Breakwater Effectiveness to Reduce Ocean Waves In The Karangantu Fisheries Port, Serang City, Banten Province, Indonesia

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ABSTRACT

The ease of mooring anchorage in a port is influenced by the level of the calm of the waters. The dynamics of wave movement found in coastal areas, especially in the anchorage pool area, are caused by several factors including the influence of wind, currents, tides and the action of ocean waves. For this reason, one of the most important coastal protective structures is Breakwater which is expected to reduce and reduce the effects of ocean waves. This research was conducted in November 2019 at the Karangantu Port of Fisheries (PPN) in Karangantu, Serang Regency, Banten Province. The purpose of this study was to determine the level of effectiveness of breakwater as a shock wave for mooring boat anchors at PPN Karangantu, Banten. This research method uses quantitative analysis based on primary wave height data which is connected with some secondary data, to produce the value of the wave transmission coefficient and the effectiveness percentage of sea wave attenuation. Based on the results of the study showed that the average height of the incident wave was 224.60 cm and the average height of the transmission wave was 169.66 cm. The results of the analysis showed that the average value of the transmission coefficient was 1.32 and the level of effectiveness of the breakwater in absorbing the waves was 24.42%. Based on the value of the effectiveness of the breakwater it can be said that the existing breakwater at the Port of Karangantu, Serang Regency is quite effective in reducing the incident wave action..

Keywords: incident wave; transmission wave; transmission coefficient, wave attenuation effectiveness

INTRODUCTION

The breakwater is a coastal building structure that functions as a protecting area on the coast from wave attacks. The main purpose of building a breakwater is to provide a protected area for loading and unloading ships, to manipulate coastal transportation conditions by trapping the movement of sand particles (Ketabdari, *et al*, 2015). With the construction of breakwaters, it is expected that the strength and wave energy coming from offshore will decrease after reaching the coast so that the activity of ships in the port will be more stable. Breakwater function as a wave damper is expected that the wave height comes before the breakwater will decrease after passing through the breakwater. Thus, the smaller the wave height that passes through the breakwater (transmission wave) compared to the height of the incident wave, it can be said that the breakwater function is effective in absorbing the wave. Thus, the comparison between the transmission wave height and the incident wave height will produce the transmission coefficient (K_t).

The effectiveness of the breakwater depends on the transmission coefficient (K_t) which is affected by several breakwater physics parameters such as the breakwater curtain (which affects the draft breakwater S) and the width of the chamber (Lc). The smaller the value of Kt, the breakwater function is also getting better (Wurjanto, *et al*, 2010). Wave transmission is caused by the presence of a structure that inhibits the wave speed so that some waves are broken and reflected but some will be transmitted through the structure. The height and period of the transmitted wave will be smaller than the incident wave (Gemilang and Kurnadi, 2016).

Breakwater development, especially in the port area, is very much needed so that the mooring activities of the ships at the port will be more secure and stable. One of the breakwaters in Indonesian waters is the Karangantu Fisheries Port, Serang City, Banten Province. Karangantu Fisheries Port is a type B Fishingport in Banten Province. This is since it’s one of the most important capture fisheries centers in Serang City and as a port that supplies most of the fish needs in the Banten Province region. To facilitate ship loading and unloading activities, mooring vessels and other fishery activities, it is necessary to maintain the stability of the waters at the port. Based on physical observations, it shows that the wave height conditions in the Karangantu Fisheries Port pool are stable. But physical observation needs to be supported by data analysis based on related oceanographic parameters. Therefore, it is necessary to analyze the effectiveness of the breakwater to absorb the waves and the extent of the percentage of wave attenuation caused by the breakwater. Thus, this study aims to determine the coefficient of wave transmission and the effectiveness of wave attenuation in the Karangantu Fisheries Port, Serang City, Banten Province.

METHODOLOGY

Time and Location of Research

This research was conducted at Karangantu Fisheries Port, Serang City, Banten Province, Indonesia in November 2019. Primary oceanographic parameter data were taken at hourly intervals starting at 07.00 am -17.00 pm for one month. Secondary oceanographic and meteorological parameters were taken from the Meteorology, Climatology and Geophysics Agency (BMKG, 2019) and the Navy's Hydrographic and Oceanographic Center (PUSHIDROSAL) in November 2019. Data analysis was conducted at the Karawang Marine and Fisheries Polytechnic. The location of the Karangantu Fisheries Port study is shown in Figure 1.

Data

This research was conducted at PPN Karangantu, the data taken in this study are primary data and secondary data. Primary data include data on incident wave height and transmission wave height, as well as tides (tides) of seawater. Data collection on wave height and tidal is done using a scale board in a time series for one month with time intervals every hour starting at 07.00 am-17.00 pm. Secondary data sourced from the Meteorology, Climatology and Geophysics Agency includes seawater velocity, height and direction, wind direction and velocity data and tidal data sourced from the Navy's Hydrographic and Oceanographic Center in November 2019.

Data analysis

Tides Analysis

Data analysis in this study includes tides analysis by knowing tidal harmonic components, then to determine the tidal type Formzahl number values are calculated using the Admiralty method approach, with the following formula (Pariwono, 1989):

$$F = \frac{(O_1 + K_1)}{(M_2 + S_2)} \quad (1)$$

F : Formzahl numbers
O1 : Amplitude of the main single tidal components caused by the pull of the moon
K1 : Amplitude of the main single tidal components caused by the pull forces of the moon and the sun
M2 : Amplitude of the main double tidal component caused by the pull of the moon
S2 : Amplitude of the main double tidal component caused by the tensile force of the sun

Criteria for Formzahl numbers:

$0.00 < F \leq 0.25$: half-daily (semidiurnal / double)
$0.25 < F \leq 1.50$: mixed tide with double type
$1.50 < F \leq 3.00$: mixed tide with a single type
$F > 3.00$: single daily tides

After knowing the components of tidal harmonics, it is used as a basis for calculating sea level elevation. Some components for sea-level elevation analysis are knowing Mean Sea Level (MSL), Highest High Water Level (HHWL), Mean High Water Level (MHWL), Lowest Low Water Level (LLWL), and Mean Low Water Level (MLWL).

Analysis of Wave Transmission Coefficient (K_t)

The transmission coefficient (K_t) is the ratio between the transmission wave height (H_t) that passes through the breakwater structure to the incident wave height (H_i), with the following formula (CERC, 1984)

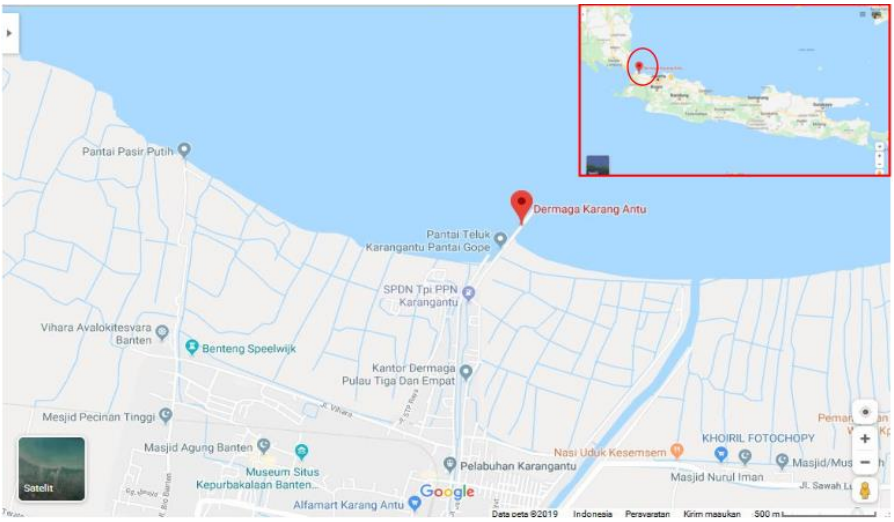

Figure 1. Map of Research Location in Karangantu Fisheries Port (Google map, 2019)

$$K_t = \frac{H_t}{H_i} \quad (2)$$

Thinness:

K_t : Wave transmission coefficient
H_t : transmission wave height through breakwater (m)
H_i : incident wave height (m)

To find out the percentage of breakwater effectiveness in reducing waves, the following formula is used:

$$E_b = \frac{H_i - H_t}{H_i} \; x\, 100\% \quad (3)$$

Thinness:

E_b : breakwater effectiveness (%)
H_t : transmission wave height through breakwater (m)
H_i : incident wave height (m)

RESULTS AND DISCUSSION

Sea Level Fluctuation

Based on the results of the tidal analysis using the Admiralty method it was found that the value of Formzahl in November 2019 was 1.37, which indicates that the tidal type in Karangantu Fisheries port is a mixed tidal type with a tendency to double type, with the highest amplitude based on tidal components of 0.5998 meters. This shows that there are two tides and two tides in a day, which are characterized by the first tidal waveform not the same as the second tidal wave (asymmetric) with a semidiurnal skewed shape, as in Figure 2. The results of tidal analysis by the Admiralty method based on tidal components shown in Table 1. Based on observational data showing that the time of occurrence of tides (tides to tides) and tides (tides to tides) experienced differences. The time needed to change from tidal to tidal conditions is longer than the tidal to tidal conditions. This condition is called tidal asymmetry. This is due to the rotation of the earth which is under the water surface which is bubbling resulting in a periodic rise and fall in sea level in the coastal area. The gravitational pull of the sun also has the same effect but to a lesser degree. Coastal areas experience two tides and two ebbs during the period of just over 24 hours (Priyana, 1994).

Mean sea level (MSL) is an average based on the water level at high tide and low tide, where the MSL value in Karangantu Fisheries port is 0.6 m. Whereas the highest mean water level (MHWL) was 0.82 m and the mean low water level (MLWL) was 0.37 m.

Breakwater Effectiveness

Breakwater construction aims to reduce the action of incident waves towards the coast and or harbor, so that it is expected that the wave height after passing through the breakwater will decrease further. In other words, the smaller the wave height that passes through the breakwater (transmission wave) compared to the height of the incident wave, it can be said that the breakwater function is effective in absorbing the wave.

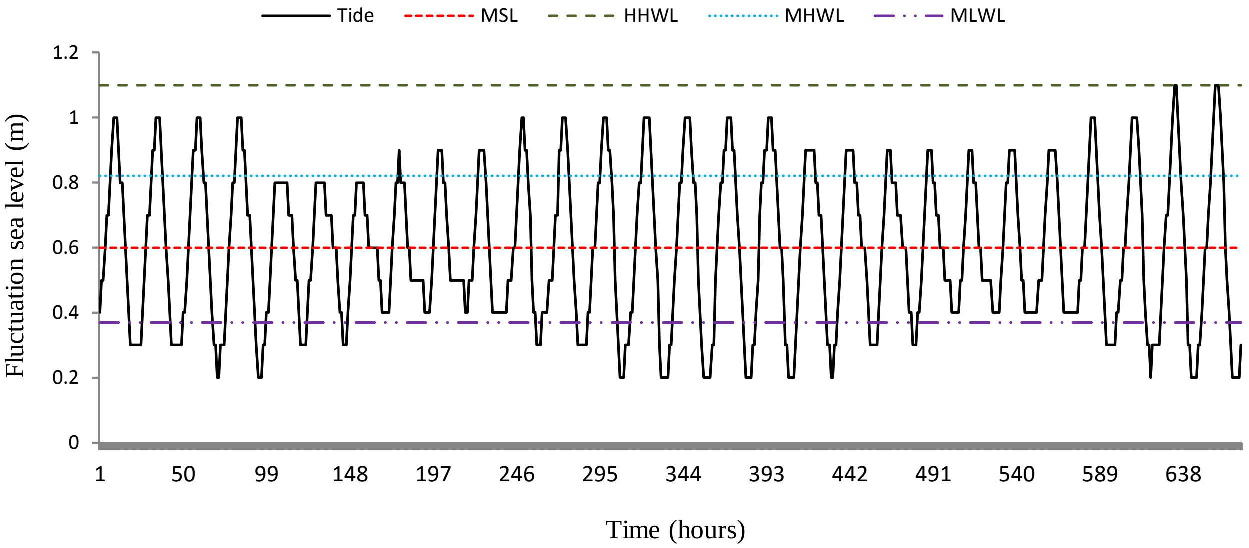

Figure 2. Sea Level Fluctuation in Karangantu Fisheries port on November 2019

Table 1. Components of the Tidal Sea in Karangantu Fisheries port on November 2019

No	Symbol	Parameter			Amplitude (m)	Phase (der/jam)	Phase (rad/jam)
		Z0	A	B			
0	Z0	0,5998			0,5998		
1	M2		0,0505	-0,0415	0,0654	320,5778	5,5951
2	S2		0,1111	0,1214	0,1646	47,5325	0,8296
3	N2		-0,0119	0,0000	0,0119	180,2208	3,1454
4	K2		-0,0986	-0,0681	0,1198	214,6122	3,7457
5	K1		-0,1952	0,0704	0,2075	160,1563	2,7953
6	O1		-0,0402	-0,0996	0,1074	248,0005	4,3284
7	P1		-0,0677	-0,0788	0,1039	229,3351	4,0027
8	M4		0,0004	0,0149	0,0149	88,5511	1,5455
9	MS4		0,0001	0,0101	0,0101	89,1541	1,5560

Thus, the comparison between the transmission wave height and the incident wave height will produce the transmission coefficient (K_t). The effectiveness of breakwater depends on the transmission coefficient (K_t). The smaller the value of Kt, the breakwater function is also getting better (Wurjanto, *et al*, 2010). Wave transmission is caused by the presence of a structure that inhibits the wave speed so that some waves are broken and reflected but some will be transmitted through the structure. The height and period of the transmitted wave will be smaller than the incident wave (Gemilang and Kurnadi, 2016).

The results of measurements of incident wave height and transmission waves are carried out for 9 (nine) days with time intervals every 1 (one) hour. Based on the results of the analysis showed that the average height of the incident waves was 224.60 cm, while the average height of the transmission waves was 169.66 cm. The results of the analysis showed that the average value of the transmission coefficient was 1.32 and the level of effectiveness of the breakwater in absorbing the waves was 24.42%. Based on the value of the effectiveness of the breakwater it can be said that the existing breakwater at the Port of Karangantu, Serang Regency is quite effective in reducing the incident wave action. The results of the analysis of the transmission coefficient (Kt) and breakwater effectiveness (in percent) are shown in Table 2 and Figure 3.

CONCLUSIONS

The main purpose of building a breakwater is to provide a protected area for loading and unloading ships, to manipulate the condition of coastal transportation by trapping the movement of sand particles, reducing the energy and wave height contained at the coast or

Table 2. Results of Analysis of the Effectiveness of Breakwater at Karangantu Fisheries Port

Day	Incident wave height (H_i) (cm)	Transmission wave height (H_t) (cm)	Wave transmission coefficient (K_t)	Reduction percentage (%)
1	219.25	169.02	1.30	22.91
2	225.86	173.94	1.30	22.99
3	233.25	166.86	1.40	28.46
4	230.80	169.83	1.36	26.42
5	225.08	165.66	1.36	26.40
6	219.38	166.02	1.32	24.32
7	216.55	169.83	1.28	21.57
8	233.05	176.77	1.32	24.15
9	218.19	169.02	1.29	22.54
Average	**224.60**	**169.66**	**1.32**	**24.42**

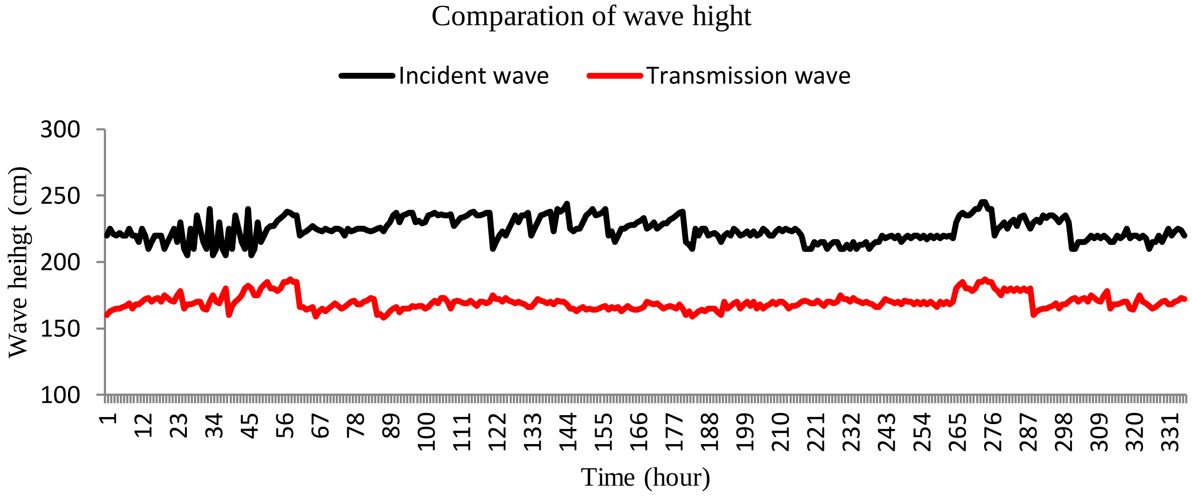

Figure 3. Comparation of Incident Wave Height (H_i) and Transmission Wave Height (H_t)

port so that the activity of ships at the port will be more stable. The results of measurements of incident wave height and transmission waves are carried out for 9 (nine) days with time intervals every 1 (one) hour. Based on the results of the analysis showed that the average height of the incident wave (H_i) was 224.60 cm, while the average height of the transmission wave (H_t) was 169.66 cm. The results of the analysis showed that the average value of the transmission coefficient was 1.32 and the level of effectiveness of the breakwater in absorbing the waves was 24.42%. Based on the value of the effectiveness of the breakwater it can be said that the existing breakwater at the Port of Karangantu, Serang Regency is quite effective in reducing the incident wave action.

Suggestions needed for further research are the need to take oceanographic and other meteorological parameters for numerical modeling in determining the effectiveness of breakwater, and long time series of oceanographic and meteorological parameters are needed so that it can be used as a strong baseline in determining the level of effectiveness of breakwater at a port.

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