Cover landfill drainage systems
Drainage and waterproofing for semi-permeable landfill capping

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1. Introduction

On landfill cover for domestic waste, the semi-permeable layer is traditionally composed of 1 m of low permeability clay soil or a Geosynthetic Clay Liner (GCL) under a drainage layer (figure 1).

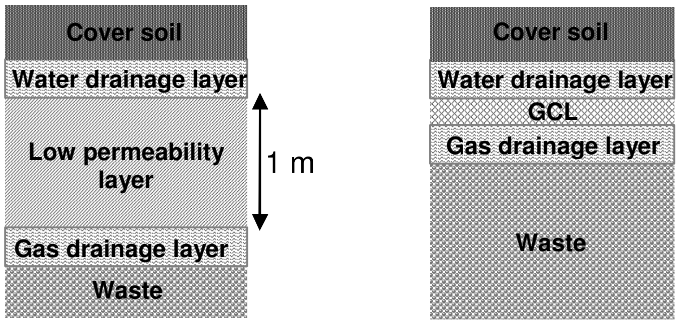


Figure 1: Typical semi-permeable landfill cover with low permeability layer or GCL

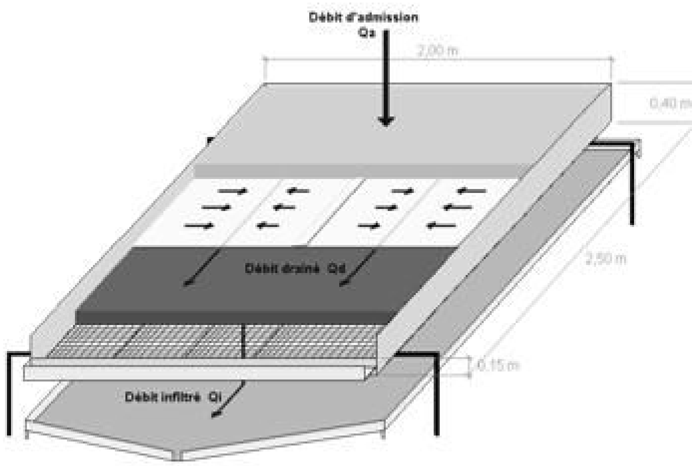
This cover allows an amount of water to go into the waste and permits to control the leachate production. The infiltration rate depends on the drainage efficiency and the permeability of the low permeability layer.

An experimental cell as been developed to simulate infiltrations through a semi-permeable landfill cover drained by geocomposites.

2. General description of the cell

The cell is an inclinable plane 2.5 m long and 2.0 m wide. It reproduces a landfill capping (picture 1).

The test consists of injecting into the cell a knowing flow Q_a and measuring the flow drained by the geocomposite Q_d and the flow infiltrated through the cover Q_i (figure 2).



Picture 1 & Figure 2: Experimental cell

The bottom of the inclinable plane is a rigid grid. The infiltrated water is collected under the cell and the drained water at the end of the cell (pictures 2 & 3).

The cell permits to vary parameters like the slope, the Inlet flow Q_a and the type of soil to see the effects on the infiltrations.

Picture 2: Infiltrated water collector

Picture 3: Drained water collector

The simulated landfill capping is constituted of (from the bottom to the top):

- clayey subgrade soil (0.15 m thick);
- drainage layer with geocomposite;
- cover soil with sand (0.20 m thick).

Two types of geocomposites with mini-pipes have been tested, a permeable geocomposite and an impermeable one.

3. Tests with permeable drainage geocomposites

The permeable geocomposite structure is (figure 3):

- a non-woven, needle-punched polypropylene drainage layer;
- polypropylene mini-pipes, perforated at regular intervals on two alternate axes at 90°;
- a non-woven needle-punched polypropylene filter layer.

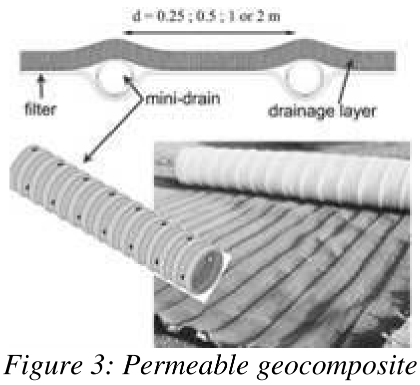


Figure 3: Permeable geocomposite

Tests have been run with 1 mini-pipe per meter and 2 mini-pipes per meter in the geocomposite.
The Figure 4 compares the Infiltrated flow Q_i for the two configurations.

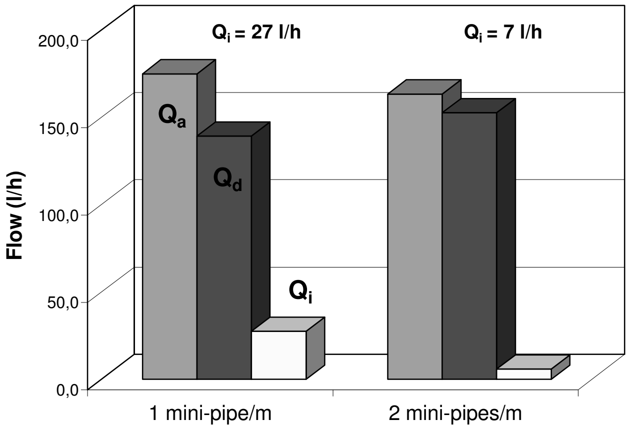


Figure 4: Infiltrations for a clayey subgrade soil and a slope of 5%

The infiltrations through the cover drained by the geocomposite with 2 mini-pipes/m are distinctly lower than the infiltrations with the geocomposite with 1 mini-pipe/m.

This can be explained by the mini-pipes function witch reduce the water pressure in the geocomposite map on one hand, and increase the discharge capacity of the geocomposite on the other hand. Indeed, the fact of increasing the number of mini-pipes into the geocomposite reduces the distance travelled by the water in the drainage map and so reduces the water pressure in it (Arab & al, 2002).

4. Tests with impermeable drainage geocomposite

With the support of ANVAR, an impermeable drainage geocomposite has been developed to ensure drainage and waterproofing of the landfill cover.

The impermeable geocomposite DRAINTUBE FT /PE is composed of (figure 5):
- a polyethylene membrane (PE).
- a non-woven, needle-punched polypropylene drainage layer;
- polypropylene mini-pipes, perforated at regular intervals on two alternate axes at 90°;
- a non-woven needle-punched polypropylene filter layer;

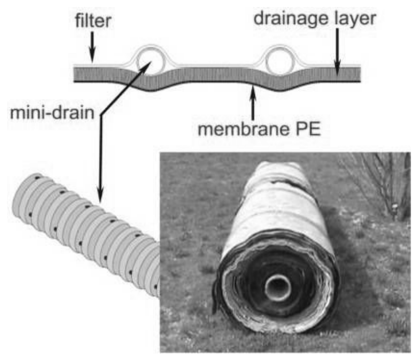


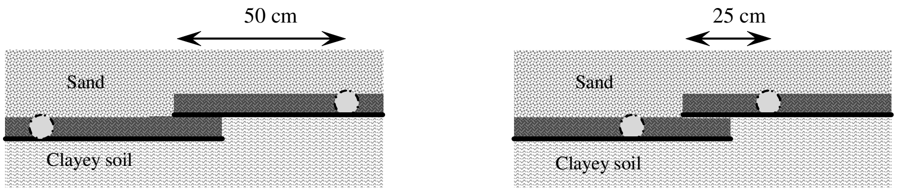
Figure 5: Structure of DRAINTUBE FT /PE

This geocomposite permits to substitute the low permeability layer or to reduce the influence of its characteristics (permeability, thickness) on the infiltrations.

The infiltrations through a cover drained by the impermeable geocomposite occur at the joints between the rolls. There are two types of joints:
- transversal overlap (downstream end of the roll),
- longitudinal overlap (parallel to the slope).

Infiltrations through transversal joints depend on the height of water in the geocomposite. With a sufficient overlap length or a small height of water in the geocomposite, they can be prevented (Faure & Mediot, 2002).

The infiltrations through longitudinal overlaps cannot be prevented as transversal overlaps. Tests have been carried out on the same cover structure drained by the impermeable geocomposite with 1 mini-pipe/m by changing the distance from the mini-pipe to the longitudinal overlap. Two distances have been tested: 0.50 m and 0.25 m (figure 6).



Configuration 1 Configuration 2

Figure 6: Tested mini-pipes configurations with the impermeable geocomposite

Results presented in the figure 7 show that the infiltrations are clearly reduced by reducing the distance from the mini-pipes to the longitudinal overlap. Close from the longitudinal overlap, the mini-pipes collect the water and limit the infiltrations.

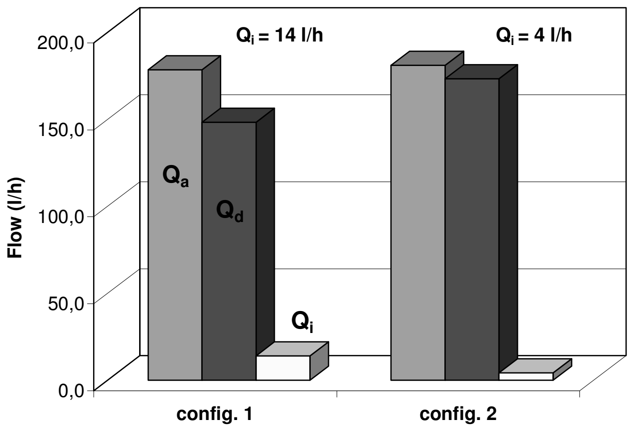


Figure 7: Infiltrations for a clayey subgrade soil and a slope of 5%

5. Conclusions

The landfill cover drainage with geocomposite with mini-pipes highly reduces infiltrations into the waste. The density of mini-pipes into the drainage map affects the infiltration rate and an average of 5% of infiltrations can be obtained with a permeable geocomposite with 2 mini-pipes/m.
The infiltrations through a cover drained by the impermeable geocomposite with 1 mini-pipe/m are less important.

The infiltration rate with permeable and impermeable drainage geocomposites depends on the distance between mini-pipes. If this distance is reduced, the water pressure in the drainage map and on the overlap is reduced and so the infiltrations are reduced.

6. References

Arab R., Durkheim Y., Gendrin P. (2002) – Landfill drainage system, *Geosynthetics 7th ICG*, pp 745-748

Faure Y. H., Meydiot V. (2002) – Secondary function of a complete drainage system: waterproofing, *Geosynthetics 7th ICG*, pp 549-553