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APPLICATION OF GEOMATERIALS FOR SECURING AND PROTECTING THE LANDFILLS

Milenko Jovanović[1a], Daniel Kržanović[1b], Radmilo Rajković[1c], Miomir Mikić[1d], Miroslava Maksimović[1e]

[1]Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia

[1a] milenko.jovanovic@irmbor.co.rs, https://orcid.org/0000-0002-6757-4143;
[1b] daniel.krzanovic@irmbor.co.rs, https://orcid.org/0000-0003-3841-8667;
[1c] radmilo.rajkovic@irmbor.co.rs, https://orcid.org/0000-0001-5905-6613;
[1d] miomir.mikic@irmbor.co.rs, https://orcid.org/0000-0001-7659-769X;
[1f] miroslava.maksimovic@irmbor.co.rs, https://orcid.org/0000-0002-5001-238X

Abstract

The earth surfaces are the main area for disposal of waste. Soil is a natural universal water purifier in which the rainwater is filtered and thus protects the quality and correctness of the underground drinking water. The soil has a great absorption capacity, both physical and chemical. Cleanliness of the soil is greatly impaired by waste dumping on the soil surfaces that have not been previously prepared for that purpose. In order to protect the soil from the harmful effects of waste, first it must be protected and use as one of the solutions, various types of geosynthetics and accompanying geomaterials. At the landfills of various types of waste material, the geogrids are used as the reinforcement as an independent element or as an integral part of a geocomposite. Of course, this refers to the geomembranes and geotextiles as a part of one of the covered - protected or drainage layers of the landfill. The geogrid must meet the requirements (resistance) of mechanical strength, as well as the resistance to the chemical agents and elevated temperature.

***Keywords**: Landfills, geosynthetics, geogrids, geocomposites*

1. INTRODUCTION

1.1 Application of geogrids for the landfill security and protection

Serbia is now somewhat at a crossroads when it comes to the geosynthetics. Let's take an example where the construction of a modern landfill becomes imperative for the local structures. The population feels the direct consequences of decades of carelessness for the environment. The funds are allocated, but only then the ultimate problem is reached - there are no standards that serve as the guidelines for contractors, and not even for the investor himself, in order to correctly determine the winner of tender.

When it is taken into account that a landfill must not release the toxic material into the environment for the next 100 years, and that, as a rule, it is a question of multimillion-dollar works, then it is clear what the risks of this situation are, and what experience and strict monitoring of the standards is necessary in order for the task to be completed properly (Germany and Scandinavian countries impose stricter regulations on designers, investors and contractors than those required by the EU).

At the waste disposal sites, geogrids are most often used to strengthen the sides - the edges under the waste, as well as to strengthen the cover in the zones above the geomembrane (if necessary) (Figure 1). In geotechnical engineering, they are most often

used to strengthen and stabilize weakly load-bearing soil. In this case, the material whose fraction size is larger than the opening of the mesh is piled on the geogrid, and material is trapped in the openings of the geogrid and a system resistant to external forces is created. [1-8]

Geogrids are most often used in the cover protective structure of the landfill so that the cover structure can absorb the tension that may occur due to the differential settlement of deposited waste. And since landfills are sometimes located in the abandoned quarries, it is often necessary to arrange steep rocky slopes in order to make the best possible use of the space for the waste disposal. [1,2,8]

Figure 1 *Representation of covering the slope of the landfill with a geogrid*

2. RESULTS AND DISCUSSION

2.1 Geogrids as an application for the slope stabilization

The greatest role of vegetation in protecting the slope from erosion and its stabilization 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, thereby preventing the degradation of the vegetative cover.

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 the water.

Figure 2 *Reinforcement of supporting slopes with a geogrid, with the additional help of natural vegetation*

Geogrids are made of the UV-stabilized polyethylene that ensures a long-term soil retention. Flexibility of the product allows it to follow the contours of the ground and prevents the formation of voids. If the soil is not anchored, it will become subject to the effects of the underground water flows and erosion. The use of these nets works by lining the working surface when creating the steeper slopes.

Organic geogrids have the 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.

The organic geogrids are more flexible than most types of synthetic geogrids. This allows them to easily follow the contour of the soil surface. The ability to make direct contact between the fibers and soil and allow the bond between them to develop allows for reduction in the soil loss by 90% or more.

In addition to the above, the organic geogrids act as a "mulch" and thereby improve the establishment of vegetation. After degradation, they do not leave any toxic material.

Hydroseeding enables easier greening immediately after the network installation is completed (Fig. 2). [6,7]

3. CONCLUSION

Geosynthetics are mainly polymer products that are used to stabilize and isolate the terrain (materials) and have a wide range of applications.

Geotextiles, geomembranes and geodrains are most commonly used in the rehabilitation of geosynthetic landslides. The primary function of geomembranes and geodrains on the landslides is drainage, while geotextiles perform multiple functions: filtering, draining, reinforcement and separation.

When applying geosynthetics in the waste disposal sites, the geomembranes have the role of permanent impermeable barriers between the source of pollution and water, i.e. soil.

Geogrids have a reinforcing function, while with geocomposites it is variable, depending on the combination of constituent materials.

The characteristics of geotextile materials can be determined using the mechanical models. Thus, each type of deformation of real materials is imitated by a simple model or this imitation is represented by the complex models, formed by a combination of simple models. Simple models used to describe the elastic, viscoelastic and plastic deformation are models that define the properties of materials that do not exist in the nature but whose properties, under certain load conditions and other external influences, approximately reflect the behavior of real materials. [4,7,9]

Geosynthetics has proven to be the most effective material for a wide application. Its building elements ensure high quality and multi-purpose use in the construction, mining and environmental protection. The use of these materials, regardless of the high price, is necessary and fully justified.

Geogrids and geotextiles made of organic (natural) material (coconut, jute) are a 100% biodegradable solution for erosion control (geogrids or geotextile mats made of coconut or jute fibers). Organic geogrids have unique characteristics. They consist of the biologically and chemically photo-degradable natural fibers. They are designed to hold the soil in place until vegetation is established. A geogrid or permeable geotextile provides a natural support system (improvement of characteristics) to the soil and vegetation.

As a possible solution in many cases, where an effective result is sought both in terms of ecology and construction, safety, and terrain security, there is a hybrid approach to the use of building materials. Namely, by using (hybrid) different types of materials when making geogrids or geotextiles, the seemingly contradictory requirements in their application can be solved.

Such hybrid materials, which would contain crossed bundles of organic and synthetic origin, can, depending on the need (purpose) and their mutual relationship, be an "ideal compromise", that is, a saving solution. Material of organic origin would have a positive effect on development and preservation the vegetation and entire ecosystem, while the geosynthetic materials would have a primary application of a mechanically stabilizing nature, as many times stronger and more time-stable materials. In addition to the above, the organic geogrids act as a "mulch" and thereby improve the establishment of vegetation. After degradation, they do not leave any toxic (harmful) material.

A special attention in further development should be paid to the use of the new natural materials and hybrid technology for production the geomaterials, as products of the future. [3,8,9]

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REFERENCES

[1] E. Nonweiler, Sliding and Stabilization of Slopes, School Book, Zagreb, 1987.
[2] Ž. Veinović, P. Kvasnička, Surface Landfills, Internal Script, Faculty of Mining, Geology and Petroleum, University of Zagreb, Zagreb, 2007.
[3] M. Bogićević, Civil Engineering, December 3, 2008. (In Serbian)
[4] SRPS EN ISO 10318:2015 - Geosynthetics - Terms and Definitions: ISO 10318, 2015.
[5] I. Lukavečki, Final Thesis on Geosynthetics and their Applications in Landfill Rehabilitation, 2010/2011.
[6] N. Gojković, R. Obradović, V. Čebašek Stability of the Slope of Surface Mine Disposal Sites; University of Belgrade, Faculty of Mining and Geology in Belgrade, 2008.
[7] M. Juras, Application of Geosynthetics in a Landfill, Final Thesis; Faculty of Geotechnical Engineering, University of Zagreb, Varaždin, 2017.
[8] M. Jovanović, Study Research II (Doctoral Dissertation): Geosynthetics - Purpose and Application (In Mining), University of Belgrade, Technical Faculty in Bor, June 2019.
[9] M. Jovanović, Study Research III (Doctoral Dissertation): Organic Geonetworks, University of Belgrade, Technical Faculty in Bor, July 2019.