Landfill organism

Introduction

World-wide the disposal of waste materials that are being produced at this time is a problem that is becoming important resulting in demands for greater landfill capacity. Everyone requires proper administration of these areas in order to improve environmental conditions that affect our life standards; to achieve this aim, it is important to understand that the landfill is not a “dump” but a living organism which has separate phases, i.e.

The landfill core and the main problems to be solved in each single phase

As with every complex organism, even the landfill has to be considered by the planner as a series of cells, sometimes very complex, interacting together, in order to discharge the living function that we can identify as the following:

1. Conception - Planning
2. Birth - Construction
3. Growth - Cultivation
4. Death - Reclamation of the area and integration into its environment
Fondation support and reinforcements

This covers the consolidation of the bottom of the landfill or of the wastes in order to provide a stable foundation layer and/or overall stability of the landfill. This aspect is particularly relevant where a new landfill has to be constructed on a soft surface (an old landfill, unstable clays soils) or in soils subjected to landslides or when we have to enlarge existing facilities. Geogrid products such as MacGrid™ W5, Paragrid®, Paradrain®, Paralink® or even gabions or Terramesh® units can provide, in various combinations, an answer to many problems faced by the designer during initial planning stages or in emergencies or unforeseen situations.
Improvement of the site's geological characteristics

To restrict the impact of leachate losses that are eventually anticipated to take place through the barrier system, the standards provide typically for either a natural low permeability layer or alternatively a geo-clay-barrier composite chosen from the family of the Madline® GCL. This second solution has found standard application on slopes where it is necessary to take into consideration the serious difficulties of placing and compacting cohesive soils (typically clay) on such surfaces.

Water drainage and filtration

Leachate waters arising from rainfall or from superficial water tables adjacent to the landfill must be diverted to avoid pollution by the waste and to avoid possible landfill stability problems or problems with the buoyancy to the barrier. It can be solved by carrying by the use of natural materials or by the use of drainage geocomposites chosen from the large family of the MacDrain® geocomposite products.

In case of conventional drainage trenches, the traditional filtration systems can be conveniently replaced, and with greater efficiency by the use of MacTex® non-woven geotextiles and, in special circumstances, when in contact with the wastes by MacTex® H-F woven geotextiles.
Waterproofing

This is the heart of the barrier system, and it is usually constructed with a synthetic geomembrane generally manufactured by the extrusion of an high density polyethylene raw material even if lower density polyethylene like LLDPE and VLDPE are sometimes suggestable. Many different types are available in order to match any technical requirement: smooth (Macline® SDH), textured (Macline® RH or TH range), fully black or coloured etc..

Geomembrane Protection & Separation

The geomembrane must be protected from the action of granular materials which form the drainage system and from cutting by sharp materials found within the waste. The range of MacTex® PN and PH geotextiles enables this fundamental protection to be provided at low costs; the same can also be provided as a secondary function, by MacDrain® drainage composites.

The possible intermixing of separate layer materials with different particle-size can be detrimental to the correct functioning of the several layers and can nullify their effectiveness. MacTex® standard range geotextiles, made from chemically inert materials, can be used to solve this problem. These geotextiles can also be used as a separation layer between the geomembrane and other materials in order to modify the friction angle and so to minimise the value of stresses transmitted to the membrane.
Leachate drainage

In order to avoid the retention of leachate within the waste it must be collected and taken to a treatment plant. This can be achieved using a drainage system built with either inert granular materials and HDPE pipes or, typically on sloped surfaces, MacDrain® drainage geocomposites.

Leachate filtration

The leachate can easily clog/blind the filter with which it is in contact due to the growth of bacteria. For this reason, filtration layers utilise naturally inert materials or particular MacTex® HF geotextiles characterised by high permeability and larger openings being known the poor performances of the standard nonwoven geotextiles in this application.
Gas and waterfall collection

The need to collect and evacuate the gas (methane) produced within the landfill makes essential to construct a biogas pipe system and chimneys. A gravel layer of 50 cm is the typical solution for the draining layer suitable either for gas and for rainfall water collection.

Even for this application MacDrain® drainage geocomposites can provide an efficient alternative to fine gravels or other inert natural materials. In any case, when the mineral layer solution is the only accepted, reinforcement layers like Macmat® R geocomposite eventually in combination with geogrids will have to be used on sloped surfaces. For the construction of chimneys special gabions can provide an easy and efficient method of construction.
Erosion control

This is a problem that arises at the time that a landfill has to be closed, after construction of the final impermeable coverage with natural vegetative soil has to be applied (typically 1 m) either on flat or sloped surfaces. In this situation there are a number of technical solutions: MacWeb® geocells, Macmat® R geonets if necessary reinforced with double twisted wire mesh or synthetic geogrids, steep soil slope reinforced with Paragrid® or MacGrid® WG geogrids and Terramesh® units, vegetated Reno mattresses revetment or simply the biological blankets of the Biomac® range. Each of these materials can provide the right solution to the problem to be solved but need a specialist skill to design the right solution.
How to joint and mix the different materials in order to obtain a practical landfill?

The use of industrial products provides solutions for most of the problems but does require a deep knowledge not only of the characteristics of individual products but also of their interactions. Each component has specific requirements that are often in conflict with general requirements. In order to assist the user, some of the main problems that need to be addressed when a landfill is to be designed are:

- **No stresses should be applied to the geomembrane and all situations where loads might be transferred to it thus causing shearing phenomena must be avoided. How is it possible to safeguard the membrane from mechanical damage without stressing it?**

- **In the construction of different kinds of barriers several layers of geosynthetics may be used together with potential stability problem and dangerous risk of sliding. In this situation there is not one single answer but the solution will depend on the type of materials which form the layers. Which is the best solution?**

- **When the final covering has to be placed, there can be a number of stability problems related to the soil layer placed on a waterproof lining system, the geomembranes in the latter typically being characterised with friction angles varying from 8 to 15 degrees in working conditions (even if textured). How is it possible to place and keep stable one metre of soil on an sloped surface and to guarantee long term stability performance of the full layer in static and dynamic conditions?**

- **What is the long term performance of the reinforcement materials in the specific environment peculiar and chemically aggressive like a landfill?**

- **What is the long term performance of the filters in contact with the water and the leachate? How do the drainage geocomposites characteristics change when they are utilised in a landfill and subjected to heavy loads in an anaerobic habitat with temperatures which can exceed 40 to 50 degrees?**

- **How can the settlement of the body of the waste fill be considered when the capping is to be placed? What are the practical effects on the external components in terms of maintaining the waterproofing and resistance of the package?**

- **Long term experience skill in either geotechnical and waterproofing applications is required not only to solve the problems but also to identify them. Maccaferri technical staff, with his huge experience develop in the designing and construction of this structure can provide a precious and valuable support either to designers and to construction and site managers.**
### Comparative list with functions and solutions

**Keys**
- • Materials specific for the indicated applications
- * Materials that can be used for the indicated applications

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<th>NATURAL MATERIALS</th>
<th>adaptation to site &amp; geological characteristics</th>
<th>foundation reinforcement</th>
<th>water filtration / separation</th>
<th>water / gas drainage</th>
<th>water proofing</th>
<th>leachate filtration</th>
<th>leachate drainage</th>
<th>geomembrane protection</th>
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Officine Maccaferri
Group Profile

Founded in 1879, Officine Maccaferri was soon to become a reference worldwide in the design and development of advanced solutions for erosion control and reinforcement structures. Over time, however, the company has innovated and evolved so that today it is also a reliable partner for complex civil and environmental engineering applications. This aptitude for technological innovation is the result of continuous dedication, which, alongside experience and technical know-how, has enabled the Maccaferri Group to leverage high levels of efficiency. Concepts transformed into versatile solutions meet our customers specific requirements, whilst maintaining a sustainable environmental balance.

Consultancy and partnership

Maccaferri does not just offer its customers simple collaboration but a real partnership which goes beyond merely supplying products. Maccaferri is a partner that works alongside its customers from the very start. It is a reliable partner thanks to its extensive portfolio of top quality products. As well as versatile solutions that can be adapted to local situations, it makes its technical know-how available to create a virtual circle in which each factor (products, experience and innovative practice) is improved by each activity.

Maccaferri tackles every project with the aim of identifying, dealing with and resolving each customer’s actual needs, and the results of this attitude produce benefits which can be appreciated over time.

Organizational Structure

Maccaferri researches, designs and develops solutions for the construction, erosion protection and soil stabilisation sectors in over 100 countries across the world. The organizational structure has been designed to be global and local at the same time. It is made up of subsidiary companies which make Maccaferri’s products and design and offer the company’s solutions throughout the world. This ensures greater flexibility, a widespread presence and a better awareness of continued market development.

Maccaferri’s presence throughout the world allows the company to deal with problems which results in new know-how that, in turn, feeds into further innovation for other solutions offered on the market. As well as the parent company in Italy and subsidiaries in France, Britain, Russia, Spain and Portugal, the company is also active in all five continents, with 40 operating companies. Where there is no internal sales force, there are distributors in all the continents so that all markets are monitored indirectly.

MACCAFERRI

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