used to cover the slopes and protect against erosion. The jute grids stop movement of soil clearings. They have an excellent ability to shape and follow the contours of soil on which it is placed. They absorb water up to almost 4–5 times of their dry weight, keeping water from rain and preventing the soil separation. In wet conditions, their flexibility increase due to the water absorption. The jute grids provide the surface stability on the steep slopes and slopes at an angle of about 45 degrees. When the vegetation starts to grow, it takes over the role of the jute net. It takes about 2 years for jute grid to biodegrade [4,5,6].

Figure 1. *Setting up the geogrid*

Figure 2. *Coconut Geogrid*

The coconut – geogrids, made of organic material (coconut), is a natural and 100% biodegradable solution for erosion control using a geogrid base made of the coconut fibers. The permeable geogrid provides a natural support system (improvement of characteristics) to the soil and vegetation. The coconut fiber is obtained from the husk of coconut. They are naturally strong, durable and biodegradable.

The coconut fibers (Figure 2) are very strong and form a very strong and durable grid. The open weave allows seed and vegetation to be planted both before and after the

mat is laid and offers strong support to the vegetation. The lifespan of a coir mat is four to six years. A period sufficient for consolidation by consolidation. After that time, the mat slowly biodegrades. This geogrid has high tensile strength (35 kN/m) and elasticity and can be installed even on the very steep slopes of around 70 degrees. On the steep slopes, which are more prone to erosion, an organic geogrid can be installed in a combination with metal grids. Once vegetation is established, the organic geogrids no longer serve as protection. The metal mesh remains permanently as active or passive tilt protection. The geogrid can be placed up to 60 degrees, with the support of a metal grid, while the coconut geogrid combined with metal can also be placed on the vertical slopes [4,5,6].

2.1.2 Synthetic Geogrids

The synthetic geogrids are synthetic products (geosynthetics) that are used to stabilize the terrain. The polymer nature of products makes them suitable for use in the countries where a high level of durability is required. This type of geogrid is available in a wide range of shapes and (synthetic) materials. In severe conditions (such as slopes with a critical angle, channels with high flow, etc.), the vegetative cover, even when well established, will not be able to survive under the erosive force of the water. [1,2,3]

2.2 Materials and Manufacturing of Geogrids

2.2.1 Types of Materials – Fibers

In order for the fibers to be further processed into more complex textiles (materials) and final products to meet their intended purpose, the fibers must meet the certain requirements. Some characteristics reflect the behavior of fibers under the influence of external forces and influences. Mechanical characteristics describe the behavior of fibers under the influence of different types of forces and loads. In order to find out the strength of the fibers, the maximum force that fiber can withstand is measured - breaking force [cN]. Different types of fibers vary significantly in strength. Table 1 shows the strength values of fibers - building material (geogrid) under the normal conditions (environmental influence).

Table 1. *Fiber strength under normal conditions [3,6]*

Fiber	**Strength [cN/dtex]**	**Fiber**	**Strength [cN/dtex]**
Raw cotton	3 – 4.9	Viscose - standard type	0.7 – 3.2
Linen	2.6 – 7.7	Viscose – HWM type	2.5 – 5
Hemp	5.8 – 6.8	Polyester (PES)	4.6 – 9.5
Jute	3 – 5.8	Polyamide (PA)	2.5 – 8.3
Ramya	5.5	Acrylic (PAN)	2 – 4.5
Silk	2.4 – 5.1	Modacrylic (MAC)	2.5 – 3.5
Wool	1 – 1.7	Polypropylene (PP)	3 – 7.5

2.2.2 Application and Durability of Natural Types of Geogrids

Surface erosion can cause damage and instability that can lead to failure/sliding of the landfill cover. Erosion can occur due to the atmospheric and wind action. For situations where there is a less risk of erosion, even the vegetative cover is sufficient in itself as protection. Geosynthetics can be used to support the development of vegetation of this type, in the form of synthetic or natural materials, placed on or below the surface of (mining) waste disposal sites. The natural (organic) type of usable fiber allows for planting the seeds and vegetation both before and after installation the geogrid and offers a strong support to the vegetation.

Once vegetation is established, the natural geogrids no longer serve as a protection. This is where synthetic materials in geogrids come in, which significantly improve the tensile strength and permanent active and passive protection - strengthening the landfill slope.

The lifetime of natural (organic) - plant fibers in the geogrid varies, mostly, in the range of 3–4 to 10 years. The lifespan of synthetic fibers is very long and generally exceeding 100 years. [4,5,6]

3. CONCLUSION

The geogrids have proven to be the most effective material for wide application. Its building elements provide a multi-purpose use in civil engineering, construction, mining and environmental protection.

The natural geogrids are organic and 100% biodegradable solution to erosion control using the coir geomaterial mats. They have the unique characteristics consisting of biologically and chemically photodegradable natural fibers. Their role is to hold the soil in place until vegetation is established.

Special attention in further development should be paid to the use of the new natural materials and hybrid technology for the production of geomaterials. [4]

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