Constructing Sanitary Landfill Over Very Soft Ground With Very High Water Table, Next To Melaka River, In Melaka, Malaysia

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ABSTRACT: Designing landfill liners focused mainly in reducing the liner permeability rate and improving the contain ability of leachate within the landfills mass. Hence it is critical to have firm founding base to lay the geomembrane liner. However in the event the landfill site is location on a very soft ground with very high water table, controlling base liner differential settlement will become the key factor from preventing the liner from damage and the leachate collection system to function continuously. Even minor leakage of leachate via the damage liner could contaminate the ground water rapidly. The project site which will be discussed in the paper, is located next to Melaka river, in the state of Melaka, Malaysia. The site consist of exiting landfill build without liner system and next to the exiting landfill site, a new sanitary landfill were required to be build. However the ground were found to be very soft with high ground water table. Hence this paper will address the design consideration adopted to save guard the environment and the measures considered to stabilize the ground to receive the new 16m high waste. Specially designed geogrid reinforced stone columns with high strength geotextile were used to support the liner and to control ground differential settlement. As for the existing landfill site, perimeter earth bund were proposed to be installed together with subsoil trench drain to intercept and collect the existing leachate mount within the landfill mass and the leached from being discharged into the Melaka river. The details of the above will be discussed in the paper.

Keywords: Sanitary landfill, Soft clay, Geosynthethic encased stone column, High water table

1. INTRODUCTION

Majority of landfill in Malaysia are an open dump site without any protection to the environment. There are a total of 176 number of active landfills in Malaysia out of which only 10 are lined and managed sanitary landfill. The rest of landfills remain as open dump. (www.kpkt.gov.my)

As for current situation, the contamination of ground water are not manageable. In some cases the untreated leachate are released directly to the river, some places the rivers are drinking intake water source. It was reported that about 16 open dump landfills are next to drinking water intake. It is estimated that at least 5 % of the Malaysian population (approximately 1 million people) are living within 1 km radius from closed landfills and existing dumpsite. (Salim et al., 2003)

The Malaysian government have undertaken the task to close the existing open dump and environmentally harmful landfills and to open new manageable sanitary landfill. In some cases the new sanitary cells were open next to existing open dump site. As such the Krubong landfill in Melaka is an exercise under taken by the Malaysian government to close the exiting open dump landfill and to open up new sanitary landfill next to it. At present the flow of leachate were not managed. It is estimated about 2.5 million liters of leachate flows everyday into the ground and into adjacent water bodies, such as river, ponds and lakes in Malaysia, (Angamuthu et al. lecture note).

Hence the task for this project was to contain the leachate and prevent it from contaminating further the Melaka river. Hence it requires structured and implementation of a suitable layout plan for new sanitary landfill. Figure 1 shows the proposed layout plan for the landfill site.

2. PROJECT REQUIREMENT

The project is proposed to be a level 4 type landfill which requires, the following

- Leachate Collection System
- Leachate treatment plant
- Leachate detection and monitoring system
- Provide suitable cover and base liner
- Introduce Material Recovery Facilities (MRF)
- Gas Collection System
- Perimeter embankment

- Daily Soil cover

Table 1: Landfill facility and Level

Facilities	Level 1	Level 2	Level 3	Level 4
Soil Cover	+	++	++	++
Embankment		++	++	++
Drainage Facility		++	++	++
Gas Venting		++	++	++
Leachate Collection				
Leachate re-circulation				
Leachate Treatment				
Liners				++
			Semi aerobic	

The above given requirements are part of guild line for sanitary landfill. However extra attention were required for this site as the site is situated on very soft clayey ground of 12m to 15m deep and located next to Melaka river. Hence ground stabilization measures, settlement control and landfill slope stability protection measures were introduced in the project.

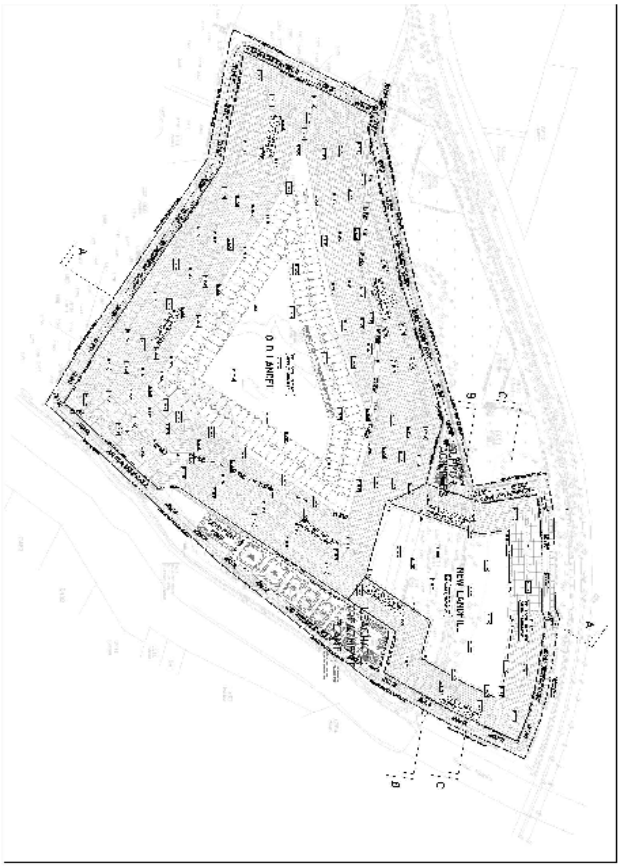

Figure 1: Proposed Landfill Development Layout Plan

3. SITE INVESTIGATION AND SITE CONDITION

Site investigation were carried out by means of boreholes and mackintosh probes. Ten number of boreholes with 30 numbers of mackintosh probes were used for the site investigation works. The boreholes were placed at both old landfill site and new landfill area. The boreholes were required to record ground stiffness by means of standard penetration test (SPT), type of materials, ground water levels and to collect water samples. With the information collected the area and depth of old waste were identified.

Based on the site investigation information, the subsoil stratum where the proposed 16 high landfill to be construct were found to be on very soft clay with SPT value of 0 to 2 blows/300mm for depth of 12 to 15m followed by stiffer ground. As for old waste area, the waste is about 20m thick followed by very soft clay layer of about 8 to 9m thick. This shows that the ground has undergone large settlement of about 4 m due to the placement of waste of about 20m thick. This large settlement is also likely to take place at the new sanitary landfill if no ground improvement is done, the new landfill of about 16m to 18m high is expected to settle about 2.5m computed. This large settlement will damage the base liner and the leachate collection system. Hence the ground is requires to be improved to place the 16m high waste on this very soft clay. The typical details of borehole at new and old landfill location is shown in Figure 2 and 3 respectively. Figure 4 shows the ground settlement undergone at old landfill site.

4. PROPOSED GROUND IMPROVEMENT

Varies type of ground improvement techniques were studied for feasibility for this project, some of the options considered were :

- In site replacement
- Piling foundation
- Cement soil mix column
- Stone Columns

Cost effective solution were required to be adopted and the of stone column option were found to be cheapest. As the ground found to be very soft and week to support 16m to 18m high waste with convention stone column. The stone columns were proposed to be encased with geosynthetic (geotextile composed with low strain geogrid)

The advantage of using this geosynthethic encased stone column are as follows:

- Increase the load carrying capacity of stone column
- Wider spacing of stone column
- Reduce wastage of stone during installation
- Cost effective compared to conventional stone column

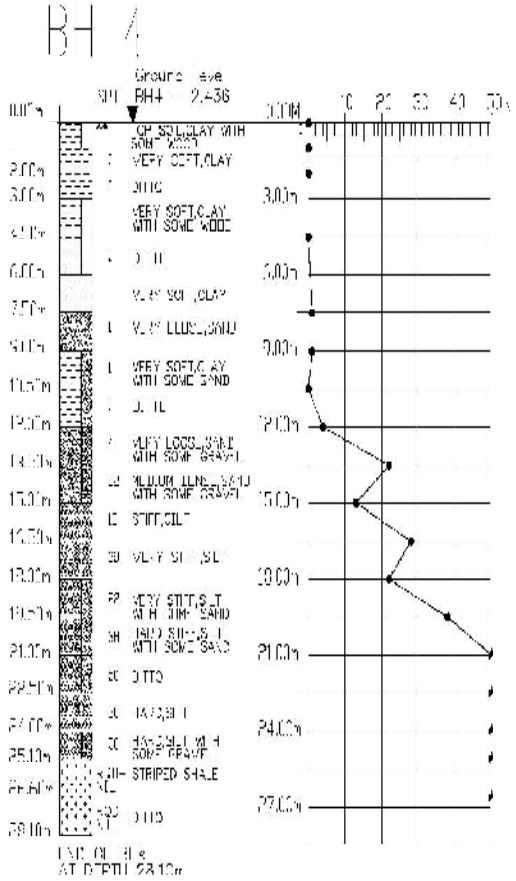

Figure 2: Subsoil stratum at new sanitary landfill

The typical details of the proposed stone column and base liner is shown in Figure 5. The advantage of geogrid reinforced stone column is shown in Figure 6.

5. ENVIRONMENTAL PROTECTION SCHEME

As for the overall solution for environmental protection works and to safe guard the Melaka river from being polluted following system were implemented.

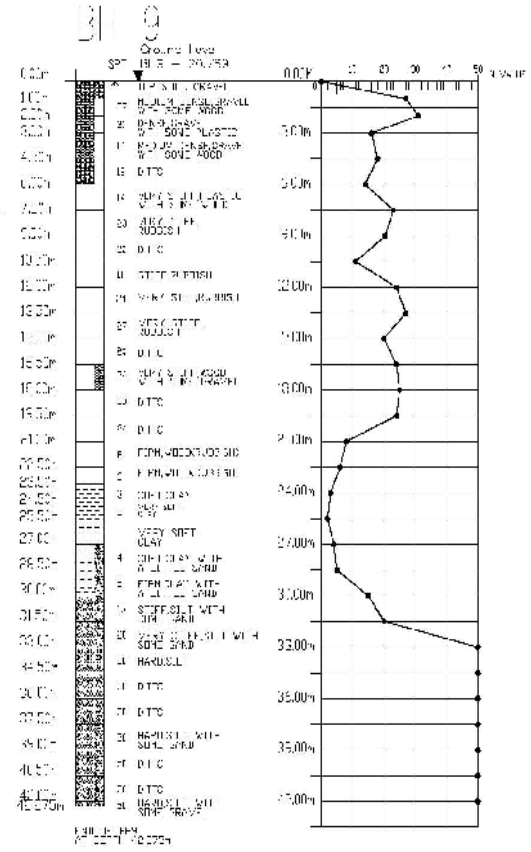

Figure 3: Subsoil stratum at old sanitary landfill

- Construction of perimeter earth bund (site boundary and for maintenance works)
- Subsoil trench drain (to intercept light weight leachate from existing waste)
- Geosynthethic reinforced stone columns as ground improvement scheme and to support the waste mass
- Systematic layout of leachate collection pipes
- Installation of gas collection system for both new and existing landfill cell.
- Install automated leachate treatment plant

Details of the perimeter containment bund with subsoil trench drain is shown in Figures 7.

6. CONCLUSION

With the proposed system implemented, the landfill at Krubong, Melaka is expected to become one of the model sanitary landfills constructed on very soft clay, with control settlement to prevent the damaged of baseline and the continuous function of leachate collection pipes. With proper construction approach and installation methods

adopted for geogrid encased stone columns, along with organized monitoring system and well planned waste management program the Krubong landfill expected to perform as per design and protect the environment for long term.

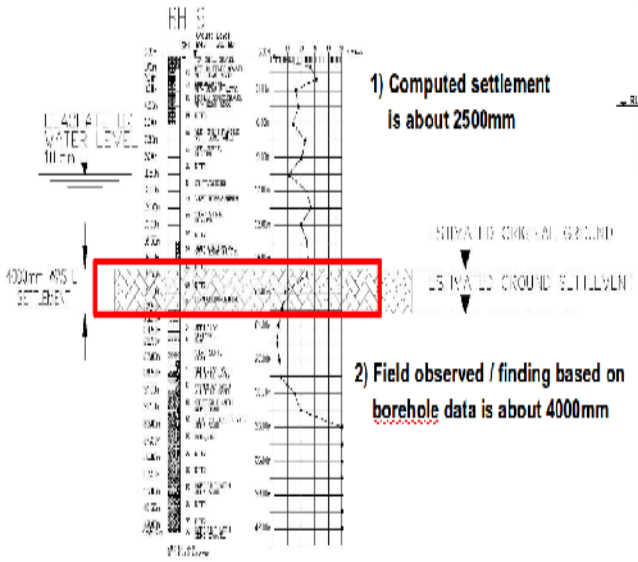

Figure 4: The settlement undergone by old landfill

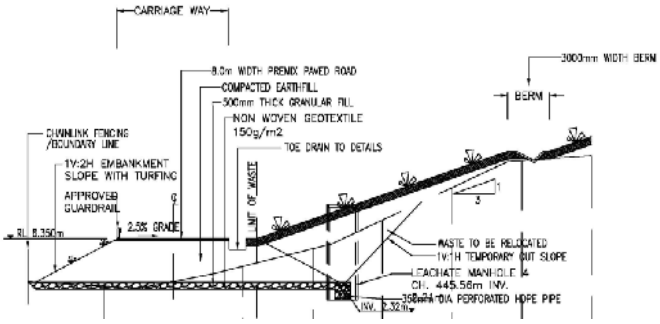

Figure 7: Perimeter bund with subsoil trench drain

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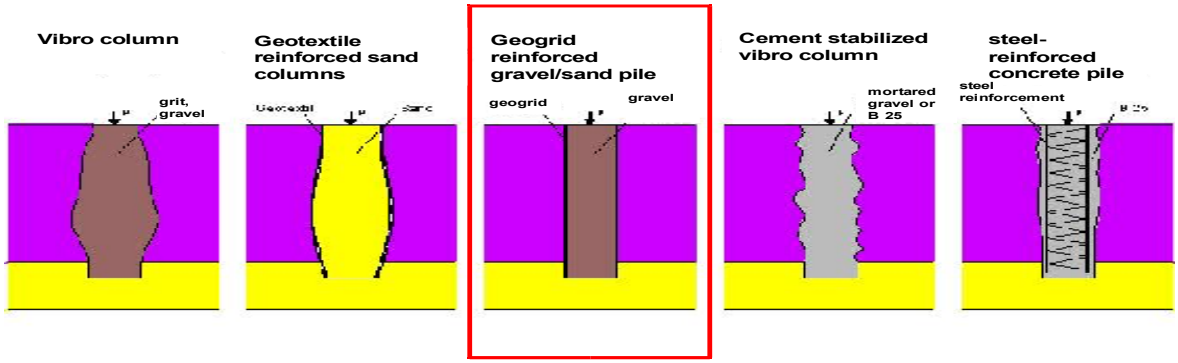

Figure 6: Advantage of geogrid reinforced column

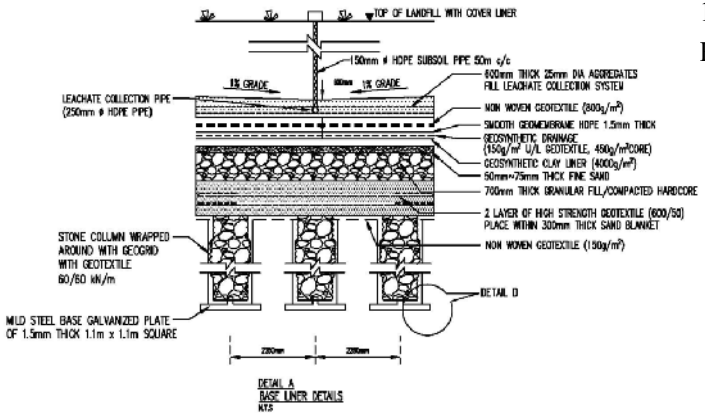

Figure 5: Typical details of base liner and stone column

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