EXPERIENCE FEEDBACK ON THE USE OF THE GEOSYNTHETICS IN ALGERIA IN THE FIELD OF PUBLIC WORKS

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Abstract: Geosynthetics have experienced considerable developments in geotechnical and civil engineering applications during the last thirty years. Currently they are present in most geotechnical works and areas of application are increasing. Several geotechnical structures including geosynthetics have been built in the last three years in Algeria. The paper will present an assessment of two representative works (an approach ramp to a civil railway structure and a landslide) by considering the hydrogeotechnical context of each of the works and the contribution of geosynthetics.

Keywords: Road, Landslip, Retaining wall, Reinforcement, Drainage, Geosynthetics.

INTRODUCTION

A major investment plan has been launched in Algeria in the public works sector which clearly illustrates the willingness of local authorities to undertake large-scale projects such as the East-West motorway (1,216km: 2x3 lane). Construction projects are executed in accordance with valid standards and recognised professional practice and take into consideration both the environment as well as a long-term development strategy. An innovative approach combined with the introduction of new technologies also have their rightful place in this concept. As natural resources of granulates are not inexhaustible, geotextiles and geocomposites have been widely used in various construction sectors over the last three decades in order to help preserve these resources. In the public road works sector, geosynthetics are used for soil support applications (stability of embankments, landslip support, protection against surface cracking, etc.), as well as drainage and filtration by replacing traditional techniques, etc. The aim of this paper is to illustrate the feedback from extensive experience gained in a country which has not hesitated to incorporate the proven results of applied research. In particular, we will examine the case of an embankment stability solution using geosynthetics which provided positive results in a record-breaking time.

TREATMENT OF A LANDSLIP AND CONSTRUCTION OF A ROAD SURFACE

Landslips are natural occurrences and are often caused by the presence and/or passage of water in the ground. The landslip examined occurred in a mountainous region following heavy rain. The slip affected the downhill side of the road over a distance of approximately 80 m (Figure1)

Figure 1. View of the landslip

Hydrogeotechnical context and diagnosis

The geological form of the land in this region is generally composed of sandstone separated by interposing layers of marl or marly slate. The sandstone on site showed considerable signs of erosion. Geotechnical examinations revealed the following geological formations from the surface down:

- −a layer of sandstone scree with a thickness of 5 m;
- −a layer of soft marly slate with a thickness of 0.5 m;
- −sandstone beds with a thickness of 1.10 m;
- −below these layers one finds alternating layers of marly slate and compact sandstone

The landslip occurred due to the infiltration of water from above and the total absence of drainage. The top layers slipped on the thin marl layer and the deteriorated sandstone beds (Figure 2)

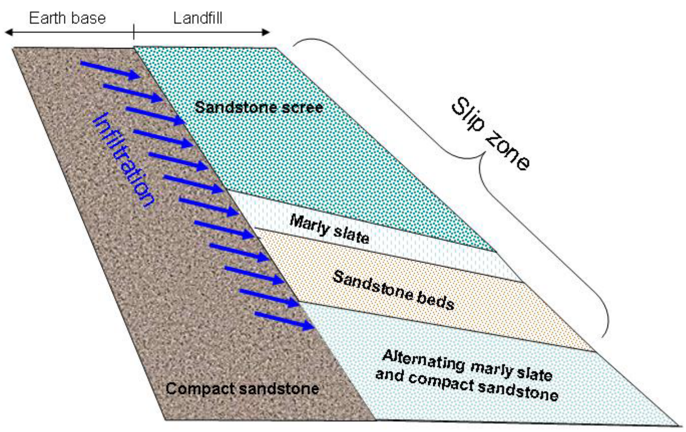


Figure 2. Landslip kinematics

Several technical solutions were proposed to the authorities to deal with the landslip problem and reconstruct the road. One of these solutions was to clear away the entire slip zone and reconstruct the embankment with a slope of 3H/2V using a clean coarse fill material (TVO), compacted in successive layers of 0.3 m. The drainage of water infiltrating from the top being provided with a granular drainage course. This solution was adopted, but during execution, longitudinal cracks appeared at the top and bottom of the new embankment created before the final thickness was attained (Figure 3). Upon detection of this problem, the owner and main contractor agreed to stop work and examine alternative solutions.

Figure 3. Longitudinal cracks which appeared due to the load of new soil

Following the abrupt stoppage of work by the owner, the following new support solutions were proposed:

- a retaining wall with gabions;
- a retaining concrete wall supported by pylons anchored at a depth of 4 m into the substratum ;
- a retaining wall reinforced by geotextile and a drainage geocomposite equipped with mini-drains of the type SOMTUBE FTF.

Due to the timeline imposed by the owner and the difficult site conditions, the third solution based on the use of geosynthetics was chosen

Solution retained

The solution retained is that of a retaining wall reinforced by geotextiles and a planted surface layer. The software package CARTAGE developed by the LCPC and LIRIGM (Delmas and al., 1986) was used to calculate the construction dimensions. The results are fully compliant with the "Recommendations for the use of geotextiles in the reinforcement of ground constructions" proposed by the Comité Français des Géosynthétiques (French Geosynthetics Committee).

This method enables, based on possible surface rupture studies, calculation of the forces applied to the reinforcement taking into consideration the extendable nature of the reinforcement geotextile used, the physical characteristics of the landfill material and the construction geometry. In this way one calculates the number, resistance, length and spacing of geotextile sheets. The construction cross-section and reinforcement density are illustrated in Figure 4.

The drainage of water penetrating from above is achieved with a drainage geocomposite of the type SOMTUBE FTF (Figure 4) (Gendrin and al., 2006; Arab and al. 2007). The water is collected by this geocomposite and then evacuated to a drainage trench at the foot of the embankment.

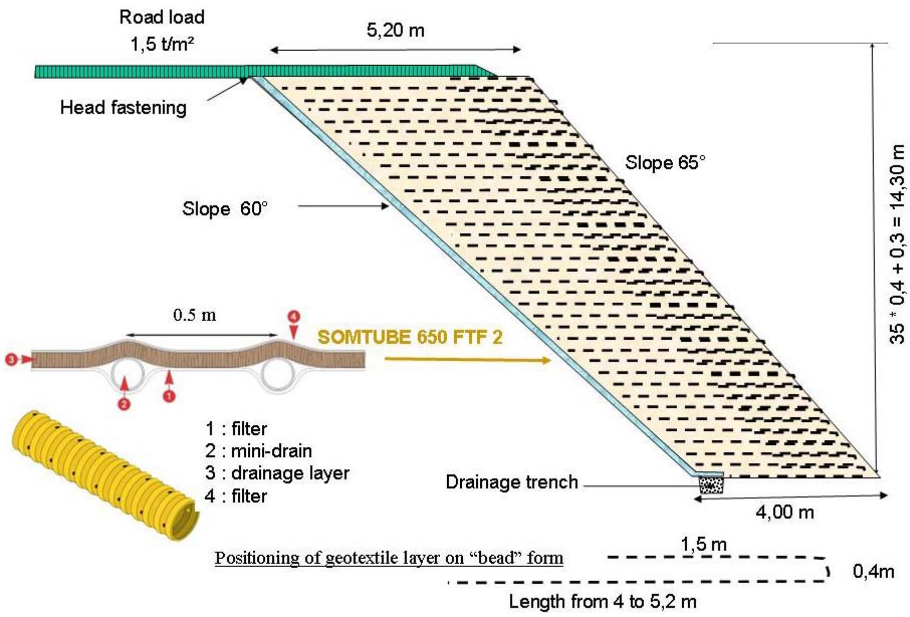


Figure 4. Cross-sectional view of construction, density of the reinforcement and structure of the drainage geocomposite

Work procedure

The work was carried out in several stages. After clearing all landslip top soil and earth removal work to attain the substratum, a drainage trench was created. The drainage geocomposite was rolled out directly onto the exposed embankment and overlapped into the drainage trench. The fill material is composed of 0.4 m thick layers and compacted to obtain optimum proctor value. The "beading" surface form is created using simple removable shuttering (Figure 5). The future vegetation of this surface is achieved by applying a layer of top soil held in place with a geo-net type Geotalus.

a .Construction in progress

b. Construction when completed

Figure 5. Views of the site during and after construction

Appropriate site organisation enabled total compliance with the deadlines imposed by the owner while ensuring the road remained open for traffic during the construction phase. Figure 5 b shows the site when finished. Once completed, this new embankment not only enabled reconstruction of the road surface but also its widening over a distance of approximately 50 m.

ACCESS RAMP TO A FLYOVER IN CONSTANTINE

To improve traffic conditions between the towns of Constantine and Didouche Mourad in Eastern Algeria, it was decided to construct a flyover (Figure 6). The owner (Public Roadwork Department) was in search of an efficient technical solution to reinforce the embankments of the access roads and blend in harmoniously with the surrounding environment.

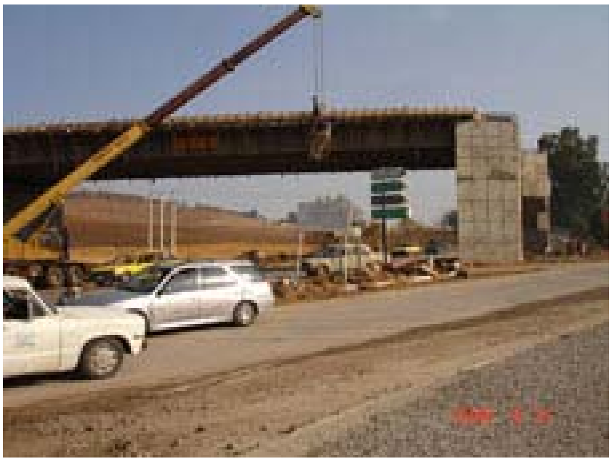


Figure 6. View of the flyover

Technical constraints relative to this project

The owner was confronted with a ground coverage problem for the construction of embankments adjacent to a flyover using the traditional solution with a slope of 2V/3H. Indeed, this solution requires expropriation with subsequent purchase of private property in the vicinity of the flyover with the fill material overlapping the existing road.

Due to the urgent nature of this project, the local administration chose to put out a call for tender for the construction of the access ramp on the Didouche Mourad side and a retention wall on the Constantine side. The aim of the administration was therefore to find a solution which would enable reinforcement of the landfill embankments, limit the ground coverage, harmonise the construction with its environment and reduce the construction period while respecting the initial project specifications without the need to purchase surrounding properties.

Various solutions were examined, in particular the solution of creating a reinforced concrete wall. This solution was discarded at it required the creation of deep foundations passing though the existing utility systems (drains, electricity, gas, etc.) which would have to be re-run with a subsequent increase in project duration and cost (Figure 7).

Figure 7. View of the various utility networks

Other solutions were also examined: prefabricated reinforced concrete wall elements, reinforced earth walls by metal strip and reinforced earth wall by geotextile with a modular cellular block facing which may then be planted.

The solution retained by the owner was to construct a support wall composed of modular cellular blocks, backed up by a geotextile (Arab and al., 2003, Tabti and al. 2006). The cellular elements are composed of 120 kg concrete units referred to as ″□atalus 120″ (Figure 8).

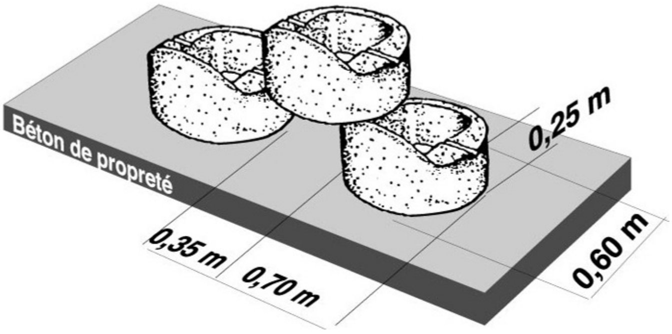
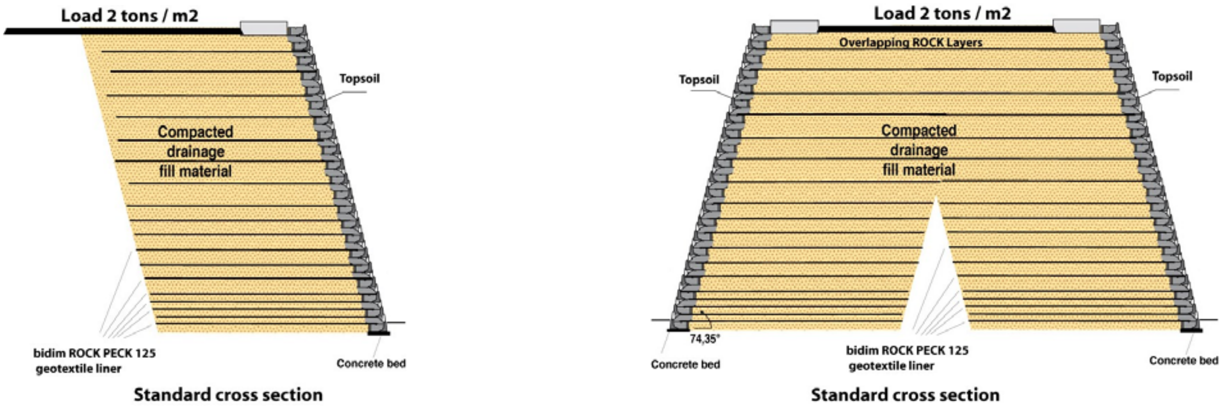


Figure 8. Dimensional characteristics of the atalus 120

The backing density (length and spacing of geotextile sheets) is illustrated in Figure 9.



a : support walls b : access ramp

Figure 9. Backing density of reinforcement

Site organisation

The wall elements are delivered on site directly from the factory. The fill materials are taken from a site not far from the construction zone. The construction phases are as follows:

- Emplacement of ramps and base for elements atalus120.
- Surface clearance of the entire project zone
- Creation of a concrete foundation with a density of 250kg
- Installation of the cellular elements and a geotextile layer
- Application of a 0.25 m compacted layer of landfill material, followed by a compaction test,
- Introduction of top soil,
- Installation of a watering system.

Figures 10, 11 and 12 respectively illustrate construction during and after work completion.

Figure 10. View of the work in progress

Figure 11. Installation of the watering system

Figure 12. The completed construction

The technical specifications and deadlines imposed by the owner and main contractor were complied with thanks to the used of geotextiles in combination with modular cellular blocks while using locally extracted materials and local labour.

CONCLUSION

The geosynthetic technique provides an appropriate response to the owner's specifications and offers alternative solutions with numerous advantages. In fact, they are easy to apply, versatile in their application and help contribute to the conservation of natural resources.

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