Journal of Young Scientist, Volume II, 2014
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

SOME ASPECTS CONCERNING THE USE OF GEOSYNTHETICS FOR SOIL EROSION CONTROL AND LANDSLIDES STABILIZATION ON SIDE SLOPES

Dan Ilie BĂLEANU[1]

Scientific Coordinator: Associate Professor Phd. Eng. Sevastel MIRCEA[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67, Email: dan.baleanu@yahoo.com, smircea@usamv.ro

Corresponding author email: dan.baleanu@yahoo.com

Abstract

The paper aims to present a short review regarding geosynthetics use for soil erosion control, as well as a case study about a landslides stabilization on side slopes using a modern solution based on geosynthetics in Galați area.
The use of geosynthetics for soil erosion control and landslides stabilization, but not only, in close connection to environment protection, is being widely recognized mainly in the developed countries in the last years. As it is known, the geosynthetics have six main functions, namely: filtration, drainage, separation, reinforcement, fluid barrier, and protection. Particularly, in terms of soil erosion control, as well as mainly for landslides stabilization, there are used geogrids for soil and land reinforcement.

***Key words**: environment protection, geosynthetics, land reinforcement , landslides stabilization, soil erosion control.*

INTRODUCTION

Landslides and soil erosion hazards exist in Romania, due to the presence of hilly terrain, steep ridges and ravines underlain by unstable geology and overlain by soils which have low carrying capacity for structures. The slope and soil of a hillside are generally balanced with the amount of precipitation, vegetative cover and the underlying geology.
However, hillsides are constantly in motion, due to gravity and the effects of weathering and erosion. Any time the load on a susceptible hillside is increased or the stabilizing vegetation altered, erosion or landslide can occur. These disturbances can also increase surface water runoff and affect water quality through erosion and siltation (Axinte, 2010).
Developments in these hazard areas can frequently result in private and public costs, either for repairs to structures, roads or other facilities or for protective measures to prevent future damage. Development in areas of landslides is also more expensive than development in flatter, more stable terrain. Sewer and water lines and roads may also require special engineering in these sensitive areas.
Landslide and soil erosion hazards can be reduced or eliminated by regulating development to ensure slopes prone to severe landslides are not destabilized. Especially important is regulating development in areas where landslides have actually occurred and where severe landslide hazards exist. When development is allowed on slopes, it must be carefully engineered and sensitively placed.
For reducing the costs of the landscaping slopes using local materials, we have available geosynthetic materials that, in time, prove to be more environmentally friendly compared to metal and concrete.
A geosynthetic material is made of textile materials. In manufacturing geotextiles, elements such as fibers or yarns are combined into planar textile structures (Holtz et al, 1997). The fibers can be continuous filaments which are very long thin strands of a polymer or staple fibers, which are short filaments, typically 20 to 150 mm long. The vast majority of geotextiles are either woven or nonwoven. Woven geotextiles are made by weaving process similar to textile clothing. Nonwoven

textile manufacture is a high-tech process in which a synthetic polymer fibers or filaments are continuously extruded and spun, blown or otherwise laid onto a moving belt. Then, the mass of filaments are either needle-punched, in which the filaments are mechanically entangled by a bed of needles or heat bonded, in which the fibers are welded together by heat and/or pressure at their points of contact in the nonwoven mass (Sofronie, 2002).

Geosynthetics have six primary functions, namely: filtration, drainage, separation, reinforcement, fluid barrier and protection. Geotextiles are used as filters to prevent soils from migrating into riprap and other armor materials, while maintaining water flow, in coastal and stream bank protection systems to prevent soil erosion. Geotextiles or geocomposites can be used as drainage media by allowing water to drain from or through soils of low permeability. Geotextiles and geogrids can also be used as reinforcement to add tensile strength to a soil matrix and thereby providing a more competent structural material. In addition to the primary function, geosynthetics usually perform one or more secondary functions (Moldovan, 2010).

MATERIALS AND METHODS

Disposing of geosynthetic materials, local materials and working methods of the specialized papers we developed a project as a case study for a landslide in Galati county.

Location where was reported the slippage is on the slope terraces near Siret river, train route Catusa-Smardan , Catusa Valley in the Sidex Galati area.

When the execution of geotechnical studies started, slope instability was at high degree, especially in the middle and bottom, where it has been affected over time by powerful landslide phenomena that had affected the railway at the lower half of the slope.

After drilling and on-site research, we found that the slope had been rehabilitated in the past, but due to infiltration, rainfall and soil layers identified, landslide occurred again.

Identified soil layers were:

1. Filling – γ = 17 kN/m^3, ϕ = 25°, c = 30 kPa/cm^2;
2. Dusty clay - γ = 20,3 kN/m^3, ϕ = 17°, c = 20 kPa/cm^2;
3. Moistened loess - γ = 20 kN/m^3, ϕ = 10°, c = 10 kPa/cm^2;
4. Clay dust - γ = 20,3 kN/m^3, ϕ = 17°, c = 20 kPa/cm^2;
5. Dusty clay - γ = 20,3 kN/m^3, ϕ = 17°, c = 20 kPa/cm^2.

Drainage system and support in the studied area was strongly affected by the slope sliding.

Analysis and mathematical modeling of losing stability of the slope was performed using a set of computer programs developed by GeoSlope - Canada.

Mathematical modeling has searched to reproduce, as far as good geological structure of the terrain geometry and stress conditions.

Determination by indirect methods specific geotechnical parameters of the foundation soil immediately before the time of transfer was made considering the massive geometry taken before failure, the limit equilibrium conditions and calculating safety factors of stability for a wide range of geotechnical parameters, are in specific loess soils heavily moistened.

The stability was analyzed near slip area by the following assumptions:

1. Slope geometry taken prior to disposal and the water table located at the railroad drain and groundwater level measured in geotechnical drilling after release.
2. Slope geometry after applying the solution resulting from the project (designed drainage system functioning) adding static and earthquake stress may result from the specific area.

First and second figures represent the two possible methods for arranging the landslides. Considering the loads exerted by the railway line, used for industrial transport and the safety to be provided by the paper, we chose in Figure 1a as a model of rehabilitation.

The third figure shows the arrangement of geosynthetics in the filling and the filling disposed as from the natural terrain of the valley.

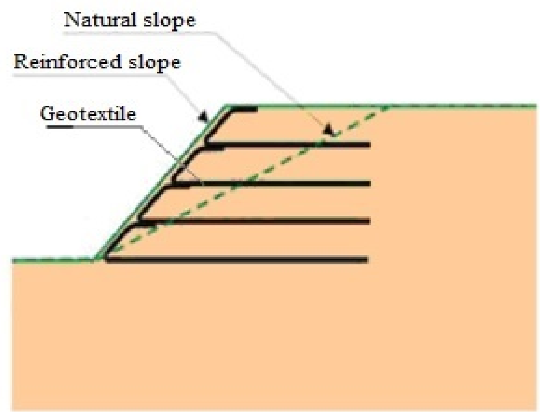

Figure 1. Reinforced slope type a

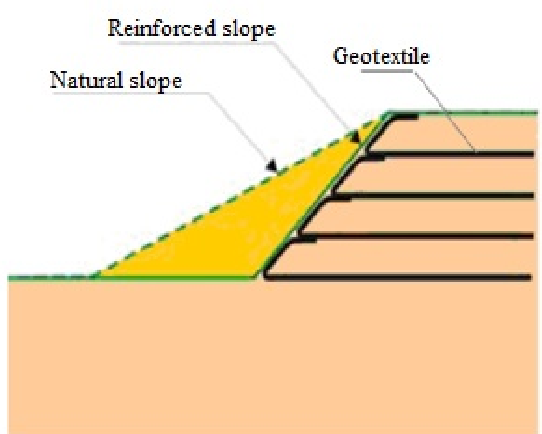

Figure 2. Reinforced slope type b

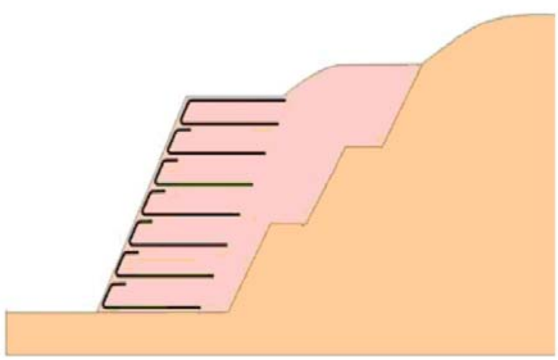

Figure 3. Slope rehabilitation

RESULTS AND DISCUSSIONS

In this context, the rational solution is to apply measures to eliminate the source of water causing excessive moistening of the land and rehabilitate the slipped area. The project foreseen the capture and disposal of surface water resulting from precipitation and prevent raising the groundwater through deep drainage and dewatering results (Mircea et al, 2007). The project had included the following measures:

1. To remove surface water sources using a system of drains that will collect and direct rainwater to existing drains.
2. Make a deep drainage system on the side that does not allow raising the groundwater level to dangerous slip the plans.
3. Restoration of area slipped slope using geosynthetic materials to ensure its stability.

Large permeability of the geotextile filter is desired but at the same time soil particles should be minimized from passing into the filter. The basic requirement of the permeability criteria is that the geotextile filter must remain more permeable than the adjacent soil (Holtz et al, 1997) such that:

K geotextile > K soil

For applications in critical projects, (Holtz et al 1997) suggested that the permeability of the geotextile should be at least 10 times greater than the corresponding permeability of thesoil.

A geotextile clogs if soil particles are trapped within the fabric structure. Clogging can reduce the permeability of the geotextile. Current geotextile-soil retention criteria are generally based on the relationships developed between an indicative pore size for geotextile and grain size of the soil such as the recommendations of (Bergado et al, 1992) as follows:

$O_{95} \leq 3\ D_{85}$
and
$O_{15} \geq 2$ to $3\ D_{15}$
where:
O_{95} = 95% opening size of geotextile filter
O_{15} = 15% opening size of geotextile filter
D_{15} = diameter of the 15% particle size
D_{85} = diameter of the 85% particle size

For geotextile strength in both separation and reinforcement applications, the formulation of the allowable values takes the following form (Koerner, 1997).

$$T_{allow} = T_{ult}\left(\frac{1}{RF_{ID}x\ RF_{CR}x\ RF_{CD}x\ RF_{BD}}\right)$$

where:
T_{allow} = allowable tensile strength

T_{ult} = ultimate tensile strength
RF_{ID} = reduction factor for installation damage
RF_{CR} = reduction factor for creep
RF_{CD} = reduction factor for chemical degradation
RF_{BD} = reduction factor for biological degradation

CONCLUSIONS

Geosynthetic materials gives technical solutions with a high degree of long-term safety. Reinforced soil with geogrids is considered in geotechnical engineering safe and economic for the following reasons:
- replace the volume and mass of classic materials,
- inverse filters minerals,
- significant savings natural material resources such as energy for extraction, processing, transport and placing,
- does not react chemically with water and ground, may also be used where are sources of aggression, which could degrade traditional materials,
- geosynthetic materials have elasticity,
- laying technology is simple, low labor consumption.

Using geosynthetic materials we minimize ground disturbance during construction by retaining natural vegetation and topographic features such as natural drainage swales and ridge lines, to the greatest extent possible, and by using measures to minimize runoff during development and after construction.

For the case study in Galati, the use of the geogrids with a drainage performance has opened up new opportunities, by increasing the time available during the year to carry out these types of works and reduces the time necessary to compact the various layers, thereby speeding up the overall construction time and minimising the time the railway must be kept closed.

Vegetation had completely covered the slope after six months, thereby returning it to its previous appearance before landslide, but in a fully stable manner.

REFERENCES

Axinte R. (2010), Studii asupra folosirii pamantului armat in lucrari de constructii, teza doctorat, Universitatea Tehnica „Gheorghe Asachi ” Iasi

Bergado, D.T., Alfaro, M.C. and Chan, E.H.C. (1992), Filtration and Drainage Characteristics of Vertical Drain, Proc. of Symposium on International Lowland Technology, Institute of Lowland Technology, Saga, Japan, pp. 181-188.

Holtz, R.D., Christopher, B.R. and Berg, R.R. (1997), Geosynthetic Engineering, BiTech Publishers Ltd., Canada

Koerner, R.M. (1997), Designing with Geosynthetics, Fourth Edition, Prentice Hall Inc., New Jersey, U.S.A.

Mircea S., Lucia Nedelcu, 2007. Indrumator pentru elaborarea proiectelor de combaterea eroziunii solului, Bucuresti

Moldovan D. V. (2010), Contributii privind utilizarea materialelor geosintetice in masivele de pamant armat, teza de doctorat, Universitatea Tehnică din Cluj-Napoca

Sofronie R. A. (2002), Comportarea seismica a structurilor din pamant armat, Al II-lea Simpozion National de Geosintetice GEOSINT 2002, 223-230