The Influence of Coastal Protective Building against Erosion in Sayung Coastal, Demak

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Abstract- In 1980, land conversion of mangrove occur in large numbers since the opening of the Causeway. Flooding and Rob have already begun to be felt since the year 1995 and beginning in 2000 has been sinking a Dukuh village near by Bedono. Year 2000 erosion occurred in district Sayung, Demak and in 2013 the large area known erosion area of 400 – 1300 acres along the coastline. To reduce and overcome the damage done by the shore, re-purposed soft structure (conservation) and hard structure (breakwater). The purpose of this research is to know the influence of the building protective coast against erosion. The method used is the quantitative methods i.e. include survey field and numerical modelling methods. Research results in the form of changes in the rate of erosion in Coastal Sayung

Keywords: *Coastal, Coastal Building, Erosion, Sediment.*

1. Introduction

Coastal areas in Demak which suffered most severely damaged by abrasion and rob are Bedono village where more than 300 hectares over the last 5 years have inundated during high tides. In the village of Bedono, two hamlets have now been drowned by the tidal namely Senik Hamlet and Tambaksari Hamlet, following Pandansari Hamlet threatened to sink (Ristianti, 2016). The threat led to a decline in output and income of farmers farmed due to abrasion of the sea that hit land embankment (Ismail, 2012). In this case, the abrasion can occur due to mangrove vegetation around the beach start marred by human beings. In fact, mangroves or mangrove trees used as anchoring waves and occurrence of preventive removal of the beach which is very useful. Threat of such damage if left untreated will lead to widespread damage to coastal areas. In this situation, the basic habitat and its functions be lost, making the coastal area vulnerable to beach erosion (Hogarth, P. J. 2007).

Coastal damage in areas already developed and dense population can lead to huge losses with the destruction of various public facilities. Necessary protection for the area that suffered damage to the beach. Coastal protection can be done naturally or make the building. On the very low level of significance, e.g. the empty land not inhabited and there are no public facilities, the protection can be done by planting crops that could serve as the protector of such mangroves, beach fires, nipah or other plants; adapted to the conditions of the local land. In the coastal regions that had been very critical, for example, the shoreline is already close to residential and public facilities, the need for the creation of a protective building beaches, such as revetment walls, beaches, breakwaters, of Gróin, and/or with the addition of sand on eroding Beach (sand nourishment) (Triatmodjo, 2014). The aim of this study is to know the influence of coastal protective building against erosion.

2. Methodology

2.1. Area of Study

Area of study had focused in coastal area of Sayung, Demak which has borderline with Semarang at west side and Jepara at east side. There are directly in front of Java Sea. All situations of area which had been discussed depict on Figure 1.

Fig. 1. Area of Study (Source : Data Processing, 2016)

2.2. Hydrodinamic Model

The hydrodynamic model is used to simulate the currents in the research area. In general, a two-dimensional equation of hydrodynamic consists of the main components which include: conservation equations of mass (continuity) and momentum conservation equation. Circulation caused by tidal currents and wind in coastal waters and assume as a homogen water mass by depth. In this model the sea water assume as an incompressible fluid (Ismanto, 2017). The continuity equation is :

$$\frac{\partial \xi}{\partial t}+\frac{\partial U}{\partial x}+\frac{\partial V}{\partial y}=Q_s \qquad (1)$$

The momentum equation is :

$$\frac{\partial U}{\partial t}+\frac{U}{H}\frac{\partial U}{\partial x}+\frac{V}{H}\frac{\partial U}{\partial y}+gH\frac{\partial \xi}{\partial x}+rU\sqrt{\frac{U^2+V^2}{H^2}}+A_h\left(\frac{\partial^2 U}{\partial x^2}+\frac{\partial^2 U}{\partial y^2}\right)=\lambda W_x\sqrt{W^2{}_x+W^2{}_y 2} \qquad (2)$$

$$\frac{\partial U}{\partial t}+\frac{U}{H}\frac{\partial V}{\partial x}+\frac{V}{H}\frac{\partial V}{\partial y}+gH\frac{\partial \xi}{\partial y}+rU\sqrt{\frac{U^2+V^2}{H^2}}+A_h\left(\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}\right)=\lambda W_x\sqrt{W^2{}_x+W^2{}_y} \qquad (3)$$

where :

x, y	: space coordinat grew to the east and north (m)
u, v	: current velocitu in x and y (m/s)
U	: transport in x direction (m^2/s)
V	: transport in y direction (m^2/s)
t	: time (s)
ξ	: elevation from sea water level from mean sea level (m)
g	: gravity (m/s^2)
H	: Real depth = h + z (m)
h	: fixed depth (m)
r	: friction coefficient
A_h	: eddy frictionn coefficient (m^2/s)
λ	: wind friction coefficient
Wx, Wy	: Wind Speed in x and y (m/s)
Q s	: debit (m^2/s).

2.4. Sediment Transport Model

Modeling of sediments distribution is carried by the method of numerical simulation based on the equation formula Adveksi – Dispersion (DHI, 2012) used to obtain the concentration of suspended sediment distribution.

$$\frac{\partial \bar{C}}{\partial t} + u\frac{\partial \bar{C}}{\partial x} + v\frac{\partial \bar{C}}{\partial y} = \frac{1}{h}\frac{\partial}{\partial x}\left(hD_x\frac{\partial \bar{C}}{x}\right) + \frac{1}{h}\frac{\partial}{\partial y}\left(hD_y\frac{\partial \bar{C}}{y}\right) + Q_L C_L \frac{1}{h} - S_c \quad (1)$$

where :

$\bar{C}$ = Average concentration of depth (g/m^3)
u, v = Average flow velocity depth (m/s)
D_x, D_y = Dispersion coefficient (m^2/s)
h = Depth (m)
S_c = Rate of deposition or rate of erosion (g/m^2/s)
Q_L = Source discharge per unit horizontal area (m^3/s/m^2)
C_L = Concentration of debit (g/m^3)

Calculation of deposition rate estimation (S_D) using the approach of Krone (DHI, 2012).

$$S_D = W_S C_b P_d \quad (2)$$

$$P_d = 1 - \frac{\tau_b}{\tau_{cd}} = \tau_b \leq \tau_{cd} \quad (3)$$

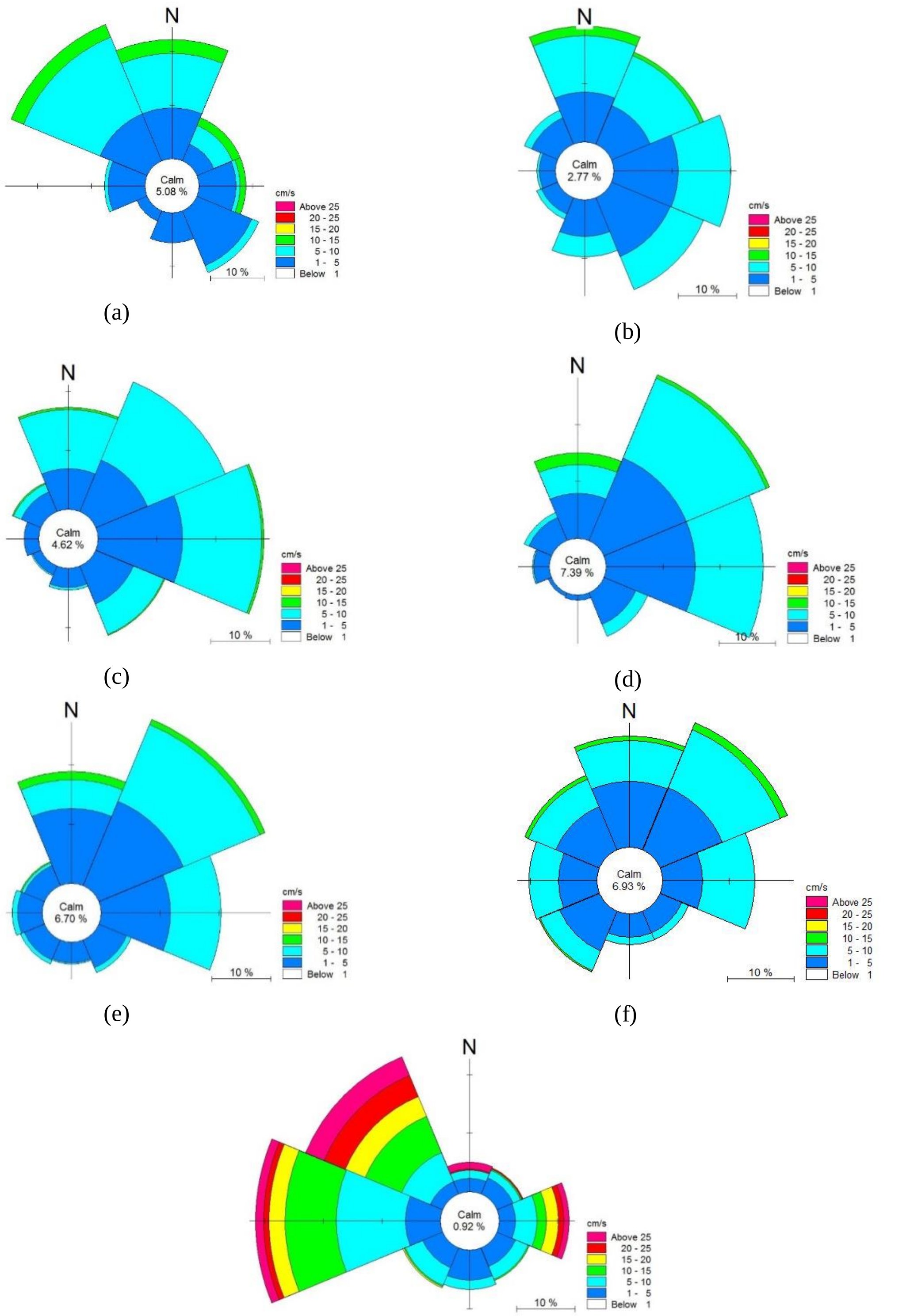
where :
W_S = Deposition speed (settling) (m/s)
C_b = Concentration near bed (Kg/m^3)
P_d = Probability of deposition
τ_b = Bed shear stress (N/m^2)
τ_{cd} = Critical bed shear stress for deposition (N/m^2).

The results of modeling the distribution of sediment deposition rates and analyzed from erosion. The value indicates the level of the rate of deposition of sediment deposition in every second of it. Whereas, the value indicates the level of erosion rate of erosion/sediment removal every second of it. By knowing the value of deposition and erosion, then it can be analysed any areas that could potentially occur sedimentation and will lead to superficiality.

3. Result and Discusion

3.1. Current Speed and Direction

The movement of sea currents in the waters of Sayung varies at each depth. The predominant direction of the movement of sea currents is to the northeast (22,5^o – 67,5^o) to Southeast (112,5^o – 157,5^o). The average speed on the entire water column between 4,17 cm/s – 13,2 cm/s, minimum speed 0,0 cm/s – 0,5 cm/s and the maximum flow speed is 39,8 cm/s. Presented by the following figure.



(g)

Fig. 2. Currentrose of depth a) Cell 1 (7,0 – 8,0 meter); b) Cell 2 (6,0 – 7,0 meter); c) Cell 3 (5,0 – 6,0 meter); d) Cell 4 (4,0 – 5,0 meter); e) Cell 5 (3,0 – 4,0 meter); f) Cell 6 (2,0 – 3,0 meter) g) cell 7 (1,0 – 2,0 meter) Tanggal 3 Juni 2016 – 6 Juni 2016 (Source : Data Processing, 2016)

3.2. Wave Height and Period

The results of the data field analysis is known the value of significant wave height (Hs), significant wave period (Ts) and the minimum and maximum values of the two parameters. The value of average Hs 0,10 m, the value of the maximum of 0,31 m Hs and Hs a minimum of 0,024 m. While the value Ts average of 3,96 det, Ts maximum of 6,3 det and Ts a minimum of 3,6 sec.

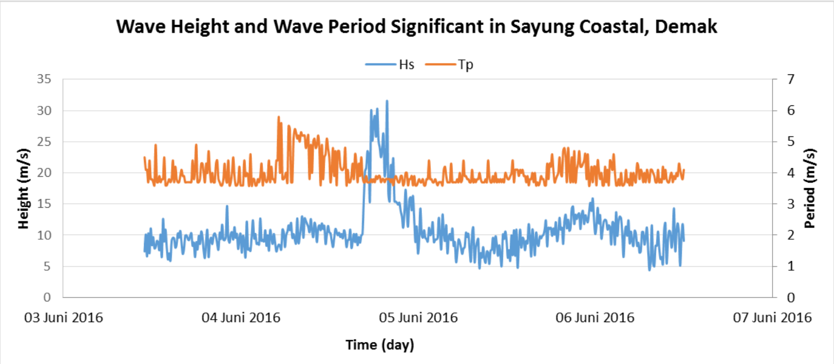


Fig. 3. Wave Height and Period Significant (Source : Data Processing, 2016)

3.3. Tidal

The value of sea water elevation was obtained by BIG reference at Semarang station in June 2016 (Table 1). Tidal observation for 30 days obtained a constant tidal (Table 2).

Table 1. Tidal Components Value June 2016

	So	M2	S2	N2	K1	O1	M4	MS4	K2	P1
A (cm)	145.71	7,19	7,30	3,77	47,96	5,05	0,98	0,14	1,97	15,82
g^0		-76,53	37,73	204	37,73	240,22	255,75	115,22	54,26	82,61

Table 2. Tidal Harmonic Constants on June 2016

F (Formhzal)	1,595	Mixed tide prevailing diurnal
HHWL	193,47	
HWL	160,22	
LLWL	78,20	
LWL	131,22	
MSL	145,72	

Tide Gauge and BIG tidal observed data are compared to obtain the same trend. In summary presented in Figure 4 below.

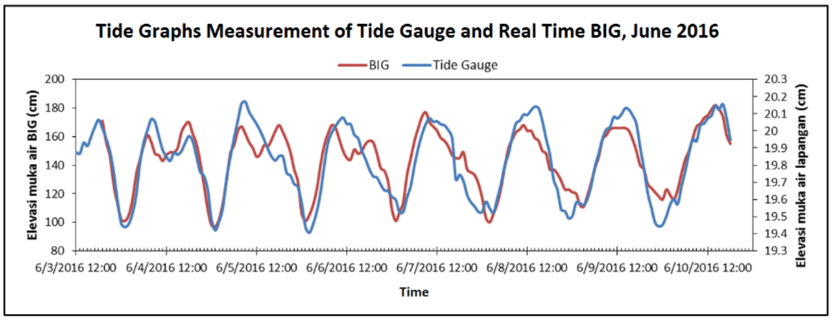


Fig. 4. Tide Graphs Measurement of Tide Gauge and Real Time BIG
(Source : Data Processing, 2016)

3.4. Sediment Transport Model

Mathematical simulation of sediment yield in the East is divided into 4 tidal conditions i.e. flood toward ebb, lowest ebb, ebb toward flood, and highest flood. Simulation results presented in the following figure.

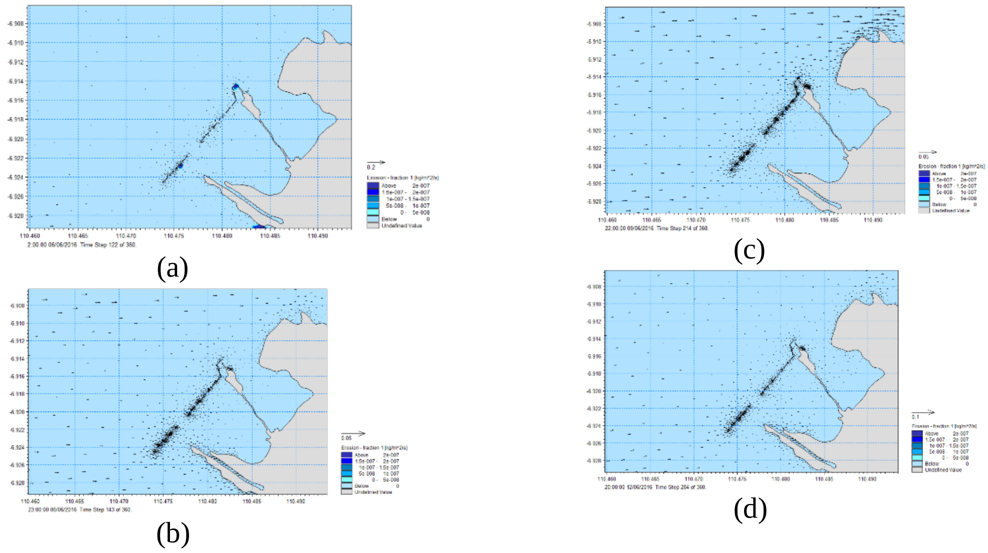


Fig. 5. The pattern of sediment transport in (a) flood toward ebb (b) lowest ebb (c) ebb toward flood (d) highest flood (Source : Data Processing, 2016)

4. Conclusion

Current velocity affects sediment concentrations because their interactions result in different concentrations of sediment concentrations at the bottom of the waters (Cartier & Hequette, 2015). The dominant current direction at a depth of cell 1 (7.0 to 8.0 meters) is to the Northeast and East with the frequency of occurrence of 30.49% and 20.32%. The dominant current velocity is 1 cm / s - 5 cm / s with an incidence frequency of 60.05%, while the maximum current velocity is 10 cm / s - 15 cm / s with an incidence frequency of 2.54%.

Sedimentary movements that slowly alter coastline conditions are a sediment transport mechanism that is directly affected by waves and currents (Lu et al, 2015). Estimated sediment transport and associated with seasonal variations can be obtained from pre-season wave data. On a large scale will lead to the evolution of the coastline (Splinter et al, 2012).

Based on the model results, erosion occurs from the left to the mainland in the direction of the dominant currents of the Northeast and East. Sediments passing through the breakwater and crashing the breakwater result in a buildup / sedimentation around the coastal shelter, which means that the coastal shielding building is able to trap the sediment, thus reducing the occurrence of abrasion.

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