R6 Study the effect of wave height variations on the.pdf

by

Submission date: 18-May-2023 10:33AM (UTC+0700)
Submission ID: 2095938079
File name: R6 Study the effect of wave height variations on the.pdf (568.5K)
Word count: 2105
Character count: 11563

PROCEEDING

The 8th Joint Conference on Renewable Energy and Nanotechnology 2019 (JCREN 2019)

ISBN 978-979-18011-3-3

November 5-6, 2019

Gowa Campus, Hasanuddin University, Indonesia

HIROSHIMA UNIVERSITY

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

EHIME UNIVERSITY

Kyutech
Kyushu Institute of Technology

OKAYAMA UNIV.

YAMAGUCHI UNIVERSITY

NANOTEC
a member of NSTDA

KMITL
พระจอมเกล้าลาดกระบัง

มหาวิทยาลัยรังสิต
RANGSIT UNIVERSITY

Sponsored by:

TOYO KOATSU

PLN

Study the effect of wave height variations on the absorption efficiency of the Floating Wave Energy Converter

Jufri*[1], Daeng Paroka[2], Jalaluddin[1] Rustan Tarakka[1]

[1]Department of Mechanical Engineering, Hasanuddin University
2 Department of Ocean Engineering, Hasanuddin University
*Corresponding author:jufri@atim.ac.id;dparoka@eng.unhas.ac.id;
jalaluddin_had@yahoo.com; rustan_tarakka@yahoo.com

Abstract

Indonesia is the largest archipelago country in the world with the second longest coastline in the world. Along the coast it has the potential for wave energy to be developed into renewable energy. Therefore, it is necessary to have studies on parameters which have an influence on the potential density and the potential technology of energy absorption from ocean waves. Parameters of buoy diameter and sea wave height are considered to provide a significant effect on energy absorption and many researchers have examined this. However, no research has been found that examines the relationship of wave height, shape and diameter of buoy diameter to wave energy absorption based on ocean characteristics in the Indonesian Archipelago. Therefore researchers interested in researching about the case. The assumption in this research is that variations in wave height based on Indonesian sea characteristics can provide basic information in designing a Floating Wave Energy Converter (WEC) appropriately. The theoretical approach used is the Strip Theory Method. The results of this study are that wave height does not have a significant effect on the absorption efficiency of buoys, but it does have a significant effect on the amount of energy absorbed from the potential wave energy available and the suitability of diameter size with wave height will provide optimal energy absorption efficiency.

Keywords: Wave Height, buoys, Strip Theory Method.

1. Introduction

Indonesia is the largest archipelago in the world with a total number of islands estimated at 18,108. Indonesia is located between the Pacific and Indian Ocean, and connects two continents, Asia and Australia. Located between the longitude of 94°45' E and 141°05' and between latitudes 6°08' N and 11°15', the total area of Indonesia is approximately 2.8 million square kilometers with a coastline length of 54,716 km. If Indonesia's exclusive economic zone (EEZ), which stretches beyond the archipelago, is included in the Indonesian sea area, the total area of Indonesia reaches 7.9 million square kilometers [1,2,3]. Based on these goegraphic conditions, Indonesia has considerable potential to utilize sea energy, especially from wave energy, currents, tides and thermal seas. Ocean waves are a source of ocean energy which has the highest energy density among ocean energy potentials. Masuda can be considered the father of modern wave energy technology [4]. In general, sea wave energy absorbers are carried out using insulated absorbent buoys. Insulated absorbent buoys are divided into three main methods for absorbing energy from waves. The first type uses a linear generator directly which usually induces high power at low speeds compared to conventional generator speeds. The second type uses a hydraulic device, this equipment uses a float-insulated float motion to move the hydraulic actuator and then rotates the hydraulic motor. Hydraulic motors are used as a driving source for electric generators. The third type uses a mechanical system, this system has been patented since 1929. This type remains a concern of researchers until now because they have some advantages compared to other types. The advantage of this type is that its size can be reduced and can be used in locations near the coast so that it can reduce construction, maintenance and operational costs. [5] . Many researchers have done research on the wave energy absorption of insulated buoy systems, but similar studies based on the characteristics of Indonesian ocean waves are lacking. Therefore this research was conducted with the aim to examine the suitability of the parameters of the buoy bullet shape and wave heights in the Indonesian sea areas.

2. Methodology

2.1. Floating buoy response

Sea waves are random and irregular movements of sea level rise and fall (irregular waves). To simplify problem solving in research the ocean waves are assumed to be regular waves with simple harmonic motion. Simple harmonic motion is the alternating motion of objects through a certain equilibrium point with the number of vibrations of the object in every second always constant. Floating objects on the surface of the water will respond to the harmonic motion of the incoming wave both in the form of motion or in the form of a force like the **Fig.1** The basic equilibrium buoy force equilibrium experienced by the buoy can be modeled as the following mathematical equation [9]:

$$a\ddot{z} + b\dot{z} + cz = F\cos(\omega t) \quad \text{...} (1)$$

Harmonic motion response from a buoy can be calculated with a mathematical approach, both the distance of motion, velocity and acceleration with the basic equation of motion

$$Z_t = Z \times \sin(\omega t + \varepsilon) \quad [\mathrm{m}] \quad \text{...} (2)$$

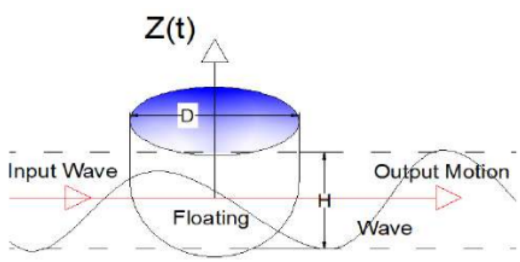


Fig. 1 Schematic Floating Absorption

2.2. Respon Amplitude Operator (RAO)

Amplitude Operator Response (RAO) Spectra method is a way to find out a structural response due to regular wave loads in each frequency. RAO or often referred to as the Transfer Function is a response function that occurs due to waves in the frequency range that affects the offshore structure. RAO can also be defined as the relationship between the amplitude of the response to the amplitude of the wave. Can be stated with a mathematical form that is (ζ response / ζ wave). The amplitude of the response can be movement, voltage, or vibration. RAO is also referred to as the Transfer Function because RAO is a tool for transferring external loads (waves) in the form of responses to a structure. The general form of the RAO equation in the frequency function is as follows [9]:

$$RAOz = \frac{Z_0}{\xi_0} \qquad (3)$$

2.3. Energy and Wave Power

Total wave energy is the sum of potential energy and kinetic energy. Potential energy is formed due to the displacement of water surface by the influence of waves. Kinetic energy is the energy that arises due to the speed of water particles caused by wave motion. The total energy of the wave energy can be calculated based on the following equation [5,7]:

$$\bar{E} = \frac{E}{L} = \frac{\rho g H^2}{8} \ [\text{J/m}^2] \qquad (4)$$

The shape of ocean waves in nature is generally very complex and random and difficult to describe mathematically because of its non-linearity [10]. So to calculate the power of a long unity wave, the speed of the wave group must be determined first. Wave velocity can be calculated based on category of grouping, deep sea, transition sea or shallow sea. The area of research undertaken is limited to the transitional sea so that the equation can be written [11]

Individual Wave Speed :

$$C = \frac{L}{T} = \frac{\omega}{k}, L = \frac{2\pi}{k}, T = \frac{2\pi}{\omega} \qquad (5)$$

Wave velocity Group

$$C_g = C.n. \qquad (6)$$

n values that can be calculated using the formula:

$$n = \frac{1}{2}\left(1 + \frac{2kh}{\cos h(2kh)}\right) \qquad (7)$$

The power obtained from the total energy of ocean waves is multiplied by the speed of a large group of waves whose value can be calculated by the following equation [11]

$$\bar{P_\omega} = E_{tot} x C_g \ [W/m] \qquad (8)$$

2.4. Power Absorption and Efficiency

The magnitude of the potential power that can be absorbed by the floating buoy depends on the length of the floating object segment through the wave, so that it can be formulated mathematically like the equation [5]:

$$P = P_{\omega} x d \ \ [Kw] \quad \text{.......} (9)$$

Actually the power that can be absorbed by the buoy is the same as the excitation power. Froude-Krylov diffraction is an excitation force, the magnitude of which can be calculated using equation [5]:

$$f_3 = \rho \xi g b e^{ikx} - e^{-kds} \left[\frac{N}{m}\right] \quad \text{.......} (10)$$

Where b is the width of the segment of the buoy (m) through which the waves travel.

The amount of excitation force experienced by a floating buoy depends on the distance of the vertical motion (heave) of the buoy as in the equation below [5]:

$$F_e = f_3 . z . \sin(\omega t + \alpha) \, [N] \quad \text{.......} (11)$$

The absorption of a floating buoy is a representation of the absorption of the excitation force and the speed of the heave, it can be written as [5]:

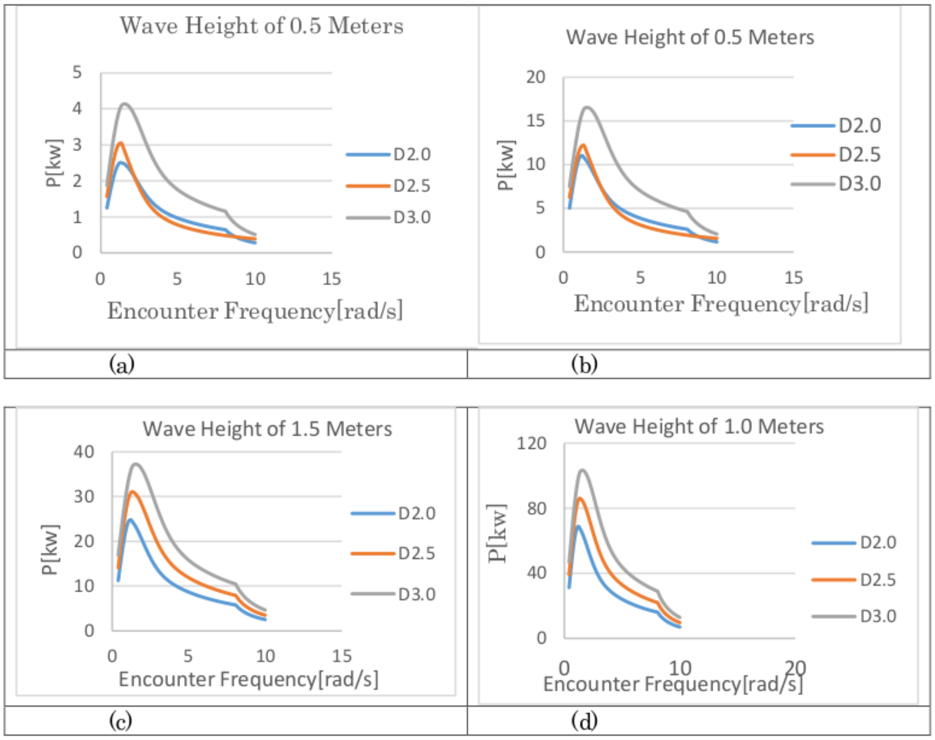
$$P_a = \frac{1}{2} x |F_e||\dot{z}| . cos\varphi \quad \text{.......} (12)$$

The efficiency of absorption of power by a buoy can be calculated comparing the large potential power that can be absorbed with the force that is actually absorbed such as:

$$\eta_a = \frac{P_a}{P} x 100\% \quad \text{.......} (13)$$

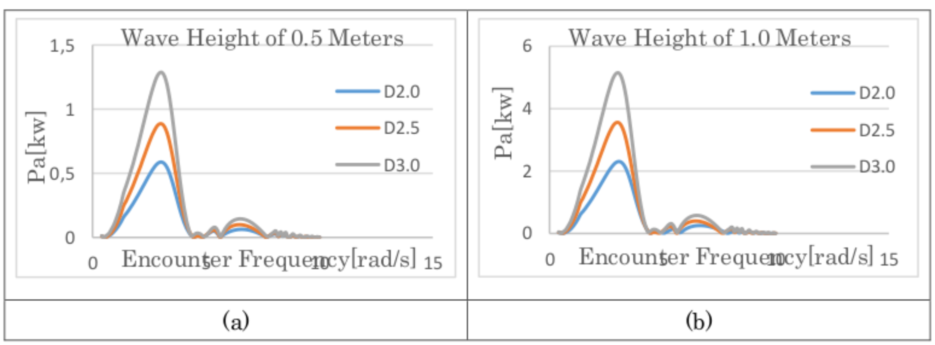
3. Results and Discussion

Computational results of the potential power that can be absorbed by the buoy in **Fig. 2** (a), (b), (c) dan (d) show that at the same encounter frequency and wave height it turns out that the change in diameter size from 2.0 - 3.0 meters has significant effect on the ability of the absorption potential by float. The same is seen in **Fig. 3** (a), (b), (c) and (d) regarding the actual absorption of the buoy. In **Fig. 2** and **Fig. 3** the difference in the encounter frequency shifts that provide maximum absorption is the ability of the potential absorption (P) to give maximum results around the 1.5 rad/sec encounter frequency while the actual absorption (Pa) gives the maximum results around the encounter frequency 3.0 rad / sec.

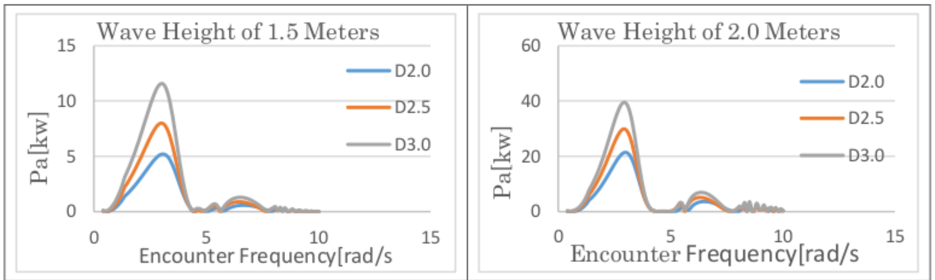


(a) (b) (c) (d)

Fig. 2 Graph of the potential power that can be absorbed by the buoy



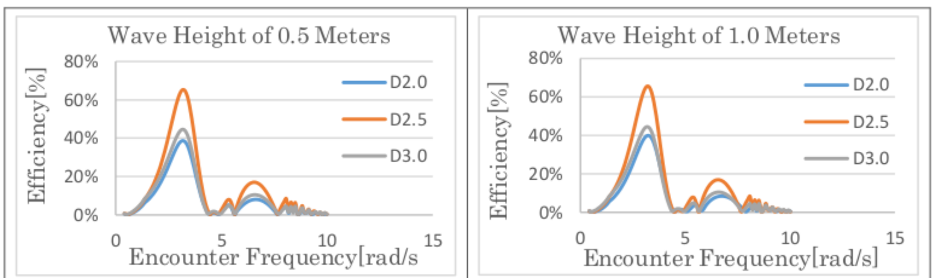
(a) (b)



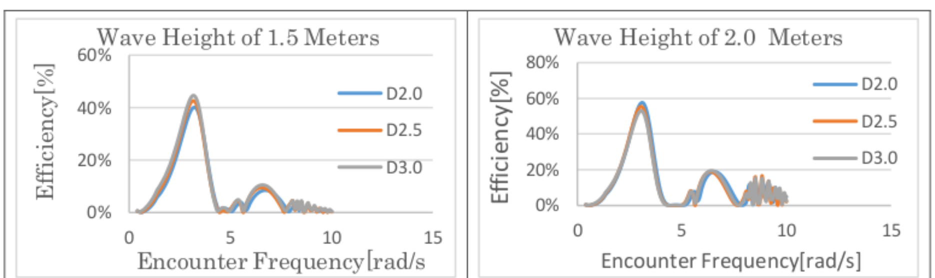
(a) (b)

Fig. 3 Graph of the actual power absorbed by the buoy

The absorption efficiency of the buoy in **Fig.4** shows that for a wave height variation of 0.5 -2.0 meters (H0.5 - H2.0) it turns out that a diameter of 2.5 meters (D2.5) provides the greatest absorption efficiency compared to other diameters. The efficiency value of the results that shows the difference in the three diameters observed, this is not only a problem due to friction, but also due to the effect of the buoy weights so that it affects the dynamics of heaven speed. Efficiency shows the results obtained are quite large, but not yet an optimal value. Factors causing changes in the dynamics of heave behavior are not entirely taken into account in this model.



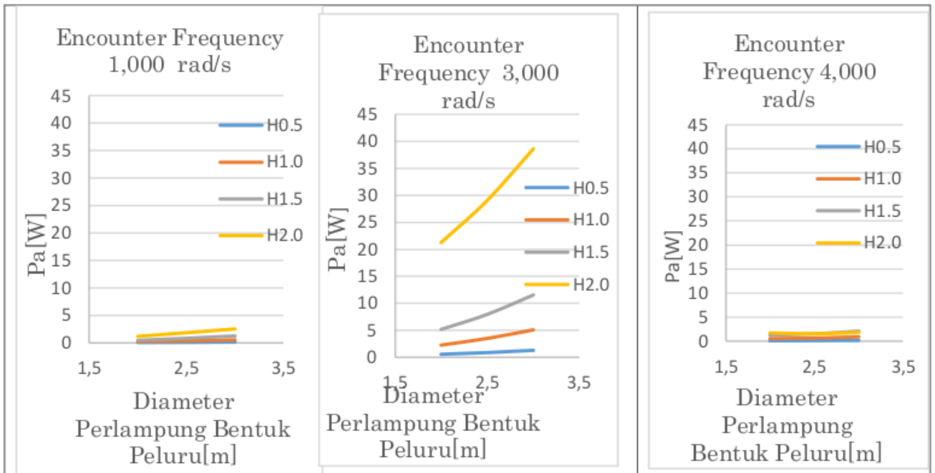
(a) (b)



(a) (b)

Fig. 4 Graph of buoyancy absorption efficiency

Fig. 5 (a), (b) and (c) show that the change in the diameter of the buoy shape buoys gives a linear effect on energy absorption. Appropriate buoy diameter with operating wave height must be optimized to increase buoy absorption efficiency.



(a)	(b)	(c)

Fig. 5. Graph of the relationship between the dieter and the actual power absorbed by the buoy

4. Conclusion

Conclusion has to be placed showing the achievement and information obtained by the submitted work.

In this study, research was conducted on Indonesia's wave energy potential. Based on the study found, Indonesia has the potential of wave energy that can be extracted with wave energy converter technology in accordance with its characteristics. Some conclusions can be drawn from this study:

- Buoy wave diameter and height. By rotating the buoy diameter and wave height, the pull of power also rises (as shown in **Fig. 2** and **Fig.3**).
- The efficiency of the buoy image on the wave height variation condition from 0.5 -2.0 meters, the float diameter of 2.5 meters provides the greatest saving efficiency in the other diameters.
- Changes in buoy diameter give a linear effect on changes in energy absorption ability. The diameter adjusted to the operating wave height must be optimized to increase buoy efficiency

References

[1] ADB:"Indonesia: Country water assessment" Mandaluyong City, Philippines: Asian Development Bank, 2016.

[2] Robert Cribb and Michele Ford; "Indonesia As An Archipelago: Managing Islands, Managing" https://www.sciencedirect.com/science/article/pii/S1364032111000487

[3] Ardy Kusuma, "Ocean energy overview: feasibility study of ocean energy implementation in indonesia",https://commons.wmu.se/all_

dissertations/608
[4] Farshid Zabihian *, Alan S. Fung, "Review of marine renewable energies: Case study of Iran", Renewable and Sustainable Energy Reviews 15 (2011) 2461–2474
[5] Phan Cong Binh, Nguyen Minh Tri, Dang Tri Dung, Kyoung Kwan Ahn , Sung-Jae Kim, "Analysis, design and experiment investigation of a novel wave energy converter", doi: 10.1049/iet-gtd.2015.0821,www.ietdl.org
[6] António F. O. Falcão, "Modelling of Wave Energy Conversion" Instituto Superior Técnico, Universidade Técnica de Lisboa, 2014
[7] J.M.J. Journée and W.W. Massie," Offshore Hydromechanicsfirst, Edition, Delft University of Technology, 2001
[8] Maxsurf Motions, and Industry," Windows Version 20,User Manual" © Bentley Systems, Incorporated 2013
[9] J.M.J. Journée and L.J.M. Adegeest,Theoretical Manual of Strip Theory Program "SEAWAY for Windows" 2013
[10] Bambang Triatmodjo, "Beach Engineering" Jogyakarta, 2016
[11] Filippos Kalofotias, "Study for the Hull Shape of a Wave Energy Converter-Point Absorber" University of Twente The Netherlands, June 2016 Wave Height of 0.5 Meters

R6 Study the effect of wave height variations on the.pdf

ORIGINALITY REPORT

15%	9%	6%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universiti Kebangsaan Malaysia Student Paper	2%
2	Submitted to Millard West High School Student Paper	1%
3	Submitted to MLA College Student Paper	1%
4	www.testmagzine.biz Internet Source	1%
5	www.jpsr.pharmainfo.in Internet Source	1%
6	Daeng Paroka, Andi Haris Muhammad, Sabaruddin Rahman. "Safety of an Indonesian ro-ro ferry with different weight distribution on vehicle deck", AIP Publishing, 2022 Publication	1%
7	I Setiawan, S M Yuni, S Purnawan, R S Isman, M Miftahuddin, Y Ilhamsyah. "Analysis of wave measurements in November 2018, January 2019, and March 2019 in the coastal waters of Leupung and Lhoong, Aceh Besar	1%

District, Indonesia", IOP Conference Series: Earth and Environmental Science, 2021
Publication

8	www.researchgate.net Internet Source	1 %
9	journal.unhas.ac.id Internet Source	1 %
10	www.coursehero.com Internet Source	1 %
11	Dung, Dang Tri, Weoncheol Koo, Kyoung Kwan Ahn, Nguyen Minh Tri, Sung-Jae Kim, and Phan Cong Binh. "Analysis, design and experiment investigation of a novel wave energy converter", IET Generation Transmission & Distribution, 2016. Publication	<1 %
12	Soon-Hyun Lee, Kwang-Jun Paik, Hong-Sik Hwang, Myeong-Jin Eom, Sang-Hyun Kim. "A study on ship performance in waves using a RANS solver, part 1: Comparison of power prediction methods in regular waves", Ocean Engineering, 2021 Publication	<1 %
13	docslide.us Internet Source	<1 %
14	fenix.tecnico.ulisboa.pt Internet Source	<1 %

15	repository.tudelft.nl Internet Source	<1 %
16	www-euromonitor-com.ezproxy.herts.ac.uk Internet Source	<1 %
17	www.iamu2018.com Internet Source	<1 %
18	www.mdpi.com Internet Source	<1 %
19	I P S Asmara, Sumardiono, M Adam. "Seakeeping and resistance analysis of 1200 GT passenger ship fitted with NACA 4412 stern foil using CFD method", IOP Conference Series: Materials Science and Engineering, 2021 Publication	<1 %

Exclude quotes On
Exclude bibliography On
Exclude matches < 5 words