Realization of the capping of Vergiate landfill in Italia

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ABSTRACT: The final capping of the Vergiate landfill has been achieved with geosynthetics for water drainage. The capping is composed from bottom to the top by the subgrade soil, drainage and filtration geocomposite and the top soil. The drainage geocomposite has been designed with a software to drain a rainfall larger than 140 mm/24h. It also has high strength and puncture resistances to avoid damages during backfilling and ensure the continuity of the drainage and filtration on the overall capping.

1 INTRODUCTION

Nowadays, drainage geocomposites are widely used in waste landfills management, particularly on slopes and in capping system. Most of the landfill capping systems contains in their structure a drainage geocomposite. Its function is to limit the infiltration of water into the waste. This solution is widely used in westearn European. The drainage geocomposites need to be designed taking into account all the project characteristics. For this purpose, we use Lymphea® Software. In our communication, we will present the case history of the capping drainage of Vergiate landfill in Italia. We will also present in this paper a synthetic analysis of the contribution and the importance of the good efficiency of geocomposite solution for the drainage in landfill capping systems.

2 DRAINAGE OF VERGIATE LANDFILL CAPPING

The covering of Vergiate landfill must reach performance objectives in accordance with the chosen design. Those objectives are mainly control on liquid flux *(collection and treatment)*, control on gazes flux *(collection and treatment)*, revegetation of the site and its reintegration to landscape.

To achieve the aims whatever the chosen covering concept, the technical solutions take into account the nature of waste *(domestic waste, non-hazardous industrial waste, etc.)*, the covering geometry *(slope, rampant length, etc.)*, the climatic conditions *(precipitations, erosion, frost, etc.)*, and the site enhancement.

The solution retained for the VERGIATE landfill in ITALIA is DRAINTUBE 600R FT 1 D20, a drainage geocomposite product by AFITEX and composed of a filter, a drain core and regularly spaced mini-pipes *(every meter for this project)*. These elements are assembled by needle-punching to avoid any change in its mechanic and hydraulic characteristics. The mini-pipes enable fast, mono-directional evacuation towards the collector trenches.

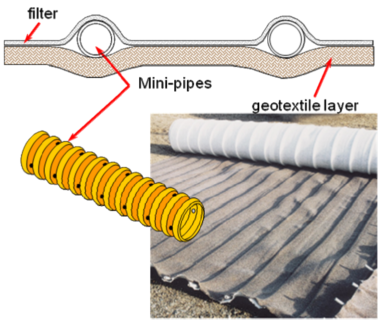

Figure 1. Drainage geocomposite

The geocomposite also has a tensile strength of 17 kN/m *(NF EN ISO 10319)* and a puncture resistance of 4 kN *(NF EN ISO 12236)* to avoid damages during backfilling and ensure the continuity of the drainage and filtration on the overall capping.

3 FUNCTIONING OF DRAINAGE GEOCOMPOSITE

The water penetrating the drainage layer runs off towards the perpendicular mini-pipes and is then evacuated by the mini-pipes to the collector trenches. The maximum distance the water runs through the drainage layer is half the distance between the mini-pipes. This enables limitation of the hydraulic pressure in the geocomposite liner.

Figure 2. Water flow through drainage geocomposite

4 DESIGN METHOD

4.1 *Presentation*

The software design Lymphea® has been developed in cooperation with the Laboratoire Interdisciplinaire de Recherche Impliquant la Géologie et la Mécanique *(LIRIGM)* of the Joseph Fourier University in Grenoble and validated together with the Laboratoire Régional des Ponts et Chaussées *(LRPC)* of Nancy. The "Lymphea" calculation code has allowed the design of drainage geocomposites for the draining of water on capping.

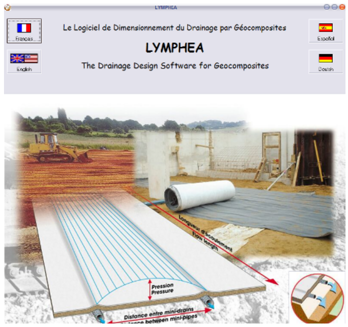

Figure 3. Drainage design software

Two flow conditions are considered for the precise evaluation:

- ✓ *water supply under a constant hydraulic head through a soil layer;*
- ✓ *water supply with homogenous velocity distribution perpendicularly to the product.*

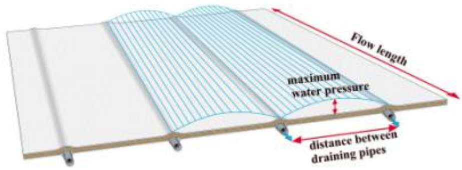

Figure 4. Diagram of water pressure graphs between the mini-pipes

The water inside the drainage layer is supposed to flow perpendicularly to the mini-pipes.

The software takes the following parameters into consideration:

- ✓ *the transmissivity of the drainage layer under compression,*
- ✓ *the flow length in the mini-pipes,*
- ✓ *the flow slope in the mini-pipes,*
- ✓ *the distance between mini-pipes,*
- ✓ *the flow conditions in the mini-pipes (saturated, partially saturated or not saturated).*

The software allowed designing the appropriate product with limiting the pressure *(water head)* in the product.

It also allowed visualizing the piezometric curves in the drainage product *(homogenous or heterogeneous one)*.

The theoretical approaches of the flow computed in the software are given bellow. The flow in the soil is assumed to be perpendicular to the plane of the drainage geocomposite with a constant speed. The head loss in each element of the geocomposite is computed according to the flow conditions into the mini-pipes.

4.2 *Results*

The drainage geocomposite of the capping of Vergiate landfill has been designed with the software to drain a net rainfall superior to 140mm/24h on the most unfavourable section of the capping, which represent a length of drainage of 75m with a slope of 15%.

Hydraulic Assumptions: Mini-Pipes NON Saturated - Uniform Flow

Input Parameters :

Draining layer transmissivity under applied Pressure (m²/s) : 1,9E-05
Distance between Mini-Pipes (m) : 1,0
Length of Mini-Pipes (m) : 75,0 ; Diameter (mm) : 20
Slope (%) : 15,0 ; Angle (degree) : 8,53
Maximum Pressure (m) : 5,48E-03

Results :

Velocity to drain (m/s) : 8,33E-07

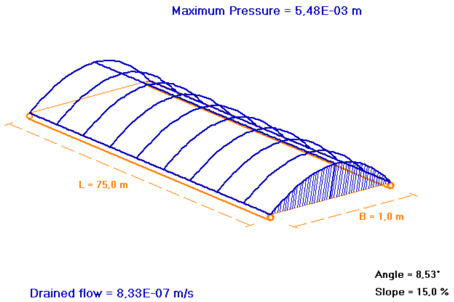

Figure 5. Results obtained with Lymphea® software

5 INSTALLATION

Geocomposite was supplied on rolls 4 m. Drainage geocomposite may be unrolled on a low permeability layer which has been graded to the required elevation or on a geomembrane. Insure that the pipes, filter layer and the capillary drainage layer are properly oriented.

Geocomposite was unrolled on the cover layer which has been graded to the required inclination. In the case of a steep slope, the geocomposite must be properly anchored. For slopes longer than the length of a roll, only full length rolls should be used at the top. Overlaps shall be shingled down the slope and/or in the direction that backfilling will occur.

Figure 6. Geocomposite installation on the cover layer

Sandbags or equal to weigh down the geocomposites prior were used to backfilling to prevent displacement by the wind or installation activities.

5.1 *Transverse Connections (at the end of a roll)*

To ensure continuity of flow in the mini-pipes between rolls, transverse joints have been used. The filter layer of the geocomposite is rolled back 20 cm. The end of the next roll is inserted into these openings and pipes are placed side by side or mechanically connected. Mechanical connections are recommended under high compressive loads.

Figure 7. Transverse connections

5.2 *Longitudinal Connections (at the side of a roll)*

Longitudinal joints have required an overlap of 5 to 10 cm minimum. To avoid displacement *(due to wind, backfilling, etc.)*, the overlap may be secured with sewn seams, additional overlap or welds *(hot air or flame)*. The spacing between welds shall be no greater than 2 m. Connection method requirements shall be at the direction of the designer/engineer.

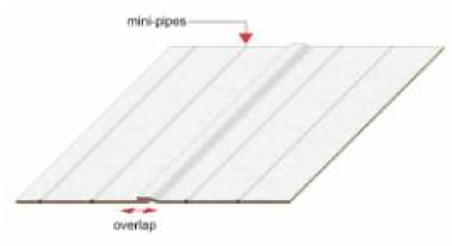

Figure 8. Connection to Liquid Interceptor Drains

Connection to an interceptor drain required a simple overlap of a minimum of 20 cm.

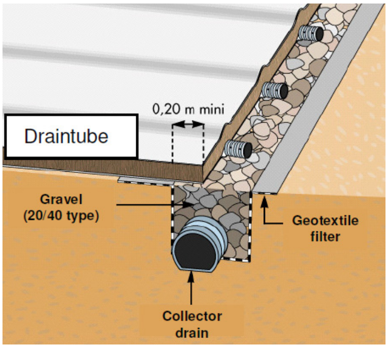

Figure 9. Link to the collector trench

5.3 *Backfill Placement*

The geocomposite drainage layer was covered with the specified. The backfill was free of angular stones or other foreign matter which could damage the geocomposite drainage layer. Top soil was put into place directly on the drainage geocomposite.

Figure 10. Backfilling of the capping Vergiate landfill

6 CONCLUSION

Too often, geocomposites 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 constraints of a project and the select the appropriate material to fulfil all requirements at once.

For the Vergiate landfill, the drainage geocomposite was used successfully. Comparatively to the traditional solutions he offer great guarantee on regularity performance, rapidity on execution and saving earthwork.

These applications have enables the development of protective drainage geocomposite and the limitation of water infiltration into the cell using a drainage.

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