Geosynthetics, J. Kuwano & J. Koseki (eds)

Long term efficiency of erosion control geomats

Pinzani, G.P.
HARPO S.p.a., Italy

Sauli, G.
University of Udine, Italy

Keywords: geomats, long term efficiency

ABSTRACT: The use of the erosion prevention geomats is one of the most widespread control techniques against erosion along slopes, rivers, channels and hydraulic applications in general. The use of these materials provides short-term and long-term protection in order to prevent erosion processes from beginning under conditions where no vegetation is present as well as in slopes where vegetation has grown through again. To study how such materials are long-term effective 9 plan executed between 1982 and 2002 using polyamide geomats were examinated. The gathered results pointed out that the used materials are technically valid and some aspects are interestingly useful for the design choices.

1 INTRODUCTION

Erosion is part of the natural phenomena of abrasion and soil entrainment. These phenomena are usually due to wind and water sometimes influencing the soil balance with disastrous effects. For such reasons the correct design of any work in contact with soil requires a valuation of the potential erosion risk and, if necessary, the choice of the suitable protection interventions. Each adopted solution must be proportional to the potential risk in order to grant the intervention to be effective and meanwhile to avoid unnecessary expense in a correct costs-benefits connection. Therefore, there are different technical solutions with different materials orienting towards various problems of erosion to face. In the erosion prevention interventions of the slopes or channels where the energies are not particularly strong, one of the most widespread techniques involves the laying of natural (biomats) or synthetic (geomats) materials onto the soil. The biomats (Figure 1) are used where the risk of erosion is extremely limited over the time and ends with turf forming. On the contrary, the geomats are used when the erosion system works both in short-term and long-term: in short-term to protect the soil before vegetation growing and in long-term to reinforce the radical apparatus and to reinforce the slope where the root system of the vegetation has not completely been successful, yet. Therefore, the geomat must be able to grant its erosion prevention long-term function by taking into account the environmental conditions which it will be subject to (weather conditions, eventual maintenance, etc.).

Figure 1. Example of biomat.

2 GEOMATS APPLICATIONS

The erosion prevention geomats (Figure 2) are lightweight structures which are usually between about 10 and 20 mm thick. They are generally made of

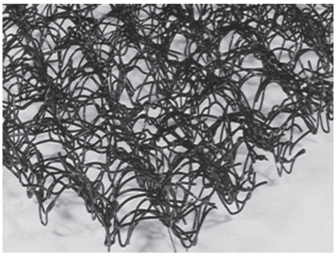
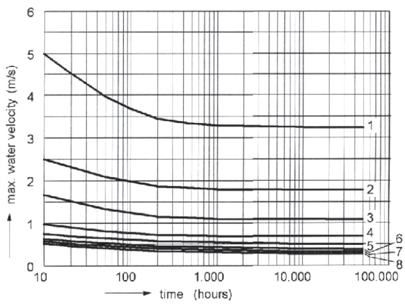


Figure 2. Example of geomat.

synthetic polyamide or polypropylene filaments welded together to form a three-dimensional matting structure with a high level of free space (higher than 90-95%).

Since these materials are set over surfaces which are not always perfectly regular, the geomats must have geometric continuity (erosion prevention solutions with geogrids turn out to be considerably less effective) and high flexibility (connected to the used polymer) to grant the complete soil-geomat adhesion. The geomats can be filled in on spot with soil or stone chipping; otherwise, when the conditions before vegetation growing could turn out to be particularly critical, geomats industrially filled in with gravel and bitumen are used. Research conducted in the '70s and '80s enabled to value the stabilizing contribution of these different materials: particularly for the hydraulic applications in channels (Figures 3 and 4) it was possible to determine the most suitable technical solution on the basis of water speed and event length.



1 = Pre-filled Enkamat (peak) – 2 = Pre-filled Enkamat
3 = Flat-back Enkamat (20 mm) + split – 4 = Flat-back Enkamat (10 mm) + split
5 = Flat-back Enkamat (20 mm) + sand – 6 = Open Enkamat (20 mm) + sand
7 = Flat-back Enkamat (10 mm) + sand – 8 = Open Enkamat (10 mm) + sand

Figure 3. Critical flow in relation to mean grain size diameter and soil type without vegetation (Colbond Guide).

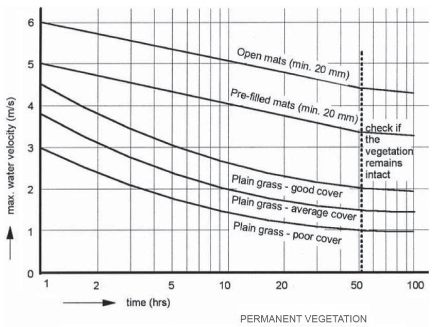


Figure 4. Recommended limiting values for erosion of plain and reinforced grass (Hewlett, 1987).

3 RESEARCH APPROACH

As geomat applications have been in use since 1970, this research was oriented toward the on spot examination of the current conditions of 9 geomat works carried out between 1-23 years in order to weigh up the real long-term efficiency of geomats and to value the behaviour of geomats over time. The examined places were chosen in order to take into consideration different weather conditions: 6 places in Italy (in the north, centre and south) and 3 places in Germany were chosen for the examination of their prevalent hydraulic applications.

One form was filled in for each place (Fig. 5) reporting:

- location and altitude
- exposure to sunlight
- morphology
- intervention purpose
- kind of intervention
- present and used vegetation species
- year and season of the intervention carried out
- remarks

MONITORING REPORT

Date: Editor:	04.06.'03 G. Sauli	
Province: Locality:	Udine Manzanella Stream	Coordinate GPS: N 45° 59,490' E 013° 21,867'
Altitude:	70 m	
Exposure:	SSE	
Slope inclination	35 - 40°	
Aspects of vegetation area:	Agricultural area	
Morphology:	Plain area (see sketch enclosed)	
Project target:	Erosion control	
Engineering:	Installation of geomat and rock stones on the river banks	
Work dimensions:	1 km	
Vegetation species used:	Grass seeds	
Designer:	Studio ing. LENA - Udine	
Execution season:	Spring 2002	
Observations:	Page enclosed	
Materials:	Prefilled polyamide matting (Enkamat A)	
Grass	*Dactylis glomerata, Arrhenatherum elatius, Lolium* sp.	
Others species of vegetation:	*Typha latifolia, Sparganium* sp., *Juncus* sp.	
Observations:	Beginning of colonisation by grass and shrubs trough the geomat	

Figure 5. Example of monitoring report.

3.1 *German sites*

The three places in Germany are all located in the area of Stuttgart; in Korb (carried out in 1982-1983), Rhemstal (1985) and Weinstadt (1985). All the works are concerned with the building of storage basins for the carriage and regulation of rain-water. The materials used are polyamide geomats which were set along the slopes in wet applications and dry applications. On the basis of a general examination of the places, all the interventions showed to be successful because of a widespread and stable vegetation blanket. In

© 2006 Millpress, Rotterdam, ISBN 90 5966 044 7

order to estimate the conditions of the used geomats, different geomat pieces were taken and examined. Particularly in Korb, the samples were taken along banks with a good vegetation growing and a short tract in connection to a concrete channel where the vegetation system had not developed and the geomat stayed directly in contact with the external weather conditions.

The observed geomats highlight that more than 20 years later the material looked in good condition (Figure 6). The test on the material from the tract without vegetation was also particularly interesting: even if subject to the most critical environmental conditions (temperatures changes, sunbeams, etc.) that part remained complete (Figure 7).

Figure 6. Sample of geomat 23 years old.

Figure 7. Sample of geomat 23 years old.

3.2 *Italian sites*

The places which were taken into examination in Italy are concerned with interventions carried out from 1988 to 2002 using different models of polyamide geomat. The examined places are in total six: three in Northern Italy (Treviso and Udine), one in the centre (Roma) and two in the south (Palermo). In the following pages three among the examined places will be shown in more detail because of their characteristics aspects and problems.

3.2.1 *Manzanella stream (Udine)*

The intervention was carried out in 2002 through the application of a polyamide geomat prefilled with chippings with a bitumen binder. The on-the-spot investigation which was conducted in 2003 after a flood of watercourse along which the vegetation had not yet spread confirmed that there was a marked interaction between roots and geomat in the already formed vegetation (Figure 8). Another inspection in 2005 pointed out a wide vegetation blanket confirming the good permeability to vegetation of this kind of geomat.

Figure 8. Roots trough the geomat after 1 year.

3.2.2 *Dese river (Treviso)*

The examined work was carried out in 1988; the geomat was filled with gravel and bitumen on site. During the inspection two different situations were found: there were areas in which the geomat showed a good efficiency interacting with the vegetation and areas where the geomat was almost totally absent, only scattered small-sized pieces were founded. The cause of such a condition was found afterwards: it came from wrong maintenance work carried out by rotating-blade, mowing-machines. Choosing the suitable machines is therefore important for the right planning and arranging of the maintenance so as to avoid ruining the banks, the works carried out before and the existing habitat.

3.2.3 *Farinella stream (Palermo)*

The intervention carried out on the Farinella stream dates back to 1988. The stream presents a regular section with a bottom about 2 m wide and banks of a varying range between 2 and 3 m high with an average gradient of 35°. The design solution planned the laying of an asphalted geomat onto the bottom and of a geomat filled in with soil for the banks (Figures 9 and 10). Both were fixed onto the soil by iron pins. During the survey in November 2003 it was observed that the intervention was completely effective since there was a good vegetation blanket on the banks.

Figure 9. At the end of construction.

Figure 10. After 1 year of construction.

When testing the bottom, the geomat could be seen to be perfectly complete. In particular over the bottom there were: areas of material storage where the geomat was covered with 5-10 cm of soil and areas at high energy water flow where the geomat efficiency to prevent erosion effects was particularly evident (Figure 11).

Figure 11. Stretch of stream without vegetation where the geomat 23 years old prevent erosion.

On the whole, the banks prevented were visible stable and with vegetation. In one tract where the gradients of the slopes reach 45° clear traces of a recent fire were found. Through a careful examination of some geomat tracts which were laid bare, it was possible to observe that, although superficially involved in the fire, the geomat was not burnt thanks to the autoextinguishing property of the polyamide. It had also kept at the same time its three-dimensional structure (Figure 12).

Figure 12. Geomat superficially involved in the fire.

3.3 *Climatic conditions*

The effectiveness of the carried out interventions and the integrity of the used geomats examined in relation to the weather-climatic conditions which the geosynthetics were subject to. On the basis of a general examination of the different climatic conditions between Germany and Southern Italy it can be seen that the materials worked under mean/month temperatures in open air between –2 and +30°C with peaks of –10 and +35°C. The slopes presenting varying gradients between 30 and 40° and made of mostly mud-clayey soils were subject to average rains between 30 and 100 mm per day with critical events sometimes higher than 50 mm per hour.

4 CONCLUSIONS

Like every technical solution, also the use of the erosion prevention systems must require an estimation of purposes, duration and laying and service conditions. The present contribution, even if limited, enabled us to confirm the long term efficiency of the examined materials after a real service period which in some cases was more than 20 years old. Moreover, it was possible to check the effect of fire, sunbeams and seasonal fluctuations and to point out that it is necessary to estimate the most suitable maintenance techniques. At this point, the next research step proceeding to test the material, to evaluate the mechanical properties variation of geomat in several service conditions.

REFERENCES

Hewlett, Boorman and Bramley – CIRIA (1987). "Design of reinforced grass waterways".

COLBOND (1997). "Enkamat Design Guide".

Ingold, T.S. and Thomson, J.C. (1990). "A design approach for preformed control system", Geotextiles, Geomembranes and Related Products, Den Hoedt (ed.) Balkema Rotterdam, Vol. 1, pp. 375-380.