The Study of Soil Permeability Test for Landfill of Slag and FABA in The Area of Location 2 LB3 in The Regency of Central Halmahera

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Abstract. One of the feasibility methods for landfill of nickel slag and FABA is the soil permeability test. Data of interpolation results from all areas consisted of 7 sampling points in location 2 LB3. The results of testing of Borehole on 7 points showed domination of sand-sized material with 74.40 – 86.10% (first meter) and 82.04 – 91.77% (second meter) compared to the clay and gravel materials. Interpolation results of permeability class in the area of Location 2 LB3 ranged from "slightly fast" to "fast" from a layer depth of 0-2 meters. Furthermore, the permeability class classification based on the Verruijt classification showed that the overall observed areas for location 2 LB3 were in the Medium Permeability class. This result was determined by the presence of sand-sized material which is more dominantly concentrated than gravel and clay-sized material.

Keywords: Permeability test, Landfill, Slag, FABA.

1 Introduction

Nickel ore smelting processing is an activity of producing nickel pig iron semi-finished products. Apart from producing nickel Pig Iron as the main product, this smelting process also produces waste, namely Slag and FABA (Fly Ash and Bottom Ash) (1). The resulting waste has a large tonnage of production per day. Consequently, this requires a proper waste dump that complies with the applicable standards and regulations. Given the importance of waste management from the processing of a laterite nickel smelter (1), it is necessary to plan and conduct a feasibility study of the appropriate waste dump according to the standard. This activity was performed by collecting soil samples (Borehole), making monitoring wells, and mapping the pattern of groundwater flow patterns as an initial study on the feasibility of slag and FABA dump. The results of this study are expected to provide consideration or recommendation for the mining companies in planning and selecting locations for the landfill.

2 Research Methods

The method of implementation of the activity is carried out by observing the field to localize and determine the coordinates of the drilling and sampling data collection using the GPS 78s tool, after that drilling is carried out at 7 points with the Auger Drill Tool to a depth of 2 meters, and taking soil samples per one meter then soil samples testing will be carried out in the Soil Mechanics Laboratory Faculty of Engineering, Khairun University. Measurement of altitude using GPS corrected elevation with secondary data, namely land contour data from digital RBI maps issued by Bakosurtanal in 2003 with a scale of 1: 25,000. Then the data is then processed and modeled with a computer using software (software) ArcGIS 9.5 and Golden Surfer with output in the form of contour maps of the groundwater table, contour maps of soil permeability and contour maps of the percentage distribution of gravel, sand and clay materials.

3 Result and Discussion

3.1 Percentage of Soil Materials

From the results of the screen test in the laboratory, interpolation of the soil sample test results was then conducted. It was shown that the percentage of alluvial sand interfering with laterite soil was dominant in the sampling location and was evenly distributed with an average of 82.11% at the first-meter depth (Table 1) This occurred because the area is a sedimentation area from a small stream (2). At the second meter depth, 85.97% sand-sized material (Table 2) still dominated the sampling area because there was a transition zone from weathered lateritic soil to Saprolite. In addition to sand-sized material, the results of interpolation of laboratory data showed the presence of gravel size material on the

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surface to a depth of 1 meter, occupying the middle of the sampling area which spreads to the south with an average percentage of 10.48% (Table 2). Furthermore, the results of interpolation of data at a depth of two meters showed the distribution pattern of gravel material remained concentrated and deposited towards the south, with an average percentage of 5.85% (Table 1). The concentration of clay at a depth of 1 meter was seen in the northern part of the sampling area. The area is an upstream area that has slightly thick laterite soil and has a slightly higher elevation than the downstream area in the south of the sampling location (2). The sample test data (Table 2) shows that the average percentage of clay material is 7.42% less than both the sand and gravel materials. At the depth of the second meter, the pattern of concentration distribution of clay looked almost the same as in the first meter. The thickness of clay was concentrated in the upstream area with an average percentage of 8.18% (Table 1). Overall, the percentage was relatively small in the sampling area. This showed that the top soil was very thin and dominated by alluvial deposits (3).

Tabel 1. Percentage of material particles at 1-meter depth in each borehole

Hole Id	Depth (Meter)		Particle Percentage %		
	From	To	Gravel	Sand	Silt/ Clay
BH-1	1	2	0.17	86.80	13.03
BH-2	1	2	5.63	83.33	11.03
BH-3	1	2	5.17	85.63	9.20
BH-4	1	2	3.40	91.77	4.83
BH-5	1	2	5.97	88.97	5.07
BH-6	1	2	7.04	83.24	9.71
BH-7	1	2	13.57	82.04	4.39
Average			5.85	85.97	8.18

Tabel 2. Percentage of material particle at 2-meter depth in each borehole

Hole Id	Depth (Meter)		Particle Percentage %		
	From	To	Gravel	Sand	Silt/ Clay
BH-1	0	1	0.53	86.07	13.40
BH-2	0	1	13.87	80.17	5.97
BH-3	0	1	6.43	85.87	7.70
BH-4	0	1	24.53	74.40	1.07
BH-5	0	1	9.00	86.63	4.37
BH-6	0	1	6.43	87.10	6.47
BH-7	0	1	12.54	74.50	12.96
Average			10.48	82.11	7.42

3.2 Permeability

Permeability testing in the research location was conducted at a depth of the first and second meters. From the results of the permeability test, data was subsequently tabulated and plotted in a graph. Permeability classification and data interpolation were then performed (4). The data presentation and data interpolation are as follows:

3.3 Permeability in the first meter

From the data processing of the test results at a depth of 1 m, the average value of Permeability is 0.00538cm/sec (Table 3).

Table 3. Permeability class at 1-meter depth in location 2LB3

Hole Id	Coordinate UTM		Depth (Meter)			Permeability
	North	East	Elev	From	To	cm/sec
BH-1	385333	54408	46	0	1	0.00410
BH-2	385496	54049	30	0	1	0.00511
BH-3	385307	53940	36	0	1	0.00554
BH-4	385373	53768	23	0	1	0.00571
BH-5	385353	53661	34	0	1	0.00573
BH-6	385230	53536	36	0	1	0.00574
BH-7	385304	53556	35	0	1	0.00574
Average						0.00538

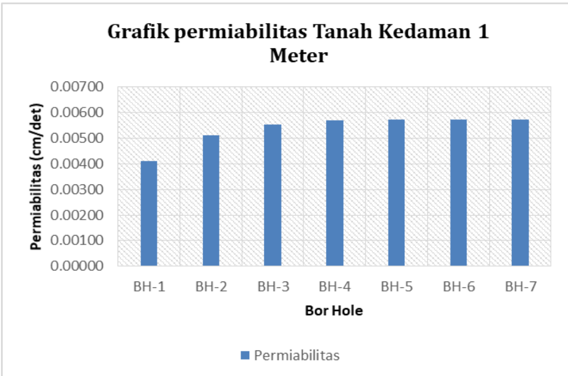

Fig. 1. Graph of permeability at depth 1 meter in Location 2 LB3

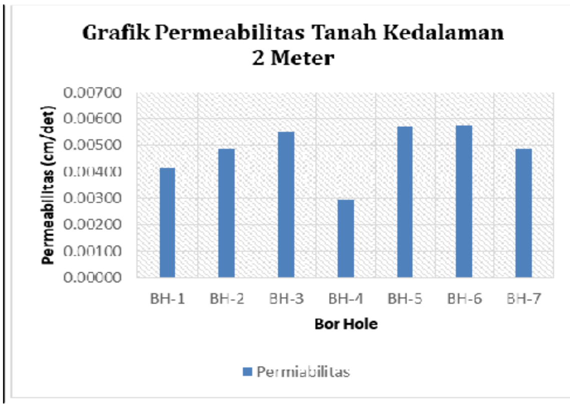

Fig.2. Graph of permeability class at depth 2 meters in each borehole at location 2 LB3

From the results of the Permeability test at a depth of 1 meter, it can be seen that from BP1 to BP7 point had a 'fast' permeability class. It can be concluded from the results of the permeability test at Location 2 LB3 at a depth of 1 meter that on average the category of permeability class was fast (5).

 https://doi.org/10.1051/matecconf/202237205001

Table 4. Permeability class at depth 2 meters in each borehole at location 2 LB3

Hole Id	Particle Percentage%			Class
	cm/sec	cm/min	cm/hours	
BH-1	0.00410	0.246	14.76	Fast
BH-2	0.00511	0.306	18.38	Fast
BH-3	0.00554	0.332	19.94	Fast
BH-4	0.00571	0.343	20.55	Fast
BH-5	0.00573	0.344	20.64	Fast
BH-6	0.00574	0.345	20.67	Fast
BH-7	0.00538	0.323	19.37	Fast
Average	0.00538	0.323	19.37	Fast

The results of interpolation of permeability data on the map show that in Location 2 LB 3 at first-meter depth permeability distribution was fast (Figure 3 of Permeability distribution map) (5). The permeability with the highest value occupies the middle area spreading downstream south from the activity location. This is due to the large amount of sand-sized materials that have good porosity. In the lithological formation, this area is included in the Alluvium (Qa) of depositional formation (6).

3.4 Permeability in the second meter

From the data analysis of the test results at a depth of 2 m, the average value of permeability was 0.00483 cm/sec (Table 5).

Table 5. permeability at a depth of 2 meters in each borehole at location 2 LB3

Hole Id	Coordinate UTM		Depth (Meter)			Permeability
	North	East	Elev	From	To	cm/sec
BH-1	0.00413	54408	46	1	2	0.00410
BH-2	0.00488	54049	30	1	2	0.00511
BH-3	0.00549	53940	36	1	2	0.00554
BH-4	0.00294	53768	23	1	2	0.00571
BH-5	0.00573	53661	34	1	2	0.00573
BH-6	0.00574	53536	36	1	2	0.00574
BH-7	0.00488	53556	35	1	2	0.00574
Average						0.00483

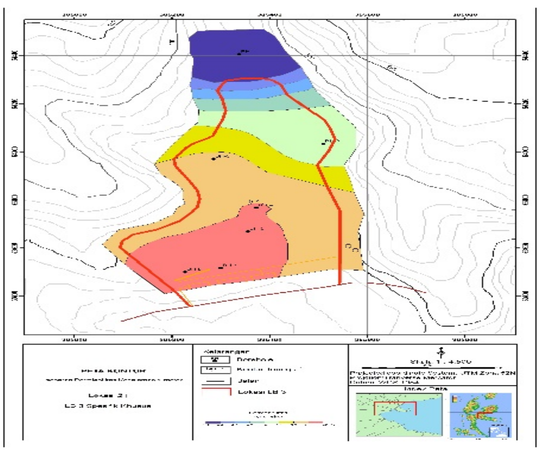

Fig.3. Map of permeability distribution of interpolation results at 0–1-meter depth categorized as fast permeability class

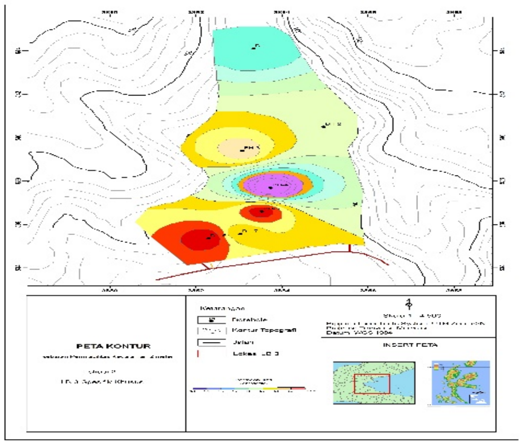

Fig. 4. Map of permeability distribution of interpolation results at 1–2-meter depth

From the results of the Permeability test at a depth of 2 meters, it can be seen that points BH-1 to BH-3 and BH-5 to BH-7 had a fast permeability class, while point BH-4 has a slightly fast permeability class (4). Overall, the results of the permeability test at Location 2 LB3 on average reveal the fast permeability class (Table 6).

Table 6. Permeability class at depth meter in each borehole at location 2 LB3.

Hole Id	Particle Percentage%			Class
	cm/sec	cm/min	cm/hour	
BH-1	0.00413	0.248	14.85	Fast
BH-2	0.00488	0.293	17.57	Fast
BH-3	0.00549	0.329	19.77	Fast
BH-4	0.00294	0.176	10.58	Slightly Fast
BH-5	0.00573	0.344	20.64	Fast
BH-6	0.00574	0.345	20.67	Fast
BH-7	0.00488	0.293	17.56	Fast
Average	0.00483	0.290	17.38	Fast

The results of the interpolation of the permeability data on the map showed that Location 2 LB 3 at the second-meter depth has a permeability class distribution ranging from slightly fast to fast. The permeability with the highest value has a slightly similar distribution pattern to that of the first meter, i.e. the distribution occupies the middle area spreading towards the downstream south of the activity site (Figure 4) (7). This occurred due to a large number of sand-sized materials so that they have good porosity. Overall, the interpolation results for the first and second meter showed that from the middle to the southern area of the sampling location, the permeability level/class was "Fast" and evenly distributed as presented in the permeability distribution map. In addition, the permeability class classification was based on Verruijt (5). The observed area of location 2 LB3 was categorized in the medium permeability class.

4 Conclusion

1. The results of the Borehole sample test at 7 points showed that the sand-sized material is dominant with 74.40 – 86.10% (in the first meter) and 82.04 – 91.77% (in the second meter) compared to clay and gravel materials.
2. Interpolation result of permeability class in Location 2 LB3 area reveals a permeability class ranging from "slightly fast" to "fast" from a layer depth of 0-2 meters. In addition, the permeability class classification is based on the Verruijt classification. Overall, the observed area for location 2 LB3 is in the medium permeability class. This is influenced by the presence of sand-sized material which is more dominantly concentrated than the gravel and clay-sized material.

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