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Measurement of Depth of Seabed and Sea Flow Rate Under SuraMadu Bridge Madura Side for Determination of Mooring Turbine Construction Sea Power Plants

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ABSTRACT

SuraMadu bridge as one of the bridge on Madura have a strategic function. Due to the rapid population growth on Madura, the people require a strategic and cheap electricity for industrial development especially in the region of Surabaya and Madura. The purpose of measuring the depth of the seafloor and ocean currents on strait of Madura is to know the contour of the seabed and the speed of ocean currents around the masts of the SuraMadu bridge of Madura. To measure the depth of a seabed and the ocean currents at a various points from SuraMadu Bridge are required to predict the characteristics of the ocean. The results showed the depth of the waters and the speed of ocean currents in the research area around the SuraMadu bridge ranges from 12 meters up to 15 meters with sea current velocity between 0.3 m /s² up to 1.6 m /s². The research method used the case study method. This research is conducted covering activity of location survey. Furthermore, bathymetry data analysis and processing bathymetry data analysis are performed.

KEY WORDS: *Bathymetry, Pillars - SuraMadu Bridge, Madura Strait.*

1.0 INTRODUCTON

As the largest archipelagic country in the world, the Indonesian seas store energy sources of both renewable and renewable energy as well as abundant non-renewable energy. New and renewable energy from the sea that has not been used intensively in Indonesia is the energy of ocean currents and ocean wave energy. Both of these energies coupled with convertible energy differences in surface sea surface temperature and seabed and sea breeze are believed to meet the considerable energy demand in Indonesia.

Given the area of Indonesia which consists of many islands with many narrow straits, the sea energy prospects to be developed into electricity is the energy of ocean currents. In addition, Indonesia is a meeting place of ocean currents caused by the dominant tidal constituent of M2 in the Indian Ocean with a period of about 12 hours and the highest K1 tidal constant in the Pacific Ocean with a period of approximately 24 hours. M2 is the tidal constant due to the motion of the moon around the earth, whereas K1 is the tidal constant due to the moon's orbital inclination as it travels around the earth.

Ocean currents are one of the potential sources of renewable energy to be developed in Indonesia because as an archipelago, in Indonesia there are many straits that have a source of strong sea currents that can be converted into electrical energy through the mechanism of changes in kinetic energy movement of ocean currents into Electrical energy at the time of ocean currents drives the turbine rotor to rotate the generator. In addition to the potential of the Strait, Indonesia also has many bridges under it is very potential also for the pairs of turbine currents considering the current under the Bridge is quite heavy, because:

1. Easy and cheap in mounting techniques (can be attached on the wall pole bridge).
2. The flow of the current will be accelerated due to the Bridge's columns that can be utilized as Duct to accelerate the flow.
3. To meet the electricity needs along the Bridge
4. The source of ocean currents will always be there year-round and environmentally friendly

The advantage of using ocean currents energy is in addition to environmentally friendly as well as ocean currents energy has a large density energy compared to wind energy. This is because the density of sea water is 830 times the air density, so with the same capacity the turbine ocean current size will be much smaller than the wind turbine.

East Java also has a Bridge that currently has the status as the longest bridge in Indonesia namely SuraMadu Bridge. The energy potential of the sea currents under the Bridge is large enough to be utilized as one of the electricity sources in the area of Jembatan. In the framework of the activity of study is to develop the potential of ocean currents as one of renewable energy source.

The research team of LHI - BPPT has conducted a study through a survey of potential depth of the seafloor and ocean currents around the SuraMadu bridge area. The experiments of marine turbine turbine prototype prototype start from power scale 5 kw as well as by doing various variations of turbine rotor configuration to know the performance in producing high operational efficiency so as to produce the optimum power output possible by reducing the level of losses although in fact we cannot eliminate the element losses 100% because of the friction on the mechanical transmission system components and losses on the transmission cable system or electrical components in general.

For that LHI - BPPT will conduct activity of study of ocean current energy potential if turbine operated under Bridge, Team of LHI - BPPT researcher will carry out prototype experiment process of marine turbine under pole of SuraMadu bridge of madura side.

2.0 METHODOLOGY

The methodology used in the seafloor depth survey and ocean currents in the area of samurban bridge SuraMadu side of madura is the measurement at the location is carried out by using equipment and methods are quite simple Equipment used include: GPS, Flow meter and underwater camera (underwater Camera). Current measurements are carried out using a small boat mounted GPS and Echo sounder. The data can be: Current velocity, Depth, time and coordinates.

The boat engine is switched off within a certain time so that the Boat will move / drift due to the current. In addition to the movement of the boat, the data will be peer automatically to the computer in accordance with predetermined time interval. After that the boat will be run again towards the coordinates in the set for re-measurement (boat engine in turn off). This measurement activity is done repeatedly so that it will be able to valid measurement data. From the results of this data can then be compared with numerical data results for the validation process to the accuracy of the data.

Direct measurements of sea depth/bathimetry depth data and the velocity of sea currents generated during the measurement take place, using:

1. Using GPS Fish Finder tool, GPS Pocket, Depth Flashlight and Flow meter
2. Collecting / measuring data periodically:
    - The depth of the ocean floor
    - Direction of current and velocity of ocean currents
    - Visual observations of ocean currents behavior on surface and ocean waves
    - Direct data collection is stored into the computer in real time
3. Data analysis
4. Discussion and Reporting

Figure 1: Measurement of sea floor depth and sea velocity

The potential of marine resources in Indonesia is enormous, covering the potential of biological and non-biological resources. The marine resources have not been maximally explored and exploited other than oil and gas in the non-biological resource sector. Similarly, the marine biodiversity sector, the exploration and exploitation of marine fish and the like requires wisdom in addition to advanced technology but not damage the environment. To support the exploration and exploitation of marine resources, can be used underwater acoustic technology. This technology is widely known as acoustic technology that is nothing else by using GPS Fish Finder, GPS Pocket, Senter Depth and current meter on navigation technology can be synchronized with the use of Radar for the detection of objects on the surface of the water.

Measurement of sea depth depth can be done by using GPS Fish Finder, GPS Pocket, Depth Flashlight while measuring ocean currents using current meters, where the depth of the seabed can be calculated from the time difference between sending and receiving the voice pulse. With consideration of the Sonar Side-Scan system at present, the measurement of the seafloor depth can be carried out in conjunction with Sea Bed Mapping and identification of the types of sedimentary layers below the seabed.

The velocity of ocean currents depends greatly on the earth's position on the moon and the sun. At the time of the position of the full moon or the moon dies, the current velocity will be high while at the time of the half month, the current velocity is very small. This is very influential on the output power generated.

In general, the current velocity in the Madura Strait is relatively small compared to the Straits in Eastern Indonesia. This is because the position of the Straits that go in so that the flow of ocean currents obstructed by land and winding. Unlike the Straits in Eastern Indonesia, the movement of currents from the free sea was directly into the Strait. Because through the narrow gap between 2 (two) islands, the current velocity will be accelerated again.

2.1. Data Collection Position

Before the position data collection is carried out, firstly the positioning is carried out. Determination of position is to determine the position of the ship at the time of measuring the

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depth of the waters so that the ship does not come out of the path that has been determined. This positioning using satellite navigation system, namely GPS (Global Positioning System). The data generated by this tool is digital and can be sent to a computer device.

Figure 2: Determination of measurement positions

2.2. Depth Data Collection

Data retrieval in this bathymetry mapping uses parallel patterns, namely: patterns where the sounding direction is perpendicular and tends to align with the longitude Or in accordance with parallel sounding patterns.

The actual depth or corrected data is made in a data format that corresponds to the data input specification of the map depiction software. Corrected data is then transferred to the drawing software, this stage includes: editing, smoothing, text addition, gridding and plotting. The end result of this stage is the bathymetric chart.

Figure 3: Measurement data collection.

3.0 RESULT OF ACTIVITY

Madura Strait is located between Madura Island and Java Island. Geographically connect the Java Sea in the northern part of the island of Madura. The topography of these waters is generally decreased to the southwest, shallow in the southern part of the strait (the island of Java), and very deep in the northern part of the strait (the side of the island of Madura). The depth of the waters of the Madura Strait increasingly heading towards the eastern side of the depth is growing.

The waters of the Strait of Madura are marine waters that have varying bathymetry conditions. In general, the southern waters of the Madura Strait of the island of Java is quite shallow with an average depth ranging from 0.5 to 1 meter is due to the sidement of mud whereas for the waters of the northern part Madura Strait side of the island of Madura is influenced by the depth of the Java sea where the depth ranges Between 10 to 14 meters.

Based on tidal data released by Hydro-Oceanography of the Indonesian Naval Forces. The tidal waters of the Madura Strait are mixed but biased to the double daily (Mixed Tide Prevailing Semidiural). The Madura Strait Waterway is chosen as the criterion to be mapped because there is a SuraMadu bridge whereby synergies with the development of renewable energy from ocean current power plants. Prior to testing prototype of ocean current power plant in the area of SuraMadu bridge, first mapping of potential locations to be installed or placed in the power plant turbine of ocean currents. Mapping the waters of the Madura Strait from the east side starting from the Pole no. 56 and Pole no. 57 with varying distances ranging from 1 km to 2.5 km from the lips of SuraMadu Bridge and performing a bathemetry mapping between Pole no. 56 and Pole no. 57.

At the time of measuring the depth of the seabed the seawater state is quite flat. This can be seen from the measurement data. Display data measurement data depth of the sea floor can be seen directly through the laptop so that it can control the status of ocean velocity and bottom depth of the seabed generated by the GPS Fish Finder and Flashlight Depth as below:

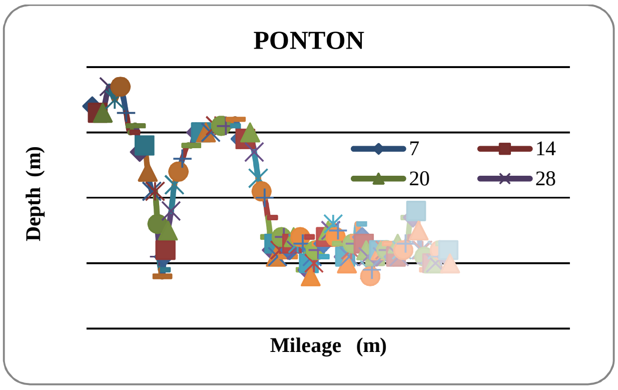

Figure 4: Location of measurement at position Latitude position S07°10.6471' 'Longitude E112°47.2749' up to Latitude S07°10.6408' Longitude E112°47.2954'

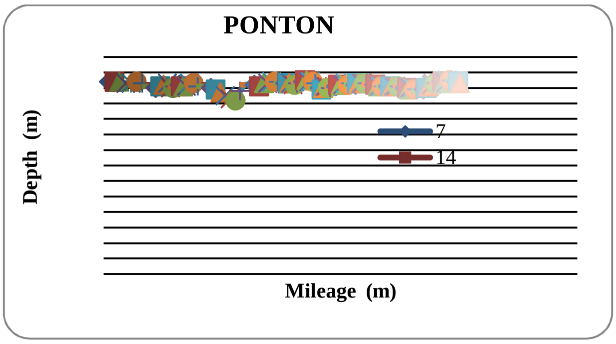

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Figure 5: Location of measurement at position Latitude position S07°10.6471' 'Longitude E112°47.2749' up to Latitude S07°10.6408' Longitude E112°47.2954'

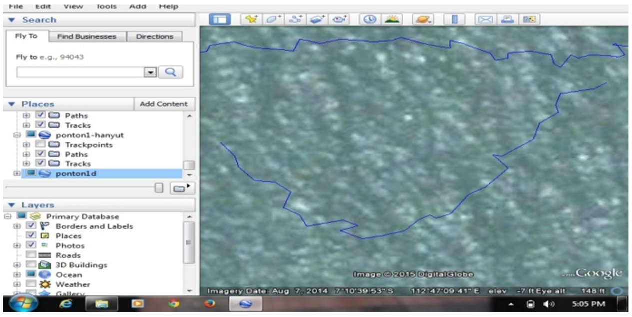

Figure 6: Location of measurement at position Latitude position S07°10.6471' 'Longitude E112°47.2749' up to Latitude S07°10.6408' Longitude E112°47.2954'

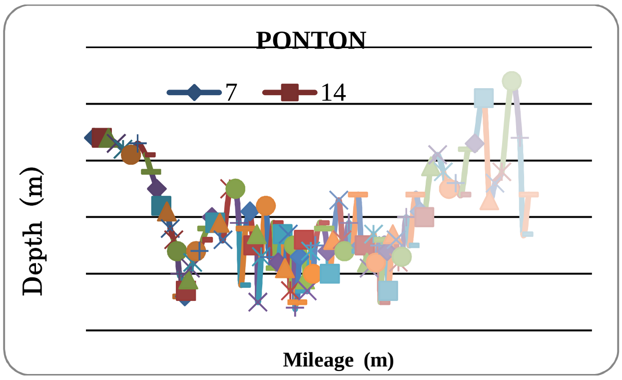

Figure 7: Location of measurement at position Latitude S07°10.6085' Longitude E112°47.1729'up to Latitude S07°10.6019' Longitude E112°47.1269'

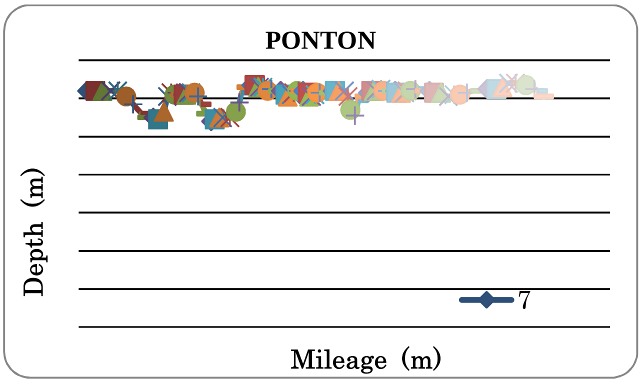

Figure 8: Location of measurement at position Latitude S07°10.6085' Longitude E112°47.1729'up to Latitude S07°10.6019' Longitude E112°47.1269'

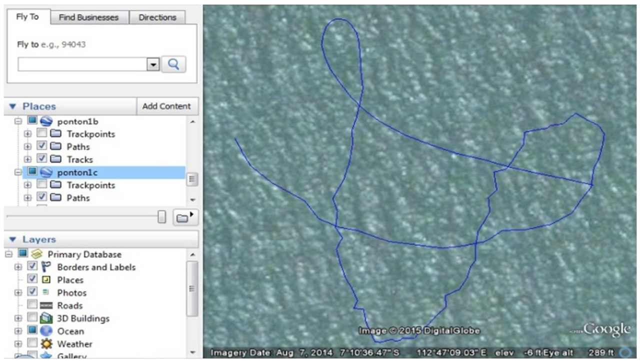

Figure 9: Location of measurement at position Latitude S07°10.6085' Longitude E112°47.1729'up to Latitude S07°10.6019' Longitude E112°47.1269'

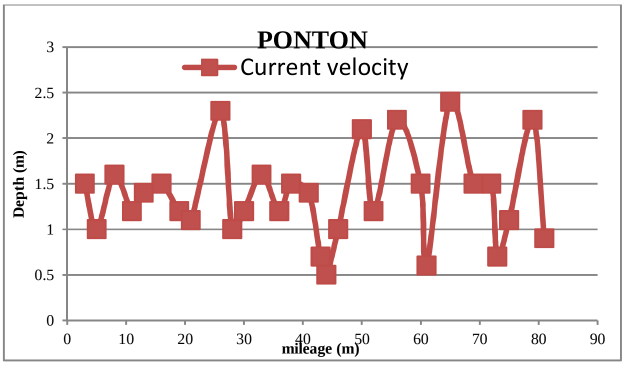

Figure 10: The measurement data of ocean current velocity at Latitude S07°10.6493' Longitude E112°47.1484' up to Latitude S07°10.6435' Longitude E112°47.1742'

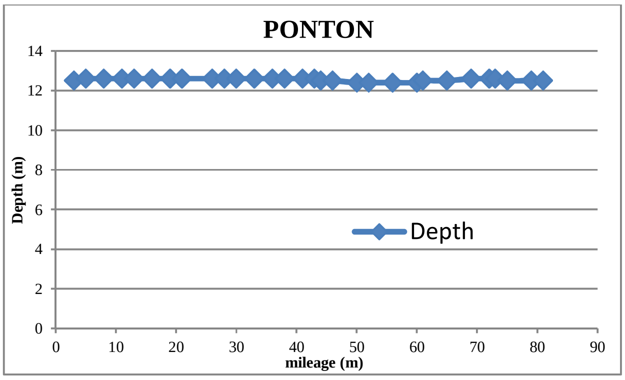

Figure 11: Data measurement of depth of ocean floor at Latitude S07°10.6493' Longitude E112°47.1484' up to Latitude S07°10.6435' Longitude E112°47.1742'

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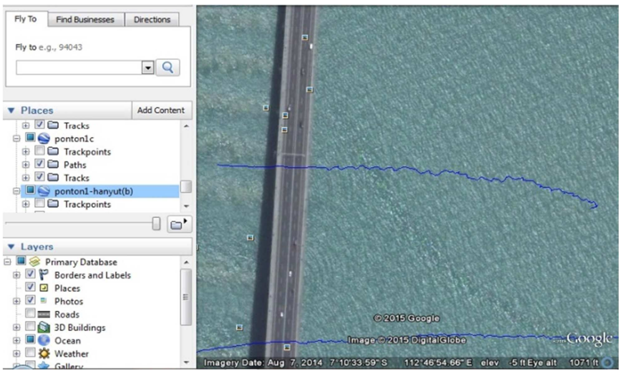

Figure 12: Location of measurement at position Latitude S07°10.6493' Longitude E112°47.1484' up to Latitude S07°10.6435' Longitude E112°47.174'

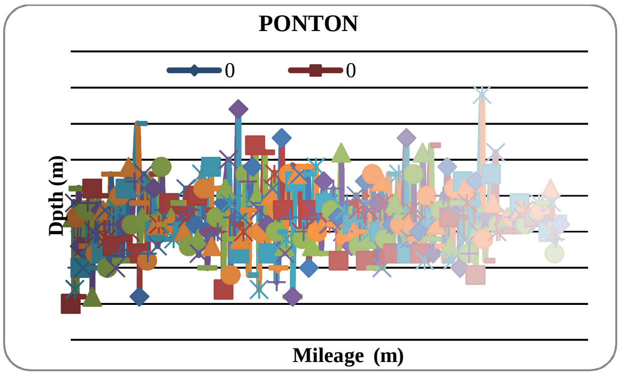

Figure 13: Location of measurement at position Latitude S07°10.6402' Longitude E112°47.1774' up to Latitude S07°10.6447' Longitude E112°46.8037'

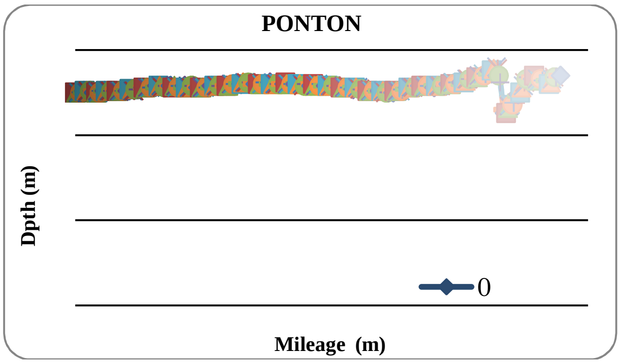

Figure 14: Location of measurement at position Latitude S07°10.6402' Longitude E112°47.1774' up to Latitude S07°10.6447' Longitude E112°46.8037'

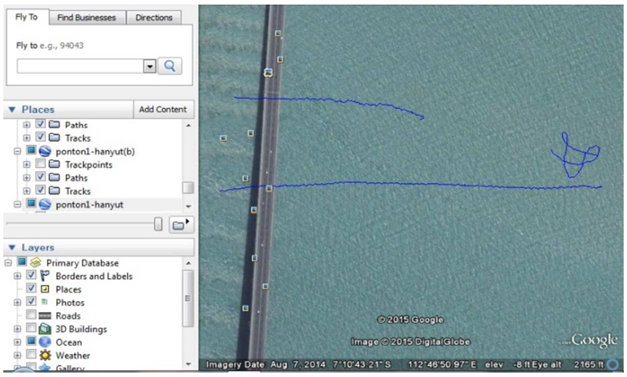

Figure 15: Location of measurement at position Latitude S07°10.6402' Longitude E112°47.1774' up to Latitude S07°10.6447' Longitude E112°46.8037'.

Table 1: Average depth data for the seafloor

Position I		Average Depth (Δh)
Pontoon	$7^0$10'38.31"S $112^0$47'13.33" E	12.25 m
Anchor 1	$7^0$10'37.21"S $112^0$47'16.45" E	12.18 m
Anchor 2	$7^0$10'39.54"S $112^0$47'16.39" E	12.09 m
Anchor 3	$7^0$10'36.73"S $112^0$47'10.53" E	12.17 m
Anchor 4	$7^0$10'39.28"S $112^0$47'10.27" E	12.55 m

Table 2: Average depth data for the seafloor

Position II		Average Depth (Δh)
Pontoon	$7^0$10'35.40"S $112^0$46'57.92" E	13.05 m
Anchor 1	$7^0$10'34.24"S $112^0$47'00.99" E	12.75 m
Anchor 2	$7^0$10'36.72"S $112^0$47'00.96" E	13.05 m
Anchor 3	$7^0$10'33.68"S $112^0$46'54.99" E	12.47 m
Anchor 4	$7^0$10'36.55"S $112^0$46'54.92" E	13.37 m

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Figure 16: Location of east side of pile between Pole no. 56 and Pole No. 57 SuraMadu bridge on the side of Madura

Figure 17: Map of SuraMadu bridge

Table 3: Average depth data of ocean floor and sea velocity speed between Pole 56 to Pole 57

Boat Position (m)	Δ Depth (ft)	Δ Depth (ft)	Current Velocity (m/s²)
1	37.5	11.4	0.8
1.5	36.8	11.2	0.925
2	37.0	11.3	1.6667
2.5	35.9	10.9	0.8667
3	36.3	11.1	0.95
3.5	36.9	11.2	1.325
4	36.2	11	1.4375
4.5	36	11	1.95
5	36	11	1.017045
5.5	35.4	10.8	1.8
6	35.6	10.8	1.425
6.5	35.7	10.9	1.8
7	36	11	1.475
7.5	35.4	10.8	1.8
8	36.2	11	1.45
9	37.0	11.3	1.475

Table 4: Average depth data of ocean floor and sea velocity speed between Pole 56 to Pole 57

Boat Position (m)	Δ Depth (ft)	Δ Depth (ft)	Current Velocity (m/s²)
10	37.8	11.5	1.475
11	38.4	11.7	1.15
12	39.0	11.9	1.15
13	39.5	12	1.15
14	39.3	12	1.1
15	38.9	11.8	1.1
16	39.1	11.9	1.1
17	39	11.9	1.1
18	38	11.6	1.1
19	38.5	11.7	1.1
20	38.1	11.6	1.1
21	38.3	11.7	1.1
22	38.2	11.6	1.1
23	38.7	11.8	1.1
24	38.9	11.9	1.1

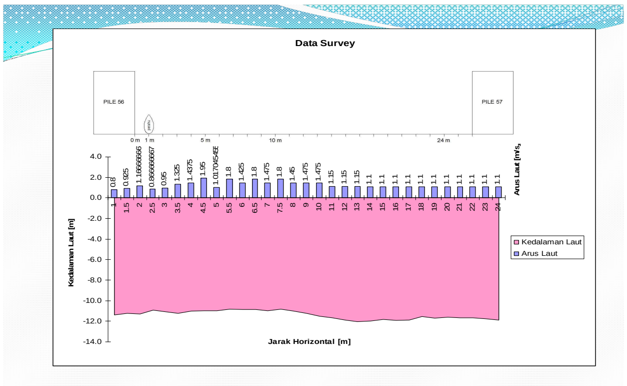

Figure 18: The measurement data of sea currents and the depth of the seabed between Pole no. 56 and Pole No. 57 SuraMadu Bridge

Figure 19: Measurement of ocean velocity and sea depth depth between Pole 56 to Pole 57.

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4.0 DISCUSSION

To obtain energy from a watershed area (strait madura) that has a small ocean velocity, it is necessary to locate a marine turbine placed in an appropriate and strategic position, the layout of this ocean current turbine placement can affect the optimum potential of ocean currents.

Measuring the velocity of sea currents and the depth of the seafloor is a first step that will result in a conclusion of the proper placement of marine turbine.

Here are some things that can be conveyed as a discussion of the results of sea velocity measurements and depth of the seabed ranging from outside the Pole of 53 to 57 Pole and between Pole 56 to Pole 57 are as follows:

1. With the consideration that the depth of the seabed around the east side SuraMadu bridge is quite flat and not too deep, on SuraMadu Bridge is very possible to install marine turbine as one of the contributors in meeting the electricity needs in the area of the bridge other than other sources of electricity
2. In addition to the SuraMadu bridge pillars there are still many other locations that can be installed prototype turbine, especially the area outside the SuraMadu bridge side of the Madura side starting from outside the SuraMadu bridge area 53 to the SuraMadu bridge pole in parallel at each, Each Pole of the Bridge so that the total electricity that can be produced will be able to meet the electricity needs of SuraMadu Bridge area.
3. Need further study on placement of position / direction of placement of the most optimal turbine in absorbing ocean currents energy
4. In Table 3 and Table 4 shows quantitatively that the layout of the ocean current turbine greatly affects the acquisition of kinetic potential of ocean currents.

5.0 CONCLUSION

1. Based on coastal morphology condition and seabed area of research area, it can be concluded the selection of location of current turbine placement at location around Pole no 56 to Pole no. 57 SuraMadu bridges are quite eligible because of the relatively sloping morphology with a depth of ± 10 to 12 meters, and still through a strong enough current. Between 0.5 up to 1.4 m / s
2. By realizing the utilization of ocean current electricity source at SuraMadu Bridge, it is expected that East Java could become a pioneer in the utilization of renewable energy source from ocean currents for other regions.
3. Potential sources of ocean currents energy in SuraMadu Bridge allows to be a source of substitution energy for fossil energy sources, so that:
   - Participate in efforts to reduce the impact of global pollution
   - Reduce the consumption of domestic BBM energy in Indonesia.

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