Wave Energy Conversion with floating objects for the coast of East Java.

Heri Saptono Warpindyasmoro[1,*], and *Hanny* H. Tumbelaka[1]

[1]Electrical Engineering Department, Petra Christian University, Jl. Siwalankerto 121 - 131 Surabaya, Indonesia

Abstract. The coast of East Java has ocean waves with varying significant wave heights and wave periods. To convert wave energy into electrical energy, equipment is needed, which is a floating object. This floating object serves to convert wave energy into mechanical energy which is then converted into electrical energy. Energy conversion will be maximum if the ocean wave frequency same with natural frequency of floating objects. The natural frequency of floating objects is determined by the shape of the floating object. This study compares two floating objects, namely cylinders and cone shaped. From the results of simulations, the cylinder shape is more suitable to be applied on the south coast, while the cone shape is more suitable to be applied on the north coast.

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1 Introductions

The energy generated by ocean waves is the most potential energy in the world and the most efficient when converted to electrical energy [1]. But implementation as a real electric power plant is still very minimal. Most are still on a laboratory scale. The energy produced by ocean waves is very dependent on the parameters of the ocean waves, namely the significant wave height and wave period. At each location has a significant wave height and varying wave periods [2]. Therefore a wave energy conversion mechanism (Wave Energy Conventer, WEC) is needed that is suitable for wave conditions at each of these locations. One of the wave energy conversion mechanisms uses floating objects. By optimizing the shape and size of floating objects, floating objects will be obtained that are suitable for the location, so that the maximum wave energy conversion will be obtained.

[*] herisw@petra.ac.id

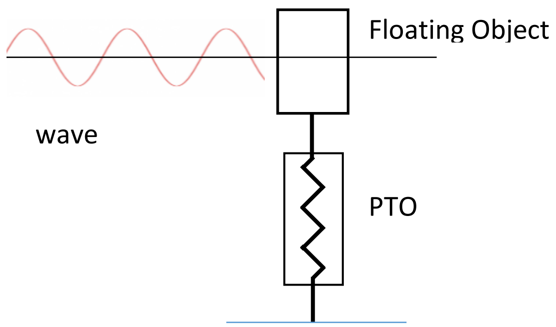

Figure 1. Structure of floating objects.

In general, the structure of the floating object as in figure 1. When the wave comes, the floating buoyancy will move vertically (heave). This floating object is called the point absorber, because in this part the wave energy is absorbed by the system. This movement will excite the movement to produce mechanical energy to be converted into electrical energy, called Power Take Off (PTO). PTO will be very efficient if the movement is limited to one dimension [3]. To maximize energy, a condition is needed where the natural frequency of floating objects must be the same as the frequency of the ocean waves. While the natural natural frequency of floating objects depends on the shape of the floating object. Therefore, to optimize the energy conversion, the structure and shape of the floating objects become very important.

2 Wave Energy on East Java Coast

The ocean wave of East Java have different characteristics between the south coast (Indonesian ocean) and the north coast (Java Sea). The differences in characteristics between two coast regions are related to significant wave height (Hs) and wave period (T) of ocean wave. The south coast has a significant wave height Hs = 1-2 m with a period T = 10-16 seconds. While on the north coast has a significant wave height Hs = 0-1 m with a period of T = 2-8 seconds [4]. This difference, especially related to the wave period, requires floating objects that have a Response Amplitude Operator (RAO) in the short period for the north coast and floating objects that have RAO for a longer period on the south coast.

The energy produced by ocean waves [5] [6] is

$$P = \frac{\rho g^2}{64\pi} H_s^2 T \tag{1}$$

Where ρ is the density of sea water (kg / m^3) g is the acceleration of gravity (m /s2); Hs is a significant (m) wave height; T is the wave peride (seconds). By using equation (1), the potential of electrical energy on the coast of East Java can reach 232 MWh / m / year [4]. Large enough energy potential to be developed further.

3 Wave Energy Conventer (WEC)

To convert ocean wave energy into mechanical energy, Wave Energy Conventer (WEC) is needed. Furthermore, the mechanical energy is converted into electrical energy. In general, WECs can be categorized as attenuators, point absobers, oscillating wave surges, oscillating water columns, terminators or submersed pressure defferential devices [7]. One of the WEC that can be directly connected to the generator is the absorber point. The parameters that need to be considered when designing an absorber point are the shape, length, volume, mass, draft, center of weight, buoyancy force and moment of inertia [8]. The development of the absorber point form has been done to obtain the form that produces the largest PTO [9] [10] [11].

4 Point Absorber

In this study two absorber point models were made, namely cylindrical and cone shaped as shown in Figure 2.

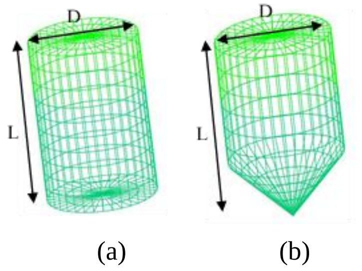

Figure 2. Absorber point model: (a) cylinder, (b) cone.

To analyze the characteristics of RAO from each form of objects used MOSES. The size of each model is L = 1.5 D, where D is the diameter. Model diameters varied, D = 6 m, 9 m, 12 m, 15 m and 18 m. From the simulation results in Figure 3 and Figure 4, the maximum RAO at each D value occurs in different periods. The larger the diameter, the greater the period in which maximum RAO occurs. In the cylindrical form for diameters of 6-18 m RAO the maximum period is 6-10 seconds. Meanwhile in the cone shape for a diameter of 6-18 m, the maximum RAO occurs in the period 4 - 8.

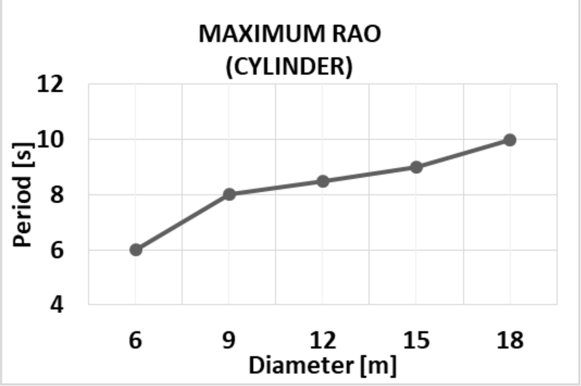

Figure 3 Maximum RAO for cylinder point absorber.

Figure 3 shows the maximum RAO of the cylindrical absorber point. From the figure, it is shown that the larger the diameter, the larger the wave period where the RAO will reach the maximum. For diameters of 6-18 m, the maximum RAO will occur in periods of 6-10 seconds. If extrapolated, with a diameter greater than 18 m, a maximum RAO will be obtained greater than 10 seconds. The cylinder shape is suitable for application for the south coast of East Java where the wave period is 10-16 seconds.

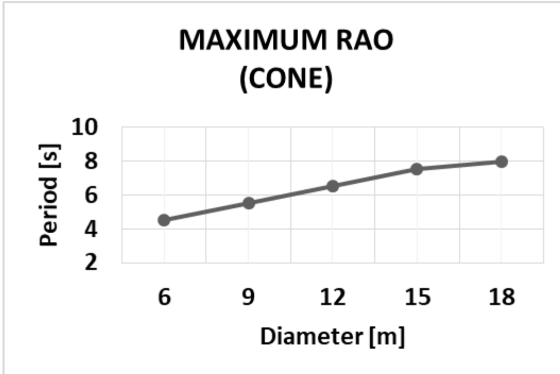

Figure 4 Maximum RAO for cone point absorber

While Figure 4 shows the maximum RAO for the cone-shaped absorber point. The greater the diameter of the absorber point, the greater the period in which maximum RAO occurs. For an absorber diameter of 6-18 m, the maximum RAO period occurs in the 4 - 8 second wave period. If extrapolated to a diameter smaller than 6 m, a maximum RAO smaller than 4 seconds will be obtained. The north coast of East Java, has a period of 2-8 seconds. The cone shape will be more suitable to be implemented on the north coast of East Java

5 Conclusion

From this study, it can be concluded that for each shape of absorber point, the larger the diameter, the greater the period of wave where the maximum RAO will be obtained. Of the 2 (two) shapes of point absorber, the cylinder shape is more suitable to be applied on the south coast, while the cone shape is more suitable to be applied on the north coast.

Acknowledgements

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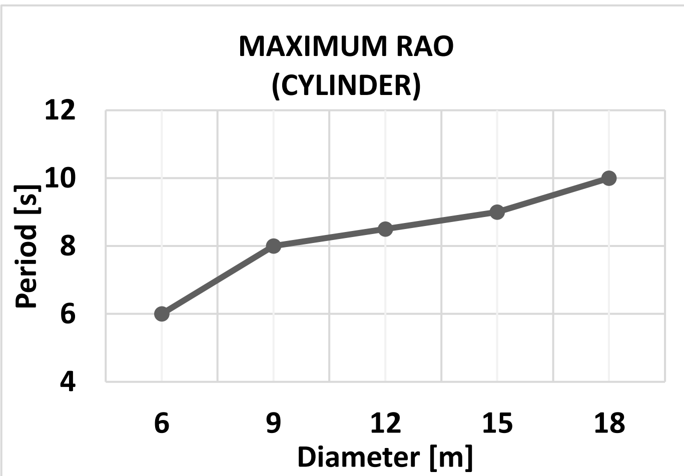
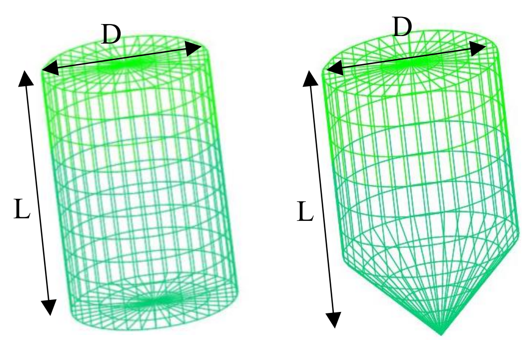

MAXIMUM RAO
(CYLINDER)
Period [s]
Diameter [m]
12
10
8
6
4
6
9
12
15
18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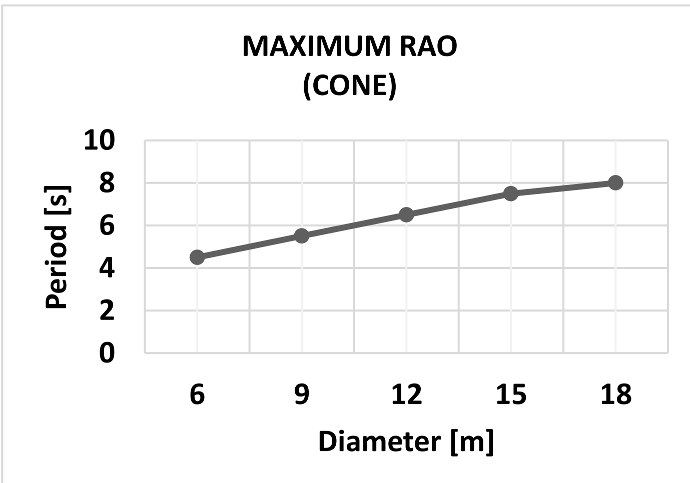
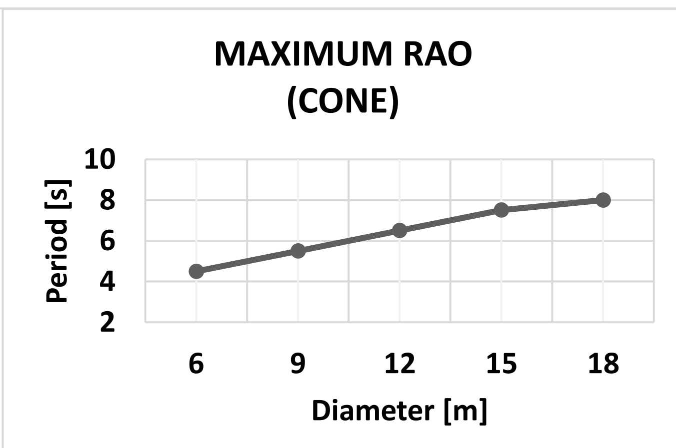

MAXIMUM RAO
(CONE)
10
8
6
4
2
0
Period [s]
6
9
12
15
18
Diameter [m]


MAXIMUM RAO
(CONE)
10
8
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Period [s]
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Diameter [m]