Innovation Design Roughness on Slope to Reduce Storms at Curved Seawall In Canggu Beach Bali

Nalarsih, Yuwono, Darsono

Abstract*: Seawall or revetment has been designed to preserve coastline erosion from waves. The seawall system or revetment could protect againstpowerful wave, reduce hydraulic power in underring material and constribute to wave reflection. The result of survey show that seawall system have to be repeatedly observed to maximize seawall action to produce a modification of seawall design.In this research, hydrodinamic seawall action is conducted by employing its curve, slope and roughness. It is investigated by using physical modeling in 2D Laboratory of Coastal Dynamics Institute Yogyakarta, Indonesia. Type of wave used in this study is Regularwave within one period of time. Wave experiment is examined in 30° of its slope, constant water depth is0.4 m and roughness on its slope using two types of sequential block position and zig zags. This research results in the significant Reflection Coefficient (Kr) which is 0.141 produced by design 1 compared to the previous research is 0.16923. Therefore, it can be concluded that design 1 is more reliable in reducing reflection wave.

***Index Terms*: Seawall, reflection coefficient, slope, roughness.**

I. INTRODUCTION

Nearly 90% hydro-meteorological disaster occurs in around the world such as el nino, la nina, landslides, cold waves, heat waves, global warming, and a powerful storm wave including massive environmental damage as the effect of decliningsupport capacity and environmental capacity. Therefore, coastal protection from erosion and abrasion grow to be the challenging issues. In todays era, various types of coastal protection structures are used worldwide such as seawall, groyne, offshore to stabilize the shore from erosion by dampening waves.

Whenever coastal protection is naturally absent, artificial coastal protection can be structured in order to protect artificial shoreline related to the waves. It can be conducted by reducing the wave energy by establishing a parallel wave building-breaker, reinforcing seawall protector and revetment as it is resistant to wave collision.

Seawall or revetment has been designed to protect coastline erosion against the powerful wave. The seawall or revetment system must resist direct wave attacks, reducing hydraulic forces to underring material and constribute for dissipating wave energy.

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Several studies have been conducted to look for coastal protection solutions of various forms of seawall, and they examine seawall with one of the major slopes being a 30-pound beam or rough surface in the form of a large dentated seawall surface and on the contrary the surface of a small four teeth that stands out (serrated seawall). The result shows that the serrated laying beam placed on the 30 ° seawall has the smallest reflection coefficient so that it can be said to be very effective in reducing wave energy.

Methods of wave reflection analysis with various types of structures, such as softness, softness and revetment of coral (permeable and impermeable), say that the reflection coefficient depends on the factor of hardness and the slope of the revetment.

Based on revetment research, it is divided into two groups: permeable revetment and impermeable revetment, including permeable revetment group is open filter material (rip-rap), stone pitching, and concrete block. While the group includes impermeable revetment is asphalt revetment and bitument grouted stone concrete block.

Further development of seawall is a flaring seawall structure of highly curved cross-section, with a maximum sea level of design (HWL) of 4.50 and has a reflector tip as a wave crusher

The study used a concrete cube as a single layer of protection against a sloping wall of a sea wall. The block model is placed diagonally on the slopes of models 2 and 4, placing each block only between the previous two, then the block model parallel to the axis of the slope. It was obtained from the test that the sequence of placements had much effect, with the cube variable being placed in a 45 ° (α) angle, the water depth should be no more than 10 Dcubes, and the highest water level in the last block position

The waves used in this study use a regullar wave, expressed in constant altitude over time, period and phase. The recorded data in time series is then read using MIKE 21, then the data recorded by the time domain is converted into frequency domain then analyzed. It is known that the water level actually has a height at different times and different direction combinations [8].

This research is a follow-up of previous research Nalarsih, 2015, using approach in the field of seawall at Canggu Bali, which is located according to the map in

Figure 1. In this study made improvised curve or curve and slope.

Figure 1. Map of Canggu Beach Bali, Indonesia

Buildings that have sloping sides and made of stone piles will absorb more wave energy than buildings erect and massive. In vertical buildings, smooth and walls are not permeable, the waves will be reflected entirely. The coming waves that hit or hit an obstacle will be reflected partially or completely. The magnitude of a reflecting wave's ability is given by the reflection coefficient, ie the ratio between the reflection Hr wave height and the wave height coming Hi [9].

$$X = \frac{H_r}{H_i} \quad (1)$$

The analysis used to calculate the wave height is Frequency Analysis Domain propagation of the coming wave and wave back after the reflection with a different direction of course the wave decomposition occurs, so must be held separation in this study using regular wave decomposition analysis method that works in the frequency domain Fast Fourier Technique (FFT) [10].

The process of converting time domain data to the frequency domain by Fast Fourier Transform (FFT), that the time series of surface wave elevation can be expressed as a sinusoidal wave with an infinite number with variable amplitude, incident wave angle, frequency and phase [11].

Based on the linear wave theory it is known that the composite surface wave elevation (ηT) can be defined as the total of the water elevation due to the incoming waves (ηi) and the water elevation because the reflected wave (ηr) is represented in the following equation with Hi and Hr = incident and reflected wave heights respectively, k = the wave number, ω = wave frequency and ε = initial phase. [12].

$$\eta_T = \eta_i + \eta_r = \frac{H_i}{2}\cos(kx - \omega t) + \frac{H_r}{2}\cos(kx + \omega t + \varepsilon) \quad (2)$$

The surface elevation in two successive points (x1 and x2) where the distance between wave probes is Δx, is shown in equations 3 and 4.

$$\eta(x_1, t) = (\eta_i + \eta_r)_{x=1} = A_1\cos(\omega t) + B_1(\omega t) \quad (3)$$

$$\eta(x_2, t) = (\eta_i + \eta_r)_{x=2} = A_2\cos(\omega t) + B_2(\omega t) \quad (4)$$

$$A_1 = H_1\cos\Phi_1 + H_r\cos\Phi_r \quad (5)$$

$$B_1 = H_1\sin\Phi_1 + H_r\sin\Phi_r \quad (6)$$

While large ϕi = kx1 + εi and ϕr = kx1 + εi, when substituted into the above equation the equation above is generated.

$$A_2 = H_1\cos(k\Delta x + \Phi_1) + H_r\cos(k\Delta x + \Phi_r) \quad (7)$$

$$B_2 = H_1\sin(k\Delta x + \Phi_1) - H_r\sin(k\Delta x + \Phi_r) \quad (8)$$

Waves obtained from the experimental data are assumed as regular waves, with different periods so that different frequencies and the amount of energy that occurs. Waves will be analyzed by converting the time domain to the frequency domain using Fast Fourier Transform Technik (FFT) theory [13].In order to facilitate the analysis, the Fast Fourier technique is used, so that A1, A2, B1 and B2 can be calculated for each wave with the help of MatLab and as a result of each wave height. The use of Fourier analysis to estimate the amplitudes of A1, A2, B1 and B2 for the fundamental frequency and also to produce a more uniformly higher wave. The amplitude of the incident wave and the reflection wave are then estimated by equations 9 and 10. This is the process of getting regular waves, actually almost the same for non-regular waves, since waves are considered superpositions with large amplitude and constant frequency. To separate between incident wave (Hi) and reflection wave (Hr) using formula [14].

$$H_i = \frac{1}{2|\sin k\Delta x|}\sqrt{(A_2 - A_1\cos k\Delta x - B_1\sin k\Delta x)^2 + (B_2 + A_1\sin k\Delta x - B_1\cos k\Delta x)^2} \quad (9)$$

$$H_r = \frac{1}{2|\sin k\Delta x|}\sqrt{(A_2 - A_1\cos k\Delta x + B_1\sin k\Delta x)^2 + (B_2 - A_1\sin k\Delta x - B_1\cos k\Delta x)^2} \quad (10)$$

The water level elevation that occurs is the actual incident wave surface level (ηT) which is the incident wave (ηi) which, at a certain time, will hit the structure of the sea wall, resulting in a wave going back in the opposite direction called the reflected wave = ηr).

Regarding the quasi-standing wave, to find the extreme values of ηT for every x, ie, the envelope of the wave height, denoted by the dashed line in Fig. 1, it is necessary to find the maximum and minimum ηT with respect to time. extreme values (ηT) can be obtained with the first derivative as follows [15]. (Dean & Dalrymple, 1991):

$$\eta_{T_{max}} = \frac{1}{2}(H_i + H_r) \quad (11)$$

$$\eta_{T_{min}} = \frac{1}{2}(H_i - H_r) \quad (12)$$

Physical modeling to simulate hydrodynamic phenomena is the most effective approach in coastal seawall structure research as a wave absorbing facility in coastal areas. The phenomenon that occurs in the characteristics of the wave in front of the seawall structure is very important that is to identify the characteristics of the wave, so as to obtain information magnitude wave number as a benchmark performance of reliable seawall is the smallest reflection coefficient generated from two modelseawall.

Based on the above references, the reason for using the 30 ° tilt seawall, with the beam as roughness in the incline, and the pattern of placement of roughness and curvature above the inclined plane is used as the variable in this study.

The novelty in this study compared to previous research is, the combination of veriabel slope, roughness and curvature in one seawall model, so that the results of the model in reducing wave reflection more leverage. This study was conducted only in relation to wave Reflection, since wave reflection is used as an important parameter in determining seawall performance.

Characteristics of seawall at Canggu Bali, the sloped seawall that has been held is used to withstand high waves especially during storms, wave data is obtained during the morning, day and night surveys, including full moon waves. The wave characteristics include transitional sea. Figure 2 shows that the seawall structure is not able to withstand wave attacks with hollow leg conditions and some of the structures collapse.

Figure 2. SeawallCrumblingon Canggu Beach, Bali,Indonesia (Nalarsih, 2016)

The Canggu Bali Beach Approach model has a 240 cm height dimension, 38 ° slope, 20 cm curved reflector, 80 cm transverse. Based on the results of previous research used 30 ° experimental slope, curved reflector 15 cm, obtained the reflection coefficient 0.16923 [15]. (Nalarsih 2015).

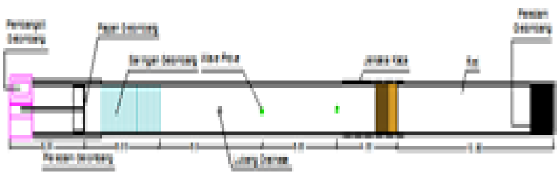

FIG. 3 is a probe placement work in accordance with a predetermined distance, in this study using 6 probes, the location of the installation is right in front of the 5 and 6 seawall models, then probe 3 and 4 and the next is probes 1 and 2. The model is made with a scale of 1: 16, water with dimensional revetment block 4.8x4.8x2.4cm, curved reflector 15cm, wide transverse 80cm, 240cm height according to Figures 4 and 5.

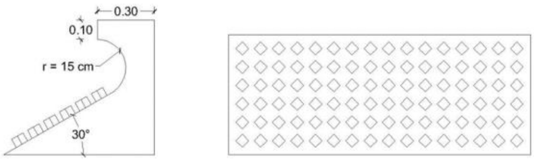

Figure 4. Design roughness 1

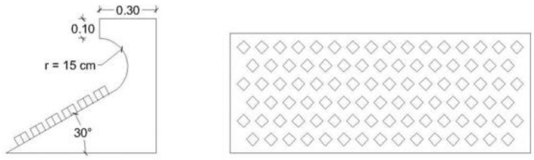

Figure 5. Design roughness

II. METHODS OF THE STUDY

The first stage is to calibrate the wave generator to find the relationship between the variables into the pool, the excentrisitas wave generator, stroke, variator, the wave period and the resulting wave height. Implementation of calibration is done after the model inside the finished wave channel. The second stage is the wave sensor calibration aims to find the relationship between the change in the length of the sensor electrode dipped in water with the voltage changes recorded on the recorder. The third stage is the calibration of the model in the wave channel is done in addition to the above also to know the exact location of the wave sensor, so the results obtained can illustrate the phenomena that occur in the model in accordance with Figure 6.

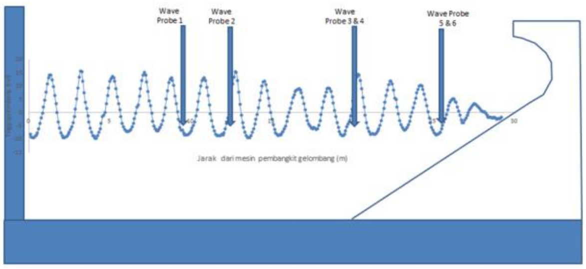

Figure 6. Schematic of hydraulic experimental model

III. RESULTS AND DISCUSSIONS

A. Results of regular wave investigations

The experiments were performed on both design with wave period parameter (T) = 1.8 s, water depth (d) = 0.5 m, slope (α) = 35 °, curvature 15 cm, and block dimension (a) = 4.

8x4.8x2 .4 cm3, different only the roughness position model, in doing the running for 30 seconds, obtained 602 data. The data is recorded on each sensor, for example from sensor 1 to sensor 6, for example the waveform elevation data on sensor 1 like Figure 7 and Figure 8 is the wave height graph with respect to time, y axis is wave height and x is time, for design 1 shows the results of the wave height coming marked with blue (Hi) and reflection wave height data

(Hr) characterized by red, with wave height results in Table 1 and Table 2.

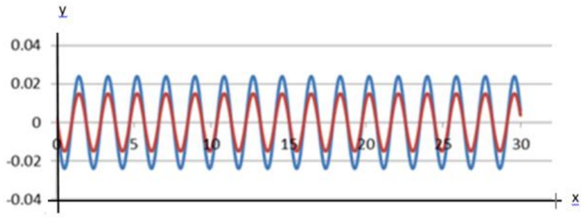

Figure 7. Hi and Hr surface elevation on sensor 1

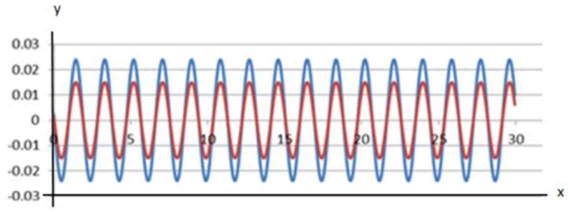

Figure 8. Hi and Hr design surface elevation 2 (Analysis Result, 2017)

No	Hi	Hr	eta_max	eta_min
	(m)	(m)	(m)	(m)
S1-2	0.0433	0.0431	0.0432	0.0001
S1-3	0.0601	0.0635	0.0618	-0.0017
S1-4	0.0600	0.0613	0.06065	-0.00065
S1-5	0.0476	0.0313	0.03945	0.00815
S1-6	0.0478	0.0299	0.03885	0.00895

Table 1. Wave height and water level in design 1

No	Hi	Hr	eta_max	eta_min
	(m)	(m)	(m)	(m)
S1-2	0.0433	0.0431	0.0432	0.0001
S1-3	0.0601	0.0635	0.0618	-0.0017
S1-4	0.0600	0.0613	0.0607	-0.0006
S1-5	0.0476	0.0313	0.0394	0.0082
S1-6	0.0478	0.0299	0.0389	0.0090

Table 2.Height of wave and water surface on design 2

Data processing performed for regular waves in the form of waveform profiles actually have higher harmonics in the form of composite waves according to equation 2, the results of running data read with MIKE 21, then in calibration based on each design, followed by extract into composite waveform obtained the incident wave and reflected wave are analyzed by using FFT and Matlab curve fitting obtained by constant A1 B1 A2 B2 so that without using equation 4, 5, 6, 7 and 8 to get the envelope wave of this wave specified Hmax and Hmin then analyzed using equation 9 and 10 followed by an analysis of equations 11 and 12.

B. Analysis of wave height design 1 and design 2

The wave height analysis at each installed sensor distance starts from sensor 1 to 2 in obtaining wave height (Hi1) and reflection wave height (Hr1), sensor 1 to 3 at high wave coming (Hi2) and reflection wave height (Hr2), sensor 1 to 4 at high wave coming (Hi3) and reflection wave height (Hr3), sensor 1 to 5 at get high coming wave (Hi4) and reflection wave height (Hr4) and sensor 1 to 6 in get high data the coming wave (Hi5) and the reflection wave height (Hr5) in Table 1. Then in the analysis using equation 2 we get the wavefront

The result of compilation of water surface elevation data from Fig. 5, at each distance from sensor 1 to 2 and so on obtained wave height (Hi) and reflection wave height (Hr), Max maximum water level (η) Max and minimum water level (η) Min corresponds to table 1.

The result of compilation of water surface elevation data from Fig. 6, at each distance from sensor 1 to 2 and so on got the wave height Hi and reflection wave height (Hr), Maximum water level (η) Max and minimum water level (η) Min corresponds to table 2.Analysis is continued to obtain maximum Maximum water level (η) Max and minimum water level (η) Min using equations 11 and 12 produce as in Tables 1 and 2 for each design.

C. Waveform Formation Envelope design 1

Based on Maximum water table height (η) Max and minimum water level (η) Min for generating incoming waves and reflections forming envelope in Figure 9 of design 1,

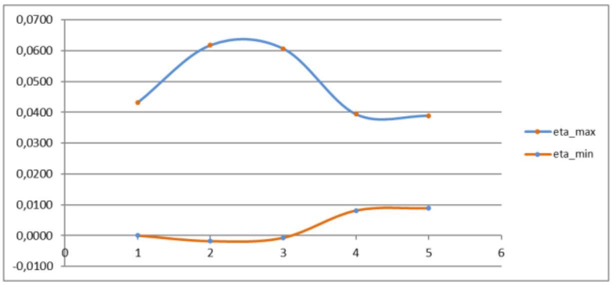

Figure 9. Envelope Wave design 1

Results of envelope waveform design 1, it is known that Hmaximum is 0.0635, and Hminimum is 0.0478, Hi is 0.05565, and Hr is 0.00785 so that the Reflection Coefficient (Kr) is 0.141.

D. Envelope design calculation 2

The result of envelope waveform design 2, it is known that Hmaximum is 0.0635, and Hminimum is 0.0300, Hi is 0.0467, and Hr is 0.0167 so that the Reflection Coefficient (Kr) is 0.3582.

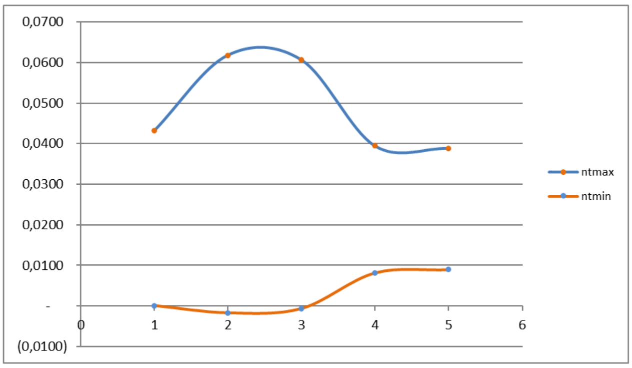

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Figure 9. Envelope Wave design 1

IV. CONCLUSION

Based on the experiments and analysis of wave height data in design 1, the reflection coefficient of 0.141 and design 2 reflection coefficient of 0.3582 means that the coefficient of reflection (Kr) produced by design 1 is smaller than design 2, so it can be concluded that design 1 is more reliable in reducing reflection wave.

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REFERENCES

1. Yuwono N., 2007, Bahan Kuliah Teknik Pantai, Jurusan Teknik Sipil dan Lingkungan FT UGM, Yogyakarta
2. Salamun, 2006, "Penanganan Abrasi Pantai Pasir Mayang". Berkala Ilmiah Teknik Keairan No.1 Th.13-Juli 2006, ISSN 0854-4549 Akreditasi No. 23a/DIKTI/KEP/2004.
3. (S. Neelamani ∗, N. Sandhya, 2003).
4. AllsopdanHettiarachchi, 1988
5. Yuwono N., 1990, "TheStability of Revetment Blockwork Under Wave Action", Ph.D., Thesis, Strathclyde University, Glasgow,UK
6. Murakami, K, Irie, I, and Kamikubo, Y, (1996). "Experiments on Non-
7. Wave-Overtopping Type Seawall," Proc 25th Inter Conf Coastal Eng,
8. ASCE, pp 1840-1851.
9. Verhagen,H.J., et al.2002).
10. CERC, 2006. U.S. Army Corp of Engineers, Coastal Engineering Manual, U.S. Army Corps of Engineers, Washingtong, D.C. http://www.publications.usace.army.mil/USACE-Publications/Engineer-Manuals
11. (Yuwono,N. , 2010).
12. Kountandos. E, Prinos. P and Gironella. X, 2005. Floating Breakwater under regular and irregular wave forcing : reflection and transmission of characteristics. Journal of Hydroulic Research Vol.43,N0. 2, pp. 174-188.
13. Ozeren , Y., 2009. Experimental and Numerical Investigations of Floating Breawater Performance. Ph.D Thesis, The University of Mississippi. USA.https://archive.org/details/CAT31080131
14. MenurutAbdolali et al.,2012:
15. [10]. Ozeren, 2009.
16.]. (Dean & Dalrymple, 1991):
17. Goda Y. and Ippen A. T. 1963. Theoretical and Experimental Investigations of Wave Energy Dissipators Composed of Wire Mesh Screens hydrodynamics Laboratory Report, Dept. of Civil Engineering, Massachusetts Institute of Tecnology, Cambridge, Massachusetts, 1963. https://books.google.co.id/books/about/Theoretical_and_Experimental_Investigati.html
18. http://www.tandfonline.com/doi/abs/10.1080/00221686.2005.9641234
19. (Nalarsih 2015)

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