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CASE HISTORY

The landfill capping system at Cerro Maggiore waste disposal facility, Milan, Italy

PRODUCT	TENAX TNT 600 geocomposite TENAX MULTIMAT 110/R reinforced geomat
LOCATION	Cerro Maggiore (MI), 1996
OWNER	SIMEC SPA Milano
PROJECT	SIMEC SPA Milano
CONTRACTOR	TENAX SpA, Gamma Verde SpA, CO.GE.TI. SpA

Cerro Maggiore (Italy)
Aerial view of the final closure of the municipal solid waste landfill

PROBLEM

Once the Cerro Maggiore waste disposal site had come to the end of its useful life, it was necessary to design a landfill cover system (known as Capping) that proved problematic due to the geometry of the existing site.
A capping system is designed to guarantee the impermeabilty of the landfill sides slopes, allowing for proper gas venting, with an adequate drainage system on top to avoid ground water infiltration, with a vegetated cover system to minimize environmental impact and to protect the geosynthetic liner. Indeed, the basic landfill profile was particularly long (60 m) and steep (between 20° and 37°), separated in three distinct sections 20 m long separated by horizontal berms having widths varying from 2.50 m to 5.00 m.

Cerro Maggiore (Italy) - Landfill capping
1: TENAX geocomposites for rainfall drainage
2: TENAX geocomposites for biogas drainage

SOLUTION

The slope was waterproofed using a bentonite geocomposite (GCL), which guaranteed a performance equivalent to 1 m of clay soil with a permeability of 10-12 m/s (alternatively polymeric geomembranes have been used). It is essential to protect the waterproofing system against mechanical puncturing and damage that may occur both during compaction of the various soil layers that cover Municipal Solid Waste and during anchorage of the capping system to the upper berms. This protection is achieved using a geocomposite layer above and below the waterproofing system and covering all with a minimum of 0,20 m thickness of topsoil (see cross section drawing). To act as a gas venting layer (below the GCL) and as a rainwater drainage layer (on top of the GCL), TENAX TNT 600 geocomposite was selected for its high drainage capacity and long-term compressive resistance. This is a combination of a TENAX CE geonet (drainage and load distribution functions) and two layers of nonwoven geotextiles (filtration action) heat bonded to the drainage net.
The TENAX TNT geocomposite offers a complete system of "filter-drainage-protection": the geotextile acts as a water/soil filter for the geocomposite and prevents intrusion within the drainage core of the bentonite migrating from the GCL during hydratation and intrusion of the loose fill material laid directly above, thus allowing for a long term hydraulic flow. A geocomposite layer was installed below the GCL liner to allow the biogas to be vented off avoiding excessive gas pressure build up and possible explosions. A geocomposite layer was deployed above the GCL liner to drain the filtered rainwater that, if left flowing in contact with the bentonite geocomposite, drastically reduces the shear resistance (angle of friction) between the soil and GCL.
The excess water, that produces soil interstitial water pressures and the loss of shear resistance, may lead eventually to a catastrophic landslide.
The choice of a geonet manufactured using the most stable polymer known, HDPE, is recommended due to the aggressive chemical nature of the leachates that are a by-product of urban waste.
The design parameters for the slope drainage were a hydraulic gradient of 0.5 (i=0.5) for an average slope angle of 26°, a slope length between drainage collection points of about 20 m and a soil fill depth over the capping of 0.20 m equivalent to about 3 kPa.
From these input parameters and given the typical rainfall distribution data of the area; it was established that a hydraulic flow rate of 1.00 E-04 m3/s/m was required allowing an adequate safety factor. Thus TENAX TNT 600 geocomposite was selected since it satisfies all requirements, as shown in the flow rate chart below.
Furthermore, slope veneer stability analysis were also conducted, showing that it was necessary to use above the geocomposite layer a reinforced geomat for soil retention, this would be achieved due to the materials tensile properties and high interlock with the surrounding soil. The design followed the principles of long term stability

and performance even during periods of prolonged heavy rainfall, and also allowed for the protection and growing of grass on steep slopes.
The project designers selected TENAX MULTIMAT 110 R that is a three-dimensional geomat composed of extruded and bi-oriented grids, with a high tenacity PET geogrid as reinforcement medium. The geomat is thus capable of withstanding long-term tensile loads and is able to distribute the stresses and minimise surface erosion.


Soil filling of the TENAX MULTIMAT 110R geomats

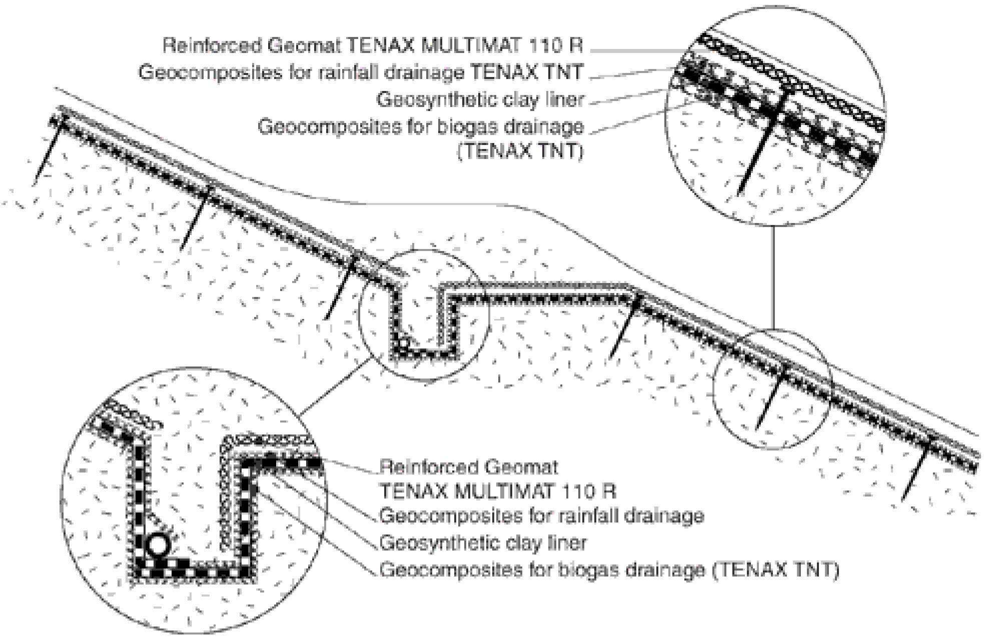

Landfill slope after geomat installation and fill soil covering

GEOSYNTHETICS INSTALLATION PROCEDURES

With reference to the below typical cross section drawing, after excavating the 0.50 m x 0.50 m anchor trench, the gas venting geocomposite was installed and connected to the gas venting system, then the GCL and the geocomposite for surface water drainage were installed on the slope.
The complete geosynthetic system was held in place by using 0.60 m long large headed anchor pins at a 2.00 m offset spacing. The GCL liner was installed with a 0.20 m overlap taking care to assure watertight seal. The geocomposite above the liner, was wrapped around a perforated drainage pipe that had been installed inside the anchor trench and space 0.20 m apart. Finally the geomat was placed in the anchor trench which was then back filled with a granular fill and compacted.
The same granular material soil was placed and compacted using a vibrating roller to a depth of 1.00 m on the top of the berm. A 0.20 m layer of organic topsoil was carefully placed on the completed slopes and was lightly compacted by roller. To help prevent surface erosion prior to the establishment of vegetation, a straw/coconut fibre biomat was installed prior to hydro seeding taking place.

SLOPE STABILITY ANALYSIS

The Geosynthetics Division of TENAX SpA carried out the slope stability analysis for the landfill capping system. The design evaluated the geometry of the covered slope, all the interface shear coefficients for the different materials used and for all the geosynthetics installed.



Typical schematic cross section:
detail of the geosynthetics anchorage trench and geosynthetics layout

CONCLUSIONS

The final capping cross section was, starting from the bottom of the cross-section (see drawing):

- Geocomposite for biogas collection: TENAX TNT 600;
- Bentonite geocomposite, GCL for water proofing;
- Geocomposite for surface water drainage: TENAX TNT 600;
- Three-dimensional reinforced geomat: TENAX MULTIMAT 110 R for veneer stability;
- 0.20 m thickness of hydro seeded topsoil.

This challenging project proved that:

- The use of TENAX TNT geocomposites (both for biogas drainage and rainfall water drainage) gives engineers the opportunity to design very long and steep slopes over impermeable and smooth faced waterproofing systems, that could otherwise prove impossible using traditional techniques such as gravel and/or sand layers that are more expensive to install and require higher factors of safety;
- To guarantee adequate veneer stability of the imported vegetated topsoil layer, it is necessary to add a reinforcement geosynthetic, such as the three-dimensional reinforced geomat TENAX MULTIMAT 110