Drainage design in a landfill lining system at the Saint Sylvain Bas Le Roc Landfill (Creuse, France)

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ABSTRACT: The necessity to open more and more landfill site leads sometime to project location where ground water table may occasionally appear. This is why the design with geocomposits needs to be carefully studied in order to avoid potential disorder in the construction and any water pressure on the bottom liner. A special attention will be taken at avoiding any mix in between ground water drainage and landfill leachate. The present paper describe a case study where each of the critical path is being taken into consideration, leading thus the choice to a geocomposits performing all designer requests.

1 INTRODUCTION

The Saint Sylvestre Bas le Roc is a municipal landfill, ranked in class 2 according to the French classification of landfills.

Three news cells have been recently constructed in line with the regulation, i.e. using a lining system made of a mineral passive barrier and a synthetic liner.

Being located against a slope particularly humid, the drainage of water under the geomembrane has been carefully studied.

The final choice was decided for a geosynthetics material providing at the same time the drainage flow required and the mechanical protection of the HDPE geomembrane.

1.1 *Requierement of the required drainage*

- Under the geomembrane: water and gas collection

The geosynthetics material is designed to avoid any pressure on the liner susceptible to create deformation, water pressure or damage on the geomembrane.

Any damage would immediately ruin the tightness of the lining system leading thus to pollution risks, especially due to the proximity of ground water table.

Gas drainage may also be necessary if the ground water table fluctuates. Gas would fill up the voids under the liner as water level is bellow the lower point of the cell. When water level increases, the gas captured under the geomembrane creates a pressure that needs to be removed toward a higher point.

- On the geomembrane: leachate collection

Leachates need to be drained toward the outlet during and after the exploitation of the landfill. During the landfill management life time, the quantity of leachate will depend upon the rain fall flow, and thus upon the location of the project.(Figure 1).

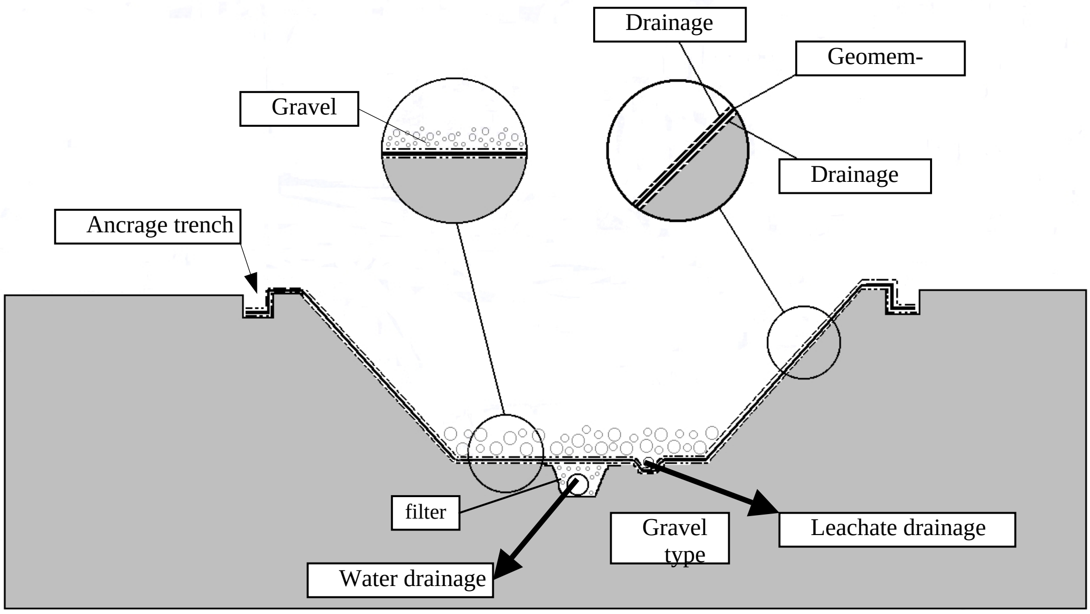


Figure 1.

1.2 *Choice of the drainage mat*

For both drainage layer, the following constraints have been taken into account:

1.2.1 *Drainage on the geomembrane :*

The geocomposits drainage capacity is to be evaluated at the completion of the infill operations, i.e. when waste has reached its highest point and the pressure on the drainage mat is at the maximum. For this reason the choice has been made to use a drainage mate made of a geotextile layer associated with mini pipes resisting to high pressure.

In permanent contact with leachate, this drainage must be particularly inert to number of chemicals. This is why a 100% polypropylene material has been selected.

1.2.2 *Drainage below the geomembrane :*

The geocomposits used must be as flexible as possible in order to match all subgrade irregularities. This property is particularly important: one must avoid that fine particles of soil in suspension are in contact with the filter of the drainage mat. The filtration of soil in suspension is at the origin of numerous cases of filter clogging.

These two drainage layers need also to play the role of antipuncture geotextiles vis-à-vis the geomembrane, not only during the installation phase but also during the lifetime of the exploitation. (Figure 2)

Figure 2.

Designers have finally chosen the Draintube FT2, a geocomposite made with the association of a filter, a drainage layer of polypropylene fibers and small diameter collector pipes incorporated every 50 cm in the machine direction of the product.

The product has a filter directly in contact with the sub grade while the other side of the product is in intimate contact with the geomembrane.

1.2.3 *Product design.*

A specific software developed in close collaboration with the university of Grenoble, LIRIGM, and the Laboratoire Régional des Ponts et Chaussées from Nancy, has allowed the precise evaluation of the parameters to take into consideration:

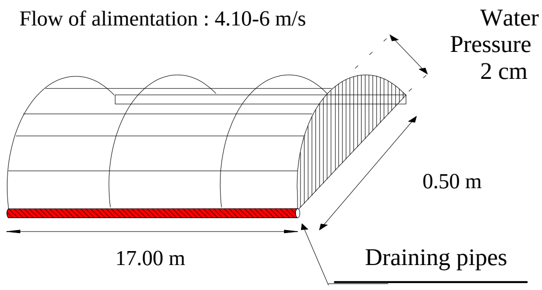
- Permitivity of the filter,

- Transmissivity of the geotextile layer of fibre under the pressure applied,
- Head loss at the entrance in the small collector pipes and all along the flow channel, depending on the choice of the flow, i.e. saturated or non saturated.

This software has been tested in real size. The testing unit allowed the measurement of in flow and out flow as well as the pressure of water in various positions of the drainage geocomposits.

The theoretical approach of the product through its design software versus the practical testing in real size has brought significant correlation of the water flow and pressure values

Pressure between the draining pipes



Product designed has been performed by taking into consideration geometrical shape of the cells as well as the constraints applied on the product.

The software allows the flow to be drained by the product according to different case of water pressure in between the pipe collectors within the geotextile drainage layer.

The study then depends on the location of the geocomposite, whether it is located on the slope or at the base of the landfill:

1.3 *Drainage of the base*

Depending the condition of use-geometry, pressure, etc.-the calculations have shown that the product can drain a flow of 4.10^{-6} m/s, much over the estimation of the water to drain. Pressure in between collectors is then limited to 2 cm of water pressure.

This low value insures safety of the geomembrane even if the ground water table fluctuates while the cell remains empty.

1.4 *Drainage of the slope*

The study has been conducted on a 3 horizontal for 2 vertical (34°). The water on the slope comes on punctual location points difficult to estimate in advance.

Nevertheless the drainage appears to be particularly adapted to this type of difficulty in as much as the pipes allow the quick diffusion of the water in the main trench.

The main collector system is one of the most important part of such a drainage design. It is being made with a pipe collector designed according to the flow to drain, buried into a trench, filled up with a 20/40 mesh size gravel wrapped into a filter to avoid any clogging of the system.

1.5 *Product installation*

The geocomposits is being deployed by unrolling the roll on its 4 meters width size. The panels are then simply overlapped in their lateral sides and maintained to one another by mean of a hot air welding equipment. This operation is only made to avoid a displacement of the product either under the wind or during the installation of the liner. At the extremity of the panels, a special attention is taken to insure the continuity of the filter. The material is then associated as described above (Figure 3).

Figure 3.

Both products, liner and geocomposits part of the lining system, are anchored on the top of the slope by mean of trench like for any geosynthetics (Figure 4). Product properties have been checked and validated toward strength and elongation properties, especially for the drainage located within the cell, subject to higher constraints.

Figure 4.

2 CONCLUSION

Too often, drainage mat are being selected on landfill projects without real calculated design of the required performance. This case study shows how much complex it is to take into consideration all the constraints of a project and then select the appropriate material to fulfil all requirements at once.

The product did fulfil most of it though, and this achievement is due to a key factor: the product can be adjusted to each specific case studied. Drainage design effectively depends heavily upon the water flow to drain and the hydraulic gradient, but in lining systems much more is usually required from a drainage mat and this is why only an open concept of geocomposits can successfully answer the requirement.