MINING AND METALLURGY INSTITUTE BOR
and
TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE

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53rd International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Ana Kostov
Milenko Ljubojev

3 – 5 October 2022. Hotel "Albo" Bor, Serbia

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ADVANTAGES AND PURPOSE OF BIOCOMPOSITE GEOGRIDS

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Abstract

Geogrids are made of polymer materials such as polyethylene, polyester and polypropylene and are characterized by a high tensile strength. Today, we have geogrids made of natural (organic), synthetic and composite type of materials (depending on the purpose of use). Natural fibers that come mainly from plants or cellulose are also defined as the green biocomposites, because the impact of plant fibers on the natural environment is ecologically positive. The application and selection of biomaterials, affects savings and improvements in the field of ecology and specific purposes (in mining...).

***Keywords**: geogrids, biocomposites, geomaterials*

1 INTRODUCTION

1.1 Geogrids - materials, differences and types

Geogrids are most often used to strengthen and stabilize weak soil. In addition to stabilizing and strengthening weakly load-bearing soil, geogrids are also used to reinforce asphalt by placing geogrids between asphalt layers. The geogrid absorbs the forces and prevents the formation of cracks on the newly laid asphalt layer. The third important purpose of the geogrid is protection against soil erosion. For this purpose, there are two-dimensional geogrids that have small eye holes and three-dimensional geogrids [1-4]:

- absorb the kinetic energy of erosive elements (rain, wind) and stabilize the soil surface, creating numerous micro-dams over it,
- keeps seed and hydroset material in place, even on steep soil slopes, leading to successful seed germination,
- helps water penetrate the soil and retain moisture, leading to better seed germination and good grass growth.

The use of anti-erosion geotextiles can increase and support the erosion control effect in the areas with particularly steep slopes or in subgrades susceptible to erosion. [1,2,3]

2 EXPERIMENTAL

2.1 Geogrids made of organic materials - fibers

The greatest role of vegetation in the protection of slopes from erosion and its stabilization is ensured when its surface enables the establishment of given vegetation and allows water to flow at a certain rate and intensity on the surface, thus preventing the degradation of vegetative cover. Organic geogrids have unique characteristics, they consist of

biologically and chemically photo-degradable natural fibers. They are designed to hold the soil in place until vegetation is established. An organic geogrid has the following roles:

- to absorb the kinetic energy of erosive elements (rain, wind);
- to facilitate the penetration of rain into ground;
- to retain moisture from rain: in addition to being environmentally friendly, it can absorb water about five times its dry weight;
- allows to avoid loss or scattering the seeds necessary for revegetation;
- enables the radical establishment of plant species;
- enables the soil temperature control by mitigating its natural oscillations: so, they can mitigate extreme temperatures and create a pleasant micro-climate for vegetation growth;
- allows reduction of soil moisture loss. Organic geogrids are more flexible than synthetic. This allows them to easily follow the contour of ground surface. The ability to make a direct contact between the fibers and soil, and to allow a bond between them to develop, allows soil loss to be reduced by 90% or more. After decomposition, they do not leave any toxic material. [1,3]

Figure 1 *Coconut Geogrid [5]*

Organic geogrids are the best for protection against erosion through vegetative growth (Figure 1 [5]). Once vegetation is established, the organic geogrids no longer serve as a protection. The metal mesh remains permanently as an active or passive slope 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 vertical slopes. [3,4,6]

2.2 Geogrids made of synthetic materials - fibers

The polymer nature of products makes them suitable for use on the surfaces where a high level of durability is required. In difficult 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 water. Therefore, in order to stabilize and strengthen the terrain, the law should define the obligation to use (set up) geogrids or geosynthetic grids and thus increase the resistance to erosion, and to protect of the natural environment. [1,3]

2.3 Division of fibers according to the origin

According to the origin, all fibers can be classified into two groups - the group of natural fibers and the group of artificial fibers. Within their group, the natural fibers are divided according to the type of natural source in which the fiber is formed, and in the group of artificial fibers there the fibers of organic polymers and fibers made of inorganic material. Fibers of organic polymers are usually further classified according to the origin of polymer,

where it is important to distinguish the man-made of natural polymers and man-made of synthetic polymers.

- Natural fibers: - vegetable: fibers from seeds, fruits, bark and leaves; - animal: hair, wool and silk and - mineral: asbestos.
- Artificial fibers: - artificial silk: viscous copper nitrate and nitrate, copper, acetate; - cellulose wool and - protein fibers: animal and vegetable.
- Synthetic fibers: - polymerization and - polycondensation. Natural fibers - Plant fibers
- The main component of plant fibers is cellulose. [2-4,6]

2.4 Biocomposite materials

By definition, a biocomposite material is nothing more than a material consisting of a matrix, in general - a resin and reinforcing element. The natural fibers are usually considered that come mainly from plants or cellulose. Biocomposite materials or biocomposites are based on the basic concept of the FRP (fiber-reinforced plastics), i.e. a combination of polymer resin and reinforcing fiber, only using elements of plant origin, instead of the initial materials of synthetic origin, which are usually obtained from oil processing.

Instead, the biomaterial represents a new generation of these materials and pays a special attention to their application as more environmentally friendly than previously used ones. [2, 6]

It is known that the composite materials combine two or more starting materials in their structure, keeping them separate in each case, thus creating the third type of material created by combining these two, which has the chemical-physical properties certainly better than ones given in [2,3,6].

3 RESULTS AND DISCUSSION

3.1 Advantages of biocomposite materials

These materials are also defined as green biocomposites, because the impact of plant fibers on the natural environment is ecologically positive. Production of renewable fibers such as plastic cellulose, polylactides, plastic starch (plastic derived from starch), polyhydroxyalkanoates, soy-based plastics. All these materials can be defined as green (ecological).

Many biocomposites use the recycled materials or fibers obtained from the fast-growing plants.

3.2 Choosing the right material

Manufacturers of geogrids strive to make their products as cheap as possible and to make them as simple to use (implementation) as possible. However, it is desirable not to focus on the producer, but more on the strict (immediate) tasks.

- For strengthening embankments and slopes - a geogrid made of propylene fibers is perfect.
- Railway track - it is suitable to strengthen with two axle grids or geogrids of increased strength. The Slavros or its analogues will do their job well.
- To strengthen the drainage system and prevent siltation of the bank - it is best to use to strengthen the height of 15-30 mm or more.
- In the road construction - the biaxial mesh made of fiberglass and polymer is perfect. For example, the Slavrosa SD 40 geogrid is perfect for this purpose.

4 CONCLUSION

Biomaterials represent a new generation of materials (for production of geogrids, geotextils, etc.). Using products (geogrids) obtained from the biodegradable plastics and natural polymers obtained from renewable crops, the biomass is used as a raw material, creating a new portfolio of sustainable, more environmentally friendly (more efficient) and competitive products on the markets. [4,6]

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Many biocomposites use the recycled materials or fibers obtained from the fast-growing plants. In this way, the demand for products obtained from the petrochemical industry or from fossil fuels is significantly reduced. The possibility of local production reduces the transport costs.

A possible solution for savings in many cases, where an efficient result is needed, both in terms of ecology, as well as (construction) and safety of terrain, it represents a hybrid approach to the use of construction materials. Using the different types of materials for geogrids (geotextiles), we seemingly contradictory requirements in their application can be solved. [3,6]

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