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Liner design
on to an existing wastefill area

BKS NEEDED TO ADDRESS various practical and technical issues and apply some innovative thinking when designing the lining system that was to piggyback on to the existing wastefill area at the infamous Coastal Park landfill (G:L:B+) site.

The Coastal Park landfill site falls within the South Peninsula administration area and lies some 8 km east of Muizenberg on the Cape Flats. It is situated south of Zeekoevlei and 400m from the False Bay coastline. The Cape Flats sewerage works is on the eastern side opposite the site and is separated from it by the Zeekoevlei canal that drains into False Bay. The Capricorn development borders the landfill site to the west. The site comprises an area of 75 ha of land in total.

The site is divided into two phases, namely Phase 1 and Phase 2. Wastefill took place in Phase 1 before the site was permitted. Since obtaining the permit, wastefill has been moved to the Phase 2 area. Phase 2 is the first lined area of the site in accordance with DWAF and DEAT requirements.

The existing Phase 1 wastefill is at least ten years old with minimal treatment – that is, additional compaction, irrigation to aid settlement, etc – coupled with minimal historical data to use in the analysis. The depth of the wastefill is unknown. The depth of the wastefill lifts used to construct this old wastefill is unknown. The compaction efforts used in the past are unknown. Records of the material disposed into the old wastefill area are also not available.

Design of the lining system onto the old wastefill pile involved aspects such as the following:

- Performance knowledge of the various liner types (geosynthetics) and options
- Financial implications
- Effects (movement) on the existing waste body upon placing a load onto the waste body
- Liner requirements
- Differential settlement
- General settlement
- Hydration of GCL's using pure leachate
- Slope design, slip slopes
- Shear strength relationships
- Interaction between the various synthetic liners

Initially the lining of the embankment was going to be an extension of the double lining system up a 1V:3H slope. Subsequent to a meeting with DWAF, the lining system was reduced to a single hydraulic barrier.

BKS then decided to reduce the grade to a 1V:6H slope to allow for earth moving machinery to travel on this embankment as the layer-works included sand drainage layers, natural mineral erosion protection layers, etc. By reducing the grade, many other required design investigations became redundant, because of a more stable slope.

Two critical items needed to be addressed in this embankment design, namely settlement stability of the slope under load and guaranteed performance of the single hydraulic barrier.

SETTLEMENT OF THE WASTEFILL EMBANKMENT

Knowing the threat of large-scale settlement globally over the embankment and local differential settlement, the synthetic material types in the lining system were limited to flexible synthetic membranes. No clay is available nearby. Being the only hydraulic barrier, the materials considered were HDPE, LLDPE, GCL and fPP.

As a result of the threat of differential settlement, and to achieve a functional hydraulic barrier, BKS incorporated three main items in the design:

- **Initial compaction of the embankment** It was a requirement of the contract to clear the embankment, ensure sufficient soil cover, send a 12 t vibratory roller up and down the embankment over three times and measure the settlement for information purposes. (See table 1.) The sand cover ranged from 220 mm to 450 mm over the waste body. The aim was to compact the wastefill embankment as much as possible before installing the lining system.
- **Geosynthetic reinforcing grid** This is a new product by Kaytech called polyester yarn with a non-woven geotextile attached

Table 1 Settlement due to mechanical compaction

Strip no	SV	Settlement	Average
1	10 m 20 m 30 m	73 mm 53 mm 53 mm	50 mm
2	10 m 20 m 30 m	65 mm 53 mm 67 mm	
3	10 m 20 m 30 m	47 mm 38 mm 50 mm	
4	10 m 20 m 30 m	22 mm 27 mm 53 mm	

which has high tensile strength at low strain and directly interacts with sand-sized particles, that is, the aperture is such that the sand particles interlock and interact with the grid. BKS decided to install this grid to reduce the effects of differential settlement. This grid was placed simply (embedded) in the sandy subgrade layer.

- **Convex shape of the embankment** The design principle was to place the GCL to perform as a hydraulic barrier only and to not necessarily take up tensile stresses in the embankment. Over and above placing the grid, the embankment was shaped to a convex shape to take up general settlement whilst a tensile grid was added to the subgrade to lessen any potential localised and general differential settlement. As settlement occurred, the geosynthetic reinforcing grid would start to strain and take up the tensile load (and elongation) slowing down settlement (as the load is transferred to the yarn). At the same time the convex shape of the fill slowly lost its shape while the GCL remained under no real tensile load.

SINGLE HYDRAULIC BARRIER

Knowing the threat of differential settlement, as stated above, the material options for the single hydraulic barrier considered were HDPE, LLDPE, GCL and fPP.

- The GRI specification for fPP has been removed from the Geosynthetics website for various reasons and the material is undergoing further tests
- To DWAF, 2 mm nominal thick LLDPE was not an option as a single, primary liner The material is also generally more expensive than 2 mm nominal thick HDPE and mid-grade GCL. There is also a shortage of resin, so the price is increasing
- Although HDPE has a poor coefficient of elongation (typically 30% multi-axial elongation) compared to the other alternatives (LLDPE typically has 65% multi-axial elongation), it was nevertheless an option
- GCL was eventually chosen, but various issues discussed below needed to be attended to

Extra overlap

The GCL panels would require extra overlap to cater for movement in the GCL because of possible differential settlement. The design allowed for a 1 000 mm overlap in the horizontal plane and a 600 mm overlap in the vertical plane. A 300 mm overlap is generally recommended in 'normal' applications, depending on the supplier. This obviously affects the cost of installation per square metre; nevertheless, this alternative proven a viable financial option. It was required that the overlap be staggered along the embankment - that is, not all along the same horizontal plane - as the embankment is longer than the typical roll length.

Hydration of the bentonite using raw leachate

BKS needed to be sure that the bentonite would form a 'impermeable' paste when in contact with raw leachate from the site, being the only hydraulic barrier on the slope. To enable BKS to accept GCL as the suitable single hydraulic barrier on the embankment, a series of practical tests were carried out.

- BKS sent chemical test reports of the raw leachate (done over a period of time) to suppliers. In return letters of guarantee were obtained from suppliers to state that the use of GCL would be acceptable and the GCL would function when in contact with such leachate (leachate and bentonite interaction). Letters were received from suppliers stating their support for

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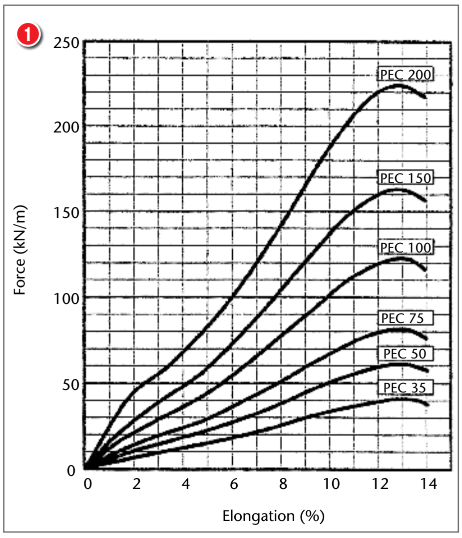

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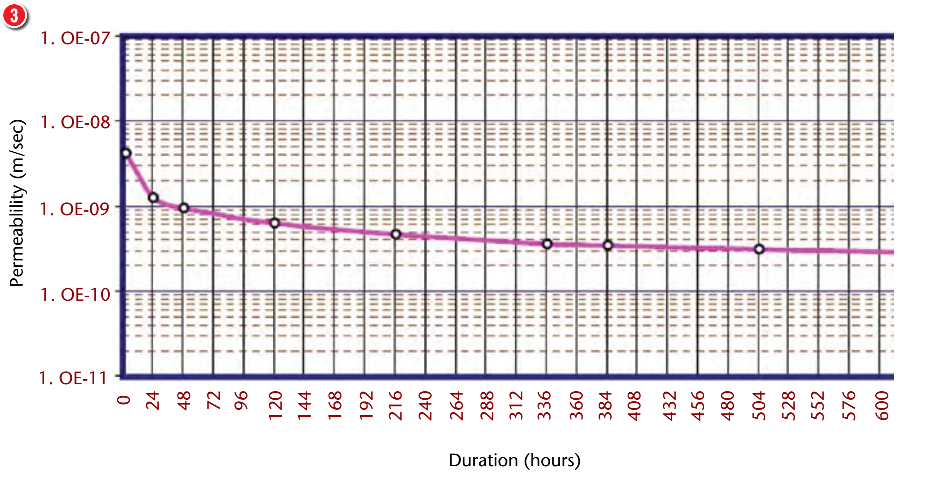

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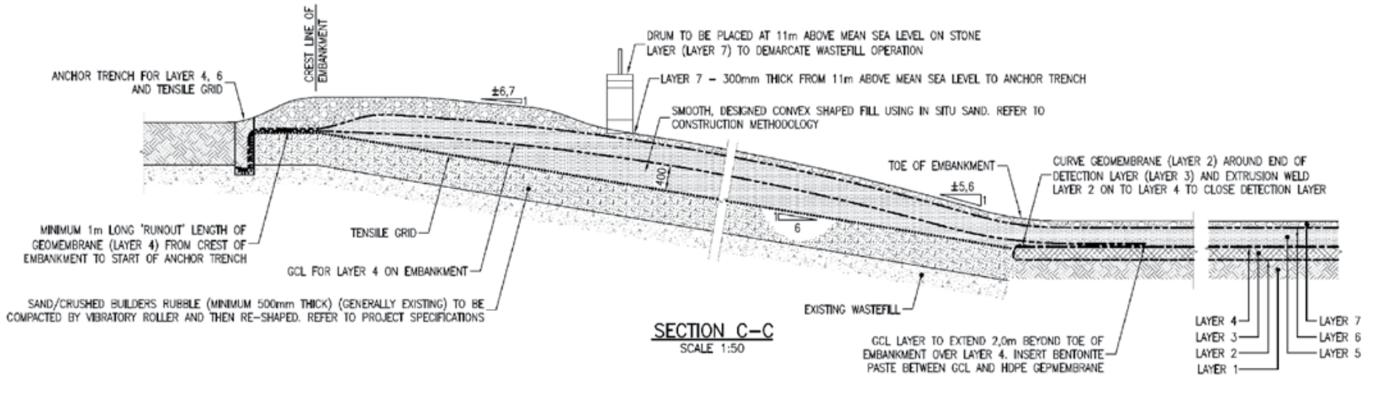

this application, vouching that the GCL would function as required.

- Crude on-site testing was done over a few days to visually inspect the hydration of the GCL using raw leachate. Basically the wheelbarrow has holes in the base, and the GCL was the only barrier stopping the leachate from leaking out the wheelbarrow. Raw leachate was extracted directly from the landfill cell and poured into the wheelbarrow and left. The area beneath the wheelbarrow was prepared in such a way that any drops from the wheelbarrow would be detected. The test was run over three days. The results were that little or no leachate managed to permeate through.
- A sample of the GCL was sent to the testing laboratory in Durban together with a sample of the raw leachate for hydration and permeability testing. Twenty litres of the raw leachate was put into new fuel cans and couriered to the laboratory in Durban. A variety of tests were done, some pre-hydrating the GCL, some being tested from dry-to-direct contact with leachate. In all the tests, done over a length of time (30 days), the GCL did hydrate to acceptable levels.

Over and above all the tests, historically GCL has also been used at Bassasar Road Landfill in Durban with a slope of 1V:3,5H (albeit these slopes are relatively short). No problems have arisen thus far on this portion of the site. ◻

1 Graph indicating the typical characteristics of the geosynthetic reinforcing grid

2 Section of convex-shaped embankment (image has been stretched)

3 Permeability analysis

4 Installing the grid

5 Wheelbarrow with holes in the base, lined with GCL and filled with raw leachate

6 Joles in the base of the wheelbarrow (the arrow shows one of the holes)

7 Sampling the raw leachate for the crude 'wheelbarrow test' and for sending to the laboratory in Durban

Source:
http://www.saice.org.za/downloads/monthly_publications/2007/CivilOct2007/#/0