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A Preliminary Assessment of Physical Properties of Sediment at Sembrong Reservoir

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Abstract: Reservoir is one of the main sources of water supply and provides functions to hydroelectric power, domestic use, agriculture, flood protection and recreation. Due to the rapid farming, agricultural activities and oil palm trees plantation development that contribute to the increment of sediment, the Sembrong reservoir is slowly endangered due to the shrinkage of reservoir storage. Therefore, this research is initiated to characterize the sediment which could be used as control in future research in the treatment of contaminated sediment. The objective of this study was to determine distribution of physical properties of sediment based on Sembrong Reservoir sediment. In this study, sediment samples were collected using gravity corer at different points in the reservoir area. The physical properties of sediment was investigated by conducted experiments include particle size distribution, bulk density test, moisture content, loss of ignition and scanning electron microscope (SEM). From the data obtained, the bulk density at horizontal distribution was almost the same and the average values obtained was between 10-17 kN/m^3. Moisture content of sediment at horizontal distribution at location 3 was the highest with 185.04%. From the particle size distribution, it can be concluded that location 2 had the highest percentage of finer sand where the value was 81% while 19% were silt and clay. For horizontal distribution of organic content, location 5 had the highest result with the percentage of 12.768%. For particle shape of sediment, it was in bulky and flaky categories while the void ratio was getting smaller by the depth.

Keywords: Bulk density, particle size distribution, moisture content, sedimentation

1. Introduction

Reservoir is a natural or human construction to accommodate the needs of water, flood prevention, slowing down flow, as well as power generation, but the major problem that always occurred on lakes or reservoirs is sedimentation. Dam, reservoirs and lakes are important in the conservation of basic national resource-water. In recent years, monitoring quality of water body or reservoir has become a main concern for the determination of current condition and long term pattern for future management [1].

Sediment is a major cause of various problems related care and management of the lakes or reservoirs. Sedimentation process will also lead to a shallower lakes and reservoirs and may continue to disappear. The implication would cause flash floods and flooding at the mouth of a drain. Too much sediment collected in lakes and rivers will result in shallow lakes and rivers. The effect during the rainy season, the area will be more susceptible to flooding. Measurements of sediment physical properties describe in various ways the density of sediment particles, their packing relations, and connections between particles [2]. While, according to Waddel [3], the interactions between the sediments and overlying water significantly affect the chemical and physical characteristics of lakes and reservoirs, also the processes governing those interactions are complex.

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2. Materials and Methods

Laboratory experimental procedures and analysis were done to achieve the research objectives in order to measure the physical properties of sediment produced by natural or human activities. Sediment samples used were obtained from Sembrong Reservoir. In order to check the properties of the sediment, the sediment were tested and evaluated to get the accurate result. Physical properties were measured using particle size distribution, bulk density, moisture content, loss of ignition and Scanning Electron Microscope (SEM).

2.1 Sampling location

Fig. 1 shows the sampling location according to coordinates stated in Table 1. The locations were divided into three zones where each zone has two sampling points. List of testing done was listed in Table 2.

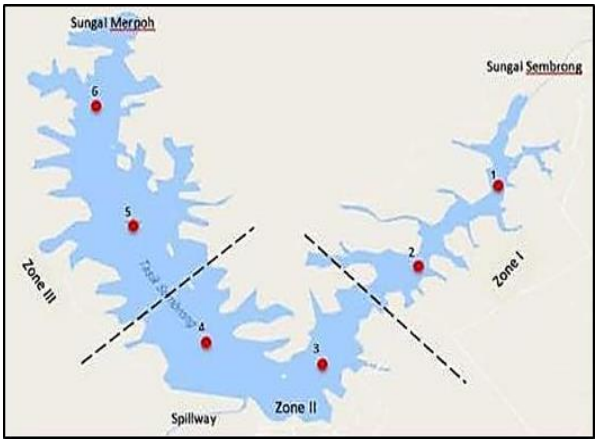

Fig. 1 - Computational domain with boundary types.

Table 1 - Description of each zones.

Zone	Station	Coordinates of sampling location	Description of station
Zone I	1	N 01° 59' 50.4" E 103° 12' 08.0"	This station is located near to the inlet of Sungai Sembrong. The stations are surrounded by farming and agricultural activities.
	2	N 01° 59' 24.4" E 103° 11' 45.6"	
Zone II	3	N 01° 58' 49.2" E 103° 11' 19.4"	This station is located near to the spillway of reservoir.
	4	N 01° 59' 03.5" E 103° 10' 44.7"	
Zone III	5	N 01° 59' 38.6" E 103° 10' 26.0"	This station is located near to the inlet of Sungai Merpoh. There are many stump, dead trees and oil palm at this area.
	6	N 02° 00' 34.8" E 103° 10' 01.4"	

Table 2. Laboratory Testing.

No.	Station	Description of station
1	Bulk Density	BS1377: Part 2:1990
2	Moisture Content	BS1377:PART 2:1990
3	Particle Size Distribution	BS1377: PART 2:1990:9.3
4	Loss of Ignition	BS1377: PART 3:1990
5	Scanning Electron Microscope	JOEL SEM

3. Results and Discussion

The data obtained from the experiments were analyses to get the results. The data were analyses in form of graphs to show clearer results of the experiment. Furthermore, results from previous studies were included to compare with the results obtained from this study.

3.1 Scanning electron microscope (SEM) of sediment in Sembrong reservoir

Scanning Electron Microscope (SEM) testing captured the image according to the depth of 6 different locations to describe the particle shape.

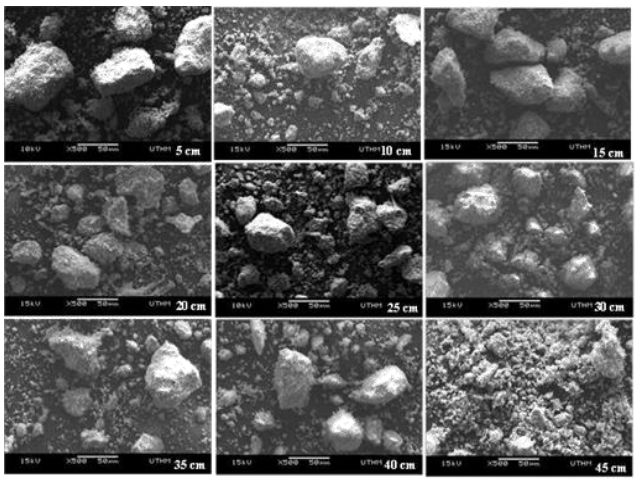

Fig. 2 - Scanning electron microscope between 0-45 cm depths for Zone II (Location 3).

Fig. 2 shows shape of particles of sediment, it can be seen that the shape is more to bulky and flaky categories. Bulky particles can be described into angular, sub angular, sub rounded and rounded shapes and it is clearly shown from their subfigure angular, sub rounded shape and also flaky particles. Besides that, it can be seen that the voids ratio is getting smaller as depth is deepens. Referring to Das [4], bulky particles are formed mostly by mechanical weathering of rock and mineral, while flaky particles have very usually 0.01 or less, these flaky particles are predominantly as clay minerals. It also stated that the shape of granular particles in a soil mass has a great influence on the physical properties of the soil, such as maximum and minimum void ratios, shear strength parameters and compressibility.

3.2 Particle size distribution

The result of analysis from dried sieves was plotted using a semi-logarithmic graph as shown in Figure 3. There was a major texture classification including gravel (> 2 mm), sand (0.06 -2 mm), silt (0.002 -0.06 mm) and clay (<0.002 mm).

Semi-logarithmic graph from Fig. 3 shows the distribution of particle size at various locations. From the results, checkpoint 1 had obtained 52% of sand while the other 48% are silt and clay. At checkpoint 2, the result obtained 81% of sand and 19% are silt and clay. For checkpoint 3 and 4, 68% and 56% are sand while the other 32% and 44% are silt and clay respectively. Lastly, checkpoint 5 and 6 had obtained 67% and 76% of sand while the other 33% and 24% are silt and clay respectively.

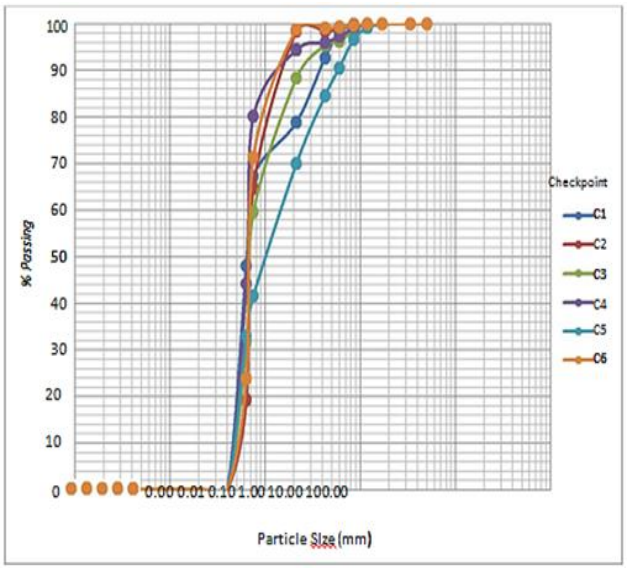

Fig. 3 - Horizontal distribution of particle size.

3.3 Bulk density of sediment in Sembrong reservoir

The analyses of bulk density were tested in laboratory for 6 different locations of sediment. Each samples were sliced at 5cm for tested. The result of this test was shown in Fig. 4.

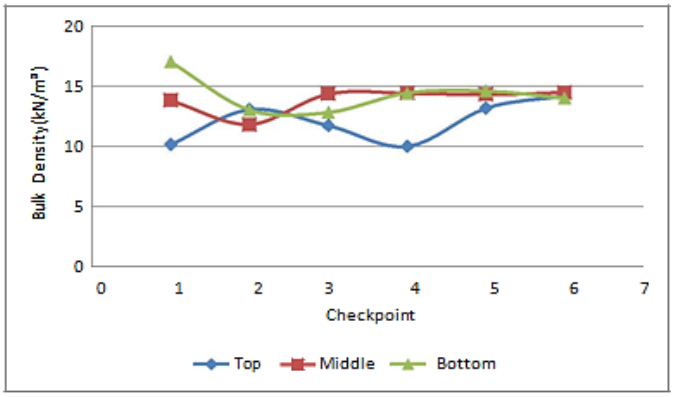

Fig. 4 - Horizontal distribution of bulk density of sediment.

From Fig. 4, the result of bulk density was fluctuated at each location. The highest value of distribution of bulk density in sediment at top layer was at checkpoint 6 with 14.23 kN/m3 , followed by checkpoint 5 (13.19 kN/m3), checkpoint 2 (13.08 kN/m3) and checkpoint 3 (11.74 kN/m3), while the lowest value was 10.00 kN/m3 at checkpoint 4, followed by checkpoint 1 (10.17 kN/m3). At the middle layer, the value was constant at checkpoint 1 (14.38 kN/m3), 4 (14.43 kN/m3), 5 (14.32 kN/m3) and 6 (14.49 kN/m3), while checkpoint 3 was 13.81 kN/m3 and checkpoint 2 was 11.82 kN/m3. The highest value at bottom layer was obtained at checkpoint 1 with 17.04 kN/m3 compared to checkpoint 2 (13.01 kN/m3), checkpoint 3 (12.85 kN/m3), checkpoint 4 (14.44 kN/m3), checkpoint 5 (14.61 kN/m3) and checkpoint 6 (14.00 kN/m3).

Void space in sandy soil has a gap between 25-48% depending on the composition of sand grains compaction. Sand will have more void space when it has other blends such as silt and clay [5]. This is because the presence of this mixture in sufficient quantity allows the formation of a soil structure capable of producing more macro void space between the aggregates formed as well as the presence of micro-space in the aggregate itself. The content of organic matter also affects the content of void space in the soil. The presence of organic matter in sand debris besides loosening the soil also increases the percentage of micro void space and decreases the percentage of macro void percentage. This can help in the detention of more water in sand dunes for plant use.

3.4 Moisture content distribution

The moisture content result is analyzed from different location in horizontal distribution. The graph is shown in Fig. 5.

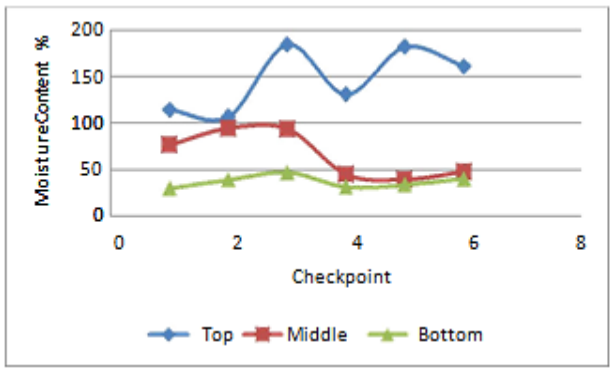

Fig. 5 - Percentage of moisture content for horizontal distribution.

From Fig. 5, the value of moisture content in sediment at top layer for checkpoint 3 was the highest compared to other checkpoint with the percentage of 185.04%. It was a big gap of difference compared to checkpoint 1 (114.7%), checkpoint 2 (107.38%), checkpoint 4 (131.43%), checkpoint 5 (182.50%) and checkpoint 6 (161.51%). Meanwhile, the higher results of middle and bottom layer for MC in sediment was at checkpoint 3 where the percentage was 93.93% and 47.27% respectively.

It can be concluded that the bottom sediment layer has a smaller void ratio compared to the surface layer while the bottom sediment layer is more compacted than the surface layer. According to Das [4], all the void volume is occupied by water when a soil mass is completely saturated. It has been proven that when the soil is more compact and the void ratio was smaller, the moisture content in the soil will be lesser.

3.5 Organic content distribution

Fig. 6 shows the graph of horizontal distribution of percentage organic content at different sampling location.

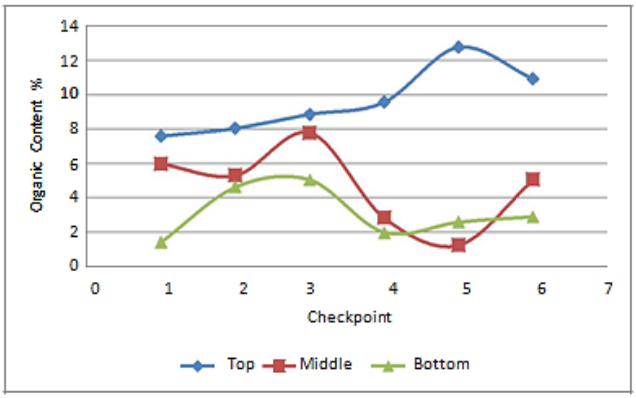

Fig. 6 - Percentage of organic content for horizontal distribution

From Fig. 6, it shows that Zone III which were checkpoint 5 and 6 had the highest organic content compared to other checkpoint which was 12.768% and 10.930% respectively and followed by Zone II with checkpoint 4 (9.577%) and checkpoint 3 (8.858%). Besides that, Zone I which was checkpoint 1 (7.598%) and 2 (8.057%), the organic content was almost the same amount and had the lowest percentage. This was because at this checkpoint, it was located nearest to the inlet area where the organic and sediment introduce from the catchment area and the flow is starting to reduce and accumulated all the organic and sediment at that zone.

Overall, it can be concluded that the organic content at the top layer was higher compared to the bottom layer, where the upper surface is more prone to the water pollution. The topmost layers of the bottom soils are enriched with organic content and have a very low density [6]. According to Ali [7], the percentage of organic content is high due to the inclusion of waste from agriculture activities and animal husbandry to the river, where it can increase nutrient content in the environment thus enhancing organic content.

4. Conclusion

This study has been successfully carried out and had achieved the objectives. From the data obtained, the bulk density at horizontal distribution was almost the same and the average values obtained was between 10-17 kN/m^3. Moisture content of sediment at horizontal distribution at location 3 was the highest with 185.04%. From the particle size distribution, it can be concluded that location 2 had the highest percentage of finer sand where the value was 81% while 19% were silt and clay. For horizontal distribution of organic content, location 5 had the highest result with the percentage of 12.768%. For particle shape of sediment, it was in bulky and flaky categories while the void ratio was getting smaller by the depth.

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