Study of sediment deposition at Tanjung Laboh due to jetty structural

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Abstract. Changes in coastal areas are due to factors such as natural factors. In recent years human activities and coastal development have contributed greatly to the change of the coast. Concerned with this problem, a study was conducted on the coast of Tanjung Laboh in March 2019 to collect oceanographic data related to coastal change. The purpose of this study was to compare the distribution of sediment size in jetty structure areas and unstructured areas. Specific gravity has been compared between sampling lines A, B, C and D. The study area has been divided into three zones and every sampling line is in between of 80 meters. Field work to collect current velocity data was done during high tide. Estimates of sediment accumulation were carried out by comparing sediment characteristics obtained in structured and unstructured areas that related to current velocity. The results show that the beach profile is silty clay. The current velocity is also found to be low at 0.044 m/s to 0.218 m/s. In conclusion, the sediment transportation and sediment deposition can be influence by current velocity of a coastal and factor of any barrier. Test have been carried out shows that different particles size distribution around jetty structure and without jetty structure.

1. Introduction
Malaysia is a country located in Southeast Asia that has two distinct parts: Peninsular Malaysia to the west and East Malaysia to the east. The country covers an area of 329,750 km² with a coastline of 4809 km and is divided into two areas separated by the South China Sea. The 8,759 km of Malaysia's coastline is characterized by various geomorphological conditions. However, the report on the National Coastal Erosion Survey (1984-1986) found that 1,372 kilometers (29%) of the country's coastline was eroding [1]. Also in Johor, areas such as the shores of Batu Pahat, Tanjung Piai, Pontian and Pulau Kukup, have been found to be critically endangered and some locations have been facing problems for the past three decades. Tanjung Laboh is a coastal area of Johor located in the southeast part of the Straits of Malacca. Therefore, a study was conducted to determine the morphology and distribution of Tanjung Laboh sediment, which is the first study to determine the transport of sediment along the coast. Sediment transport is always subject to change and continuous. Although sediment load changes are due to geological, geomorphological and organic elements, sediment transport may be altered by other external factors. Changes in sediment transport can come from changes in flow rates, water levels, climates and human activity.
In Tanjung Laboh a jetty that serves as the CAGeD (Center of Applied Geomatics for Disaster Prevention) data observation complex has been built as shown in Figure 1. The jetty was officially opened by the Vice Chancellor of UTHM on August 12, 2018. The construction of these jetty is expected to open up more opportunities for UTHM students to conduct research in the field of oceanography. However, the jetty construction may affect the physical oceanography of the area. Therefore, this study has been conducted to evaluate the sediment deposition.

2. **Classification of Malaysian Beach**

Malaysia has many beautiful islands and beaches along the coast. According to DID, the total length of the coast in Malaysia is 4809 km comprising 1,972 km in Peninsular Malaysia and 2837 km in Sabah and Sarawak. Malaysia's coast is mainly sandy beach while 37% is mud. On the East Coast of Peninsular Malaysia, 91% are sandy beaches while the wetlands are mainly on the west coast of Peninsular Malaysia overlooking the Straits of Malacca. Sabah comprises 54% of sandy beaches and 39% of mud while in Sarawak, 76% is sandy beaches and 24% is mud [2]. The types of land along the coastline are important as they affect the shoreline change due to its nature and external factors such as wind, currents and waves. The coast zone is the surface between land and water bordering the coastline. Coastal zones will change due to environmental factors such as wave speed, wind speed and tidal height. The occurrence of dynamic interactions along the coastline influences the coastline through sedimentation and erosion of coastal areas. Sediment is carried out gradually as the particles in the stream move back and forth toward the shoreline and sediment is gradually produced. The occurrence of sedimentation on the coast will also be high especially during storms. The energy generated makes the coastal zone vulnerable to natural hazards.

3. **Current and structure interactions along the coast**

The direction of flow in the study area should be taken into account as it may affect sediment movement. The results from previous studies show that average wind speeds in the Straits of Malacca range from 1m/s to 5m/s during January-March [3]. Theoretically, the wind speed affects the speed of waves and current flow of the ocean. Therefore, a refraction phenomenon occurs when the waves and currents pass through the structure of the jetty. Based on previous studies, the resulting friction will also cause a decrease in current velocity across the structure. For this reason, the structure of the jetty can also function as a breaker [4]. As the current flows through the bay will be deflect or refract, the current speed will decrease and this will allow for sedimentation. The deposition of coastal sediments is greatly influenced by the flow velocity and current direction through the structure of the jetty. Coastal flow is one of the factors that brings the bottom sediment from one location to another. Sediments contained in water molecules carry fine particles of soil through water flow. At high water flow, soil particles will be transported elsewhere and at low water flow, soil particles will settle at the bottom. The speed of flow through the jetty structure will influence the sediment content that occurs behind the structure [5]. In addition, other studies were conducted to determine the theory of sediment carrier. This study builds
several cylindrical pillar sizes (Figure 2) and implements the same flow rate as the result of the same sediment movement accumulated behind the pole. The study also found that the larger the cylindrical size, the higher the volume of sediment produced.

![Figure 2. Sediment movement patterns are influenced by cylindrical pillar [6].](image)

4. Field sampling method
The effects of the construction of the jetty can only be identified after the analysis of the base sediment samples was analyse. The soil sampling method is very important to avoid contaminating the soil content and texture. Determination of tools for soil sampling should be appropriate to the soil type of the study area. For example, sampling by drying soil content on hard soil is done using a core sampler or soil extractor. Equipment suitable for soil hardness will facilitate the collection process as well as uninterrupted sample content. In addition, other equipment used for fine sampling such as sand and mud is a peat sampler. There have also been previous studies that have done soil sampling using PVC pipes due to the high density of soil conditions. The choice of tool usage also depends on the texture density of the soil during sampling at the study site. The research site at Tanjung Laboh consists of soil types with high mud content as shown in Figure 3, a geological map showing rock types and major geological features published by the Department of Minerals and Geoscience Malaysia.

![Figure 3. Summary of geological maps showing the types of rocks and key geological features [7].](image)

The study area is marked with a red circle. Referring to Figure 3, the study area consisted of soft soil of clay, clay, sand, peat and fine gravel. Based on previous studies, soil sampling methods using peat samplers are more suitable because they do not interfere with soil structure and facilitate field work. Since the main purpose of the study was to identify surface sediment, sample collection was carried out from the surface up to 2 meters [8]. Figure 4 shows the peat sampler tool used for collecting samples during field sampling.
4.1. Field sampling
Field work begins by specifying the location of the sample points. There were divided into three zone; zone A, zone B, and zone C. Sampling points were covered along the bay about 205 meters and 400 meters seaward. The total of sampling points were 20 points with known coordinates. Figure 5 shows the illustration of soil sampling points and process of collecting soil sample. In addition to soil samples, the current velocity and water depth at each sample point was also observed. This field work was carried out during high tide to facilitate the use of boats up to the coast. The samples collected have been preserved, sent to the laboratory and subjected to two types of tests which is specific gravity tests and sediment size distribution tests.

5. Result and discussion
Based on previous study by [9-10] the primary sediment along muddy beach of west coast Johor was determine as marine clay and it is normally correlated to the coastal mangrove forest. Since Tanjung Laboh beach was situated around the muddy area, marine clay is proposed to be identified. But content of sediment characteristic may also differ according to coastal area. Therefore, the characteristic of sediment with related to the current speed in this study area are discussed in the subsequent section.

5.1. Particles size distribution
Collected sediment of 40 gram to 50 gram in mass that less than 63μm has been analysed using hydrometer test. From the test, result of particle size distribution around the jetty structure at Tanjung Laboh have been plotted on the graph as shown in Figure 6(a)-(d).

Value of current velocity is getting low after the current flow passing by the jetty structure. This related to the increasing of clay percentage from point A1 to A6. Besides that, percentage of clay at point A6 is higher than other points because of close to the mangrove forest and there is 0% of gravel
in that area. Percentage of sand and gravel increasing when the points are around the center of bay. This caused by the sediments were deposited near shoreline.

The sediment characteristic of line B shows the decreasing of silt percentage and rising in clay percentage compared to sediment in line A as the velocity of current fall of. This situation occur after current passing through jetty structure. In this line, only 1% of gravel contain in point B1 and B6 differ from line A which almost all points contain gravel.

Line C is a last line of sediment sampling points that surround the jetty structure. This line shows the greater value of current velocity as the points reached middle of the sea. Therefore, the percentage of silt and clay are practically equal. However, same condition happened like other sediment sampling line after current pass by the jetty structure. The current velocity is a bit lower and increase in clay percentage.

Last two points in zone C were located away from jetty structure which means current flow was not disturbed by jetty structure. While the farther the sea, the higher the velocity. This can be verified by differentiate the velocity between Point D and Point E. In that regard, the result of gravel percentage by point E is higher that point D. However, the percentage of clay at Point E is larger than Point D. This is due to barrier by a boulders around Point E.

As a conclusion, the farther the sea, the higher the velocity value. Current velocity affect the percentage of sediment. Point E has the highest percentage of gravel. While all points in zone B mostly had a highest percentage of clay. This is due to a barrier from jetty structure that affects the speed of the current during high tide.

**Figure 6.** Percentage of sediment characteristic along with velocity (a) at line A; (b) at line B; (c) at line C; (d) at point D and E
5.2. Specific gravity
Rahman [11] state for category marine clay, the value of specific gravity is in between 2.4 and 2.6. Ramamoorthy [12] reported an average of specific gravity could be specify ass marine clay. Therefore, specific gravity, Gs for sediment at Tanjung Laboh have been conducted four different sediment sample retain at 0.063 mm by using pycnometer. The recorded data is tabulated in Table 1. Result of average specific gravity is 2.57. Therefore, sediment of Tanjung Laboh can be categorized as marine clay.

| Table 1. Result of specific gravity test for every sample. |
|-----------------|-----------------|
| Point | Specific gravity value |
| A    | 2.37             |
| B    | 2.44             |
| C    | 2.56             |
| D    | 2.75             |
| E    | 2.77             |
| Average | 2.57           |

6. Conclusion
The construction of jetty structural at Tanjung Laboh had a minimal impact on the natural process of sediment transport within the area. Particle size distribution test shows that sediment at Tanjung Laboh is monopolized by percentage of silt, followed by clay, sand, and gravel. So, sediment at Tanjung Laboh is classified as silty clay. Then, four sediment sample have gone through specific gravity test and average of these sediment sample show the result is 2.57. This proved that sediment at Tanjung Laboh is in between silt and clay. From overall result, conclusion can be made that current velocity is a factor to the sediment transportation and deposition. The current velocity is found to be low at 0.044 m/s to 0.218 m/s. Current that flow through jetty structure gave factor of sedimentation and different particle size distribution around jetty structure.

This statement is supported by [13] where high current velocity of coastal is monopoly by coarse sediment like sand and gravel while coastal with low current velocity is monopoly by fine sediments like silt and clay. Furthermore, JPBD [14] state low sediment transportation is possibly deposited at sheltered area such as mangrove forest or breaker like sediment transportation along the west coast Johor including Tanjung Laboh.

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