RESEARCH ON REINFORCING PLANTED EMBANKMENTS - ASSOCIATION OF GEOSYNTHETIC MATERIALS WITH THE VEGETAL MATERIAL

CERCETĂRI PRIVIND CONSOLIDAREA TALUZURILOR VEGETALIZATE- ASOCIEREA MATERIALELOR GEOSINTETICE CU MATERIALUL VEGETAL

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Abstract. *The research refers to the assessment and analysis of two case studies, with different field situations. Both studies refer to the landscape arrangement of two sites, one with a sloping land (less than 40%), other relatively flat, but with the need to create an artificial embankment over 50% slope . The proposed theme consists in the optimum exploitation of the land that is destined to landscape design through modeling and consolidating the slopes with different inclinations, followed by plantingon the embankment resulted from a vertical systematisation of the land. The purpose of this research is to verify in practice the result of two different technologies for building embankments with different declivities using geosynthetic Tenax materials associated with plant species meant to consolidate the embankment. The two technologies use materials agreed by the Ministry of Environment and do not endanger the ecosystem of the studied area. The results of the research contribute to the widening of the spectrum usage of the geosynthetic materials applied for consolidating the existing embankments in the landscape design, and to verify in practice the viability of the embankment strenghting systems and supervising the development of some consolidation embankment species over a year.*

Key words: reinforced soil, anti-erosion, embankment, species of upholstered plants.

Rezumat. *Cercetările se bazează pe evaluarea şi analiza a două studii de caz, cu situaţii de teren diferite. Ambele studii se referă la amenajarea peisagistică a două situri, unul dintre ele având terenul în pantă (sub 40%), celălalt relativ plat, dar cu necesitatea creării unui taluz artificial, cu pantă de peste 50%. Tema propusă constă în exploatarea optimă a terenului destinat amenajării peisagistice, prin preluarea şi consolidarea pantelor cu înclinaţii diferite, urmată de vegetalizarea taluzurilor rezultate în urma sistematizării verticale a terenului. Scopul acestei cercetări este de a verifica rezultatul punerii în practică a două tehnologii diferite de consolidare a taluzurilor cu declivităţi diferite, folosind materiale geosintetice din gama Tenax, asociate cu specii vegetale consolizatoare de taluz. Cele două tehnologii folosesc materiale agreate de Ministerul Mediului şi nu pun în pericol ecosistemul zonei studiate. Rezultatele cercetărilor contribuie la lărgirea spectrului de utilizare al materialelor geosintetice folosite la consolidarea taluzurilor existente în amenajările peisagistice, precum şi la verificarea în practică*

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a viabilităţii sistemelor de consolidare a taluzurilor şi urmărirea dezvoltării unor specii consolizatoare de taluz de-a lungul unui an.

Cuvinte cheie: pământ ranforsat, antieroziune, taluz, specii tapisante.

INTRODUCTION

The study was based on the analysis of two different climatic zones: one in the plain on the outskirts of Bucharest, the other on the hill, respectively Ramnicu Valcea. Both fields are relatively small (about 2000 sqm), and belong to different landscape arrangements.

For both works we consulted with specialists in building works and antierosion and separate specialized project were made.

Research topoc is not new, similar studies with the same theme have been made in many countries with problems of erosion and stabilize slopes (California, India), using materials and methods similar to those applied in the two cases studied in this paper.

MATERIAL AND METHOD

Peculiarities that differentiate the two case studies are given different gradient fields, respectively solve different solutions for eah landscaping site.

Different projects were carried out for the two case studies were adapted to conditions typical of each site and subsequently materialized through the implementation of two different technologies to strenghten the embankments (Geo.Co.M International, 2005).

For the plain site, the solution to achieve the link between the terace of the building located at level 1 and level 0 of the garden, involved building a slope with an inclination of 68 degrees. The technology used was the realization of „reinforced earth". The creation of the vegetationl embankment was achieved with deciduous shrubs category dendrological material, resin shrubs and deciduous trees category (Iliescu A.F, 1985, 1987, 1998; Mailliet. L, Bourgery. C. 1993).

For the hill site embankment stabilization solution was achieved by strnghtening the slope method „consolidated earth". The creation of the embankment was made by roller turf grass and planting trees and shrubs – here and there where it was needed.

Materials used in the first case were welded Buzau mesh of 100 mm mesh, geogrid material Tenax Multimat RS (fig. 2), Tenax material reinforced geomattress R (fig 1), reingorced concrete coupons, deciduous shrub of the *Euonymus* species, *Cotoneaster, Cornus, Mahonia, Acer* tree species, *Corylus* and *Vinca* species.

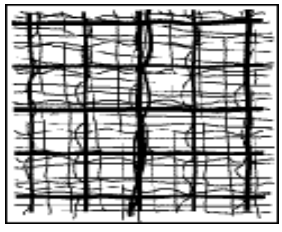

Fig. 1 – Reinforeced Geomattress material (Tenax R)

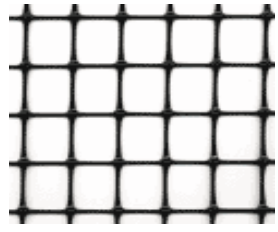

Fig. 2 – Geogrill material (Tenax multimat RS)

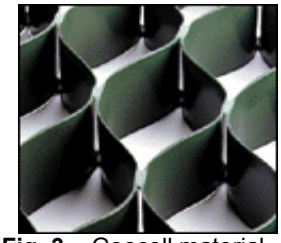

Fig. 3 – Geocell material (Tenweb)

For the hill site, the materials used were:

- Tenweb Geocell Material (fig.3),
- Tenax R, Geomattress material
- Iron Concrete coupon
- Dendrological material of the species: *Cotoneaster, Cornus, Pyracantha, Juniperus* (Iliescu A.F, 1998)
- Rollers of turf grass with perenial grass species brazdă înierbată cu specii graminee perene (*Lolium, Festuca, Dactylis, Poa*) (Iliescu A.F., 1987).

RESULTS AND DISCUSSIONS

To strenghten the slope of 68 degrees embankment, using reinforced earth technology, the execution started with the total excavation of land across the field, follower by leveling and compacting the land. Reinforced earth system involved the following steps:

1. Running an cutting the length of the geogrid to the project, lost formwork bending embankment and slope preparation anchors. After leveling and compacting the foundation layer has been installed and the first layer suttering sections were linked together, Geogrid was turned to the seen of the embankment and anchored.

2. Horizontal layer of geogrid was installed and anchored to an end with the clip to form a U shape, turnedon the undersied of the casing and leave a final anchorage area over the framework. This final portion is equal to the return length seen in the project (fig. 4).

3. The soil was spread over the geogrid, compacting in layers of approx. 30cm. In order to achieve a density of land greater than 95%. Up to a distance of approx. 0.5m from the embankment line slightly to use a roller or a vibrating plate, the remains will be compacted using a standard compactor working in the direction parallel to the slope.

Fig. 4 – Installing armed layers with Buzau Mesh

Fig. 5 – Fixing the arming

Fig. 6 – Fixing the armed embankment

4. The remaining geogrill was turned, tensioned and fixed with clipps (fig. 5).

5. The necessary operations were repeated to install each successive layer until completion (fig. 6).

6. A layer of geomattress was installed on the embankment line, which was then filled with finely grinded soil to insure the vegetal soil will stick to the embankment (fig.7).

Fig. 7 – Plant material installed on embankment

To strenghten the embankment using reinforced soil technology construction work began with stripping the land and preparing the substrate on which to install Tenweb geocells network installed in the holse to the ground with small particle size (fig. 8; 9; 10).

Fig. 8 – Installing the geocell network

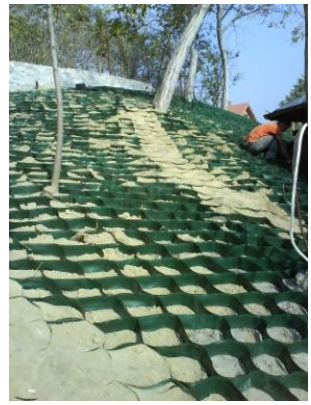

Fig. 9 – Filling the geocell with soil

Fig. 10 – Fixing the geocell network

Over the geocell layers, the reinforced geomattress Multimat was installed which is designed to reduce by more than 50% the amount of eroded soil (compared with the grond naked devoid of vegetation)

Both at the top and bottom, fixing trenches were made, upstream and downstream, made out of geocomposit material according to the project (fig. 11). The geomattress was placed in the upper trench and it was fixed with U shaped clipps (8mm) – the lengh of the anchor arms being of 15-30cm depending of the substrate composition. The geomattress roll ran down the embankment and the anchor trench was filled with vegetal soil.

Overlap between adjacent strips was 10cm, while the overlap between two adjacent rolls were 150cm. In making the overlay we took into account the

direction of water flow so that it will not divide the overlapping parts (fig. 11; 12; 13).

The geomattress strip was then fixed with clips 1,5m apart to assure a better contact between the geomattress and the support layer.

Fig. 11 – Joining the geocell stripps

Fig. 12 – Midway stage of filling the geocells with soil

Fig. 13 – The final stage of filling the geocells with soil

The geomattress was filled with vegetal grinded vegetal soil, than the roller turf grass was placed and the the dendrological material planted according to the project (fig. 14 and 15)

Fig. 14 – The resulting green embankment

Fig. 15 – The embankment with turf grass.

CONCLUSIONS

1. For the two types of slopes were adopted different stabilization solutions, depending on the configuration of the land, site condition, soil texture and climatic condtions.

2. For the solution based on stabilization of large slope over 50 degrees, we opted for „reinforced soil technology", which resulted in an embankment with a slope of 68 degrees, consisting of layers of compacted and reinforced soil with a network grid mesh (of Buzau) and geogrill.

3. Settlements made after one year of its establishment was 0.1cm, which concluded that we used an appropriate method to strngthen the embankment.

4. Vegetative planting material, irrigated with a network of automated dripping system, properly developed, after a year of achievement managing to cover the entire area around the slope.

5. For the solution based on stabilizing the embankment through the reinforced earth' techonology, we acchived a slope under 40%, completly vegetized even since the embankment was created. After a year, with automatic irrigation system, the vegetation had developed harmoniously, managing to supplement the stabilization through the surface developed root network.

6. Both methods of embankment consolidation confirm the viability of stabilizing slopes using geosinteticl materials asociated with plants specialized in slope consolidation.

7. The two different techonologies have responded appropriately to the conditions of the terrain. The study show that over a year there were no requrements regardin repair works or loss in dendrological material.

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