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

Drainage of cut slope – draining mask

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ABSTRACT: The RN 104 road widening project in FRANCE near PARIS area, involved a temporary cut slope excavated with a slope of 45%. It was then under-steeped with a covering layer made of local soil to achieve a final angle of 3H/2V.

Taking into account the presence of water in the soil, a traditional weight draining mask was first considered.

To save material and installation time, drainage with polypropylene needle-punched geocomposite equipped with mini-drains has been finally choose among other solutions.

The authors will present the geosynthetic techniques and design method used for the drainage of this project. They present also the monitoring taken out and the results analysis.

1 INTRODUCTION

The widening of the RN 104 in order to improve road traffic conditions near Paris metropolitan area. The main specificity of this project is in a significant cut section.

The excavation required a complete reshaping of the existing cutslope to obtain one final hillside of 3H/2V.

During the construction stages, it was decided to first steep the slope to 1H/1V, then to lay the drainage geocomposite connected to a trench collector at the bottom of the slope and then to fill the slope with the in situ soil to made a slope of 3H/2V (Figure 1).

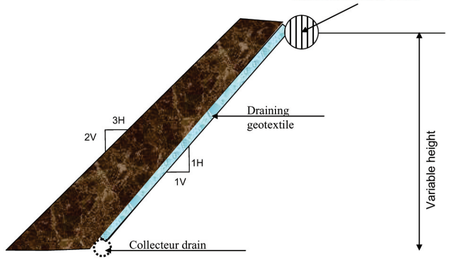

Figure 1. Schematic cross section of the cut slope.

The geosynthetic solution used for drainage at the slope to achieve its long term stability is described in this article.

2 GEOTECHNICAL CONTEXT AND SLOPE STABILITY

The soil studies carried out have revealed that the mechanical characteristics of the soil on site are mediocre, constituted with swelling clay and there were also random water circulations. The in situ soil permeability is on average 10^{-8} to 10^{-9} m/s.

To achieve the short term stability of the slope and for aesthetic reasons, it was decided to divid the total slope height of 12 m into two parts as shown on Figure 1.

The stability studies (Figure 2) carried out using Petal software have shown that these hillsides sloping with or without drainage geocomposite were safety. All safety coefficients are greater than 1.5.

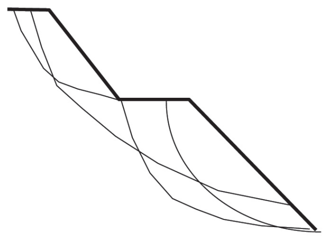

Figure 2. Slip circles and studied break lines.

The refill in material inclined at in 3H/2V, on a thickness of 3 (bottom) to 1 m (crest), guarantee the stability of the cut slopes in the time.

The various design methods proved the stability of banks once refill in place.

Nevertheless, count held by the nature of the refill materials, it was necessary to insert an effective drainage layer between the two layers of slanted materials to prevent decreasing their mechanical characteristics which could be caused by unnoticed irregular water inflows at the interface.

Cheap to produce and easy to lay, geocomposites could ensure long term drainage performance. They were therefore retained among the others solutions.

3 DIMENSIONNING OF THE DRAINAGE SYSTEM

3.1 *Drainage geocomposite*

The drainage geocomposite used in this project is SOMTUBE FTF, it is widely used in geotechnical projects (Gendrin and al., 2002), (Arab and al., 2005). Its structure is (Figure 3) described below:

- a needle-punched, non-woven polypropylene filter layer (filter 1),
- a needle-punched, non-woven polypropylene drainage layer,
- Polypropylene mini-drains diameter 20 mm, perforated at regular intervals,
- a needle-punched, non-woven polypropylene filter layer (filter 2).

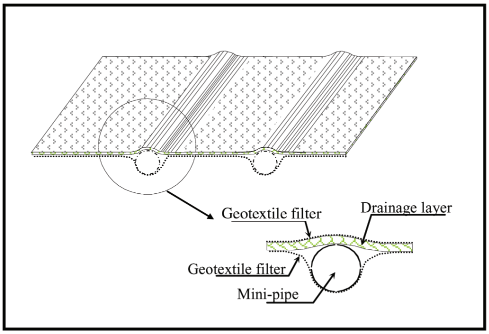

Figure 3. Geocomposite drainage structure.

The different compents are assembled by the needle-punch process.

The LYMPHEA software (Faure and al., 1993) developed in cooperation with Joseph Fourier University of Grenoble and validated together with the Laboratoire Régional des Ponts et Chaussées (LRPC) of Nancy was used to design the appropriate geocomposite.

The mini-drains system incorporated in the drainage product allows a quick exhaust for hydraulics streams resulting from the slope. Water collected this way is released towards a collector drain at the bottom of cutslope.

Slope geometrical characteristics (maximal height, hillside, thickness of the fill material) allow to figure out an exhaust stream of 3.2510^{-5} m/s with maximal pressure between mini-drains about 25 mm in height of water.

The assumptions taken into consideration to design the drainage mask under the embankment are:

- uniform flow
- height of embankment: 3 m
- mini-drains unsaturated
- four mini-drains per metre (spacing: 0.25 m)
- flow lengths: 20 m
- transmissivity of the drainage layer under stress due to 3 m of embankment: 1×10^{-5} m^2/s
- slope: 45°
- maximum pressure on the geocomposite: 0.025 m.

The result obtained is shown on Figure 4. The value of hydraulic flow has to be compared with the permeability of grounds in place to confirm the efficiency of the drainage geocomposite.

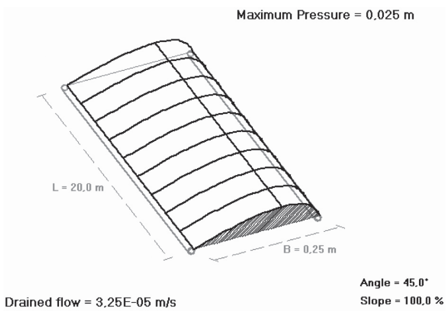

Figure 4. Assumptions and result obtained.

The filters size is 80 µm and is compatible with the underlying beds. The two filters are made of needle-punched, non-woven geotextiles specially adapted to the task of filtering. The flexibility of the drainage allows it to adapt to any ground irregularities. The last two characteristics optimise the filtering function by limiting the spaces in contact with the filter and consequent soil in suspension.

3.2 *Trench collector*

Trench design consists of dimensioning the geocomposite allows us to define the water exhaustion capability by linear meter of drain down the slope.

This value prescribes the minimal internal diameter for the road drain to be set up in the drainage trench collector.

The trench collector is constructed using permeable coarse material, it's a traditional use with gravel type

20/40 (grain size distribution), protected by geotextile filter.

3.3 *Anchorage trench design*

The strains sustained by the geocomposite in the anchoring trench (Figure 5) are function of:

- geocomposite/soil friction angle τ_s
- in situ soil/geocomposite friction angle τ_i
- thikness of the top soil.

The friction angles are measured in laboratory in shear box. Sometimes, they can be also estimated on the condition of adding adapted safety factors.

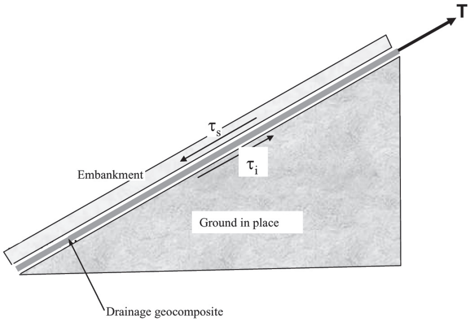

Figure 5. Design profil.

4 METHODOLOGY INSTALLATION OF THE DRAINGE GEOCOMPOSITE

The geocomposite is unrolled from the top of the slope (Photo 1). Once anchored in the trench up the slope, which will be filled later the geocomposite is batched off down the cutslope, ensuring there was no stop until footer trench.

Photo 1. Geocomposite drainage unrolling.

To prevent any movements due to the wind or refilling, the geocomposite drainage layer are fixed together using metallics U shaped bindings (Photo 2).

Connection with the slope toe trench is achieved by simple hydraulic overlap.

Photo 2. Geocomposite drainage fixation on the slope.

The flow collected by the geocomposite is discharged in the drain collector at the bottom of the slope.

At the top of the slope, the geocomposite drainage is anchored with a traditional anchoring trench (Photo 3).

Photo 3. Mechanical fastening at the summit with anchoring.

The under-steeping of the slope (3H/2V) is done with compacted in situ material (Photo 4).

Photo 4. Filling and under-steeping the slope.

The completion of the cut slope is shown on photo 5.

Photo 5. Filling and under-steeping the slope.

5 CONCLUSION

The construction was completed in May 2005.

The readings taken until now are conform to predictions.

Drainage geocomposite equipped with mini-drains was used successfully to achieve the long term stability of a high cut slope.

Comparatively to the traditional solutions with permeable coarse material, geosynthetics offers great guarantee on regularity performance, saving time work and earthwork.

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