Assessment Of Building Tools Of Spouse Breakers In The Aspect Of Oceanography Hydro In Coastal Waters Demak

Gentur Handoyo, Purwanto, Denny Nugroho Sugianto, Siti Maisyarah, Baskoro Rochaddi, Elis Indrayanti, Sri Yulina Wulandari

Abstract: Since 2011, Central River Region Pemali Juana under the Ministry of Public Works built a breakwater around Morosari, Pandansari and Tambaksari region, which is included in Bedono village, Sayung District, Demak District. However, this structure still needs to be re-examined, because the structure that was often called by the local people as “tahu – tahu” had not functioned optimally. This study aims to evaluate how this breakwater should be built, both in terms of location and elevation of the structure. This research consist of primary data which is wave data, and secondary data which is RBI map, tidal data, wind data, and data of structure’s design. Measurement of wave data used ADCP Sontek Argonout placed at coordinates 060 52' 41,34 " Southern Latitude and 1100 26' 53,31" Eastern Longitude at a depth of 12 meters, for 5 days (23-27 July 2017) with a recording interval of 10 minutes. The method used in this research is quantitative. The calculation analysis used 11 years of forecast data (2007-2017) using SMB method and tidal calculation with Admiralty method. Based on the data analysis of forecast data of all seasons, the value of breaking wave height (Hb) ranged from 0,354 – 0,638 m, breaking wave depth (db) ranged from 0,417 – 0,752 m. According to structure design data, the break water is built at a depth of 0,6 m, so the building is considered optimal for breaking the wave. The results of the wave run-up calculation ranged from 0,388 – 0,687 m, while the value of h-ds ranged from 0,153 – 0,206 m. The run-up value is greater than the value of h-ds, as the result the building encounter overtopping in each season. Based on the calculation of the peak elevation design, the break water structure should be built at a peak elevation of 3,18 m or more so that the building can function optimally.

Index Terms: SMB, Overtopping, peak elevation, Bedono.

1 INTRODUCTION

One of the areas in North Coast of Central Java the most difficult to repair is the beach in the district Sayung Demak. Subdistrict Sayung located at latitude 06^0 55 '23, 3 "LS and 1100 28 '36.4" E, with an area of 7869 ha area (Bappeda, 2005) More than 300 hectares over the past 5 years have been flooded during high tides. In the coastal area there are 4 villages that are threatened by abrasion, namely Bedono Village, Surodadi Village, Sriwulan Village and Timbulsloko Village (Bappeda,2000; Ondara et al, 2016). The village that is currently the most severely damaged is Bedono Village, even the two hamlets in the village that are now robbed are Senik Hamlet and Tambaksari Hamlet, Pandansari Hamlet which is threatened by tides. If it is not treated immediately, it is feared that in the next few years the tidal water will arrive at the Semarang - Demak Pantura route (Bappeda, 2000 Therefore, since 2011, the Balai Pemali Juana River Region under the Department of Public Works has built a Wave Breaker (APO) around the Bedono Village area.

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The study sites are located in Morosari, Pandansari and Tambaksari hamlets, which are administratively located within the Bedono Village area, Sayung District, Demak Regency. The construction of a coastal building in Demak waters which serves to reduce erosion is then developed with various types of buildings (Kristiningsih et al., 2018; Sugianto, et al., 2019). However, it still needs to be reviewed, the article of buildings often referred to by locals as "tahu - tahu" is not functioning optimally. There are still many people who feel restless with high waves that still plagues the waters. Some conditions, this building has run over water (overtopping). This condition causes the waves behind the APO to remain high enough to disrupt fishing vessel activities. An evaluation of how APO buildings should be built in terms of the elevation of the building tops, will be studied in this thesis. This research was conducted on July 23 to 27 2017. The research location is located in the waters of Bedono, Demak with coordinates 6 ° 51 '50.10 "- 6 ° 56' 58.50" South and 110 ° 26 '20.18 "- 110 ° 31 '48.47 "East (Figure 1).

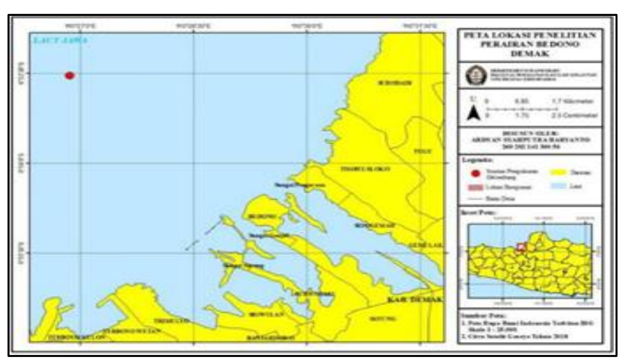

***Figure 1**. Study Area*

2. MATERIAL AND METHODS

2.1 The Research Area

The research material consists of data and tools used to obtain data and process data. The data used consists of primary data and secondary data. Primary data used are wave data taken in the field in time series for 5 days when the dominant wind causes waves, its processing uses the Sverdrup Munk Bretschneider (SMB) method which is a wave forecasting method using wind data.

While the secondary data used is supporting data from relevant agencies. Secondary data used are:

1. Bumi Indonesia Demak Map from BIG Scale 1: 25,000
2. Tidal data for July 2017 obtained from BMKG Semarang
3. Semarang Region's wind data for eleven years (2007-2017) obtained from the OGIMET website
4. Demak Watershed bathymetry map obtained from the Development and Management of Jratunseluna Water Resources, which is now renamed Pemali Juana River Basin (BBWS).
5. Detailed Data on Demak Coast Safeguard Design obtained from the Development and Management of Jratunseluna Water Resources, which is now renamed Pemali Juana River Basin Agency (BBWS).

The method used in this study is a quantitative method, because the research data in the form of numbers and analysis using statistics with data collection techniques carried out randomly or randomly and data collection using research tools (Sugiyono,2009).

2.2 Data Collection Methods

The determination of the sampling location is done by using the purposive sampling method. The purposive sampling method is determining the location of observations that can represent the condition of the observation area as a whole or have certain considerations (Sugiyono, 2009). Data collection points are done using GPS. Retrieval of wave data is carried out in the field using ADCP placed at the observation station with coordinates 060 52 '41.34 "South and 1100 26' 53.31" East at a depth of 12 meters. Measurements were taken for 5 days (July 23-27 2017) with a recording interval of 10 minutes. Recorded data are wave height (H) and wave period (T) data. The direction of the incident wave is based on processing secondary data (wind) using Windrose software. The wind data used for wave forecasting is using wind data from OGIMET downloaded via the website www.ogimet.com which is OGIMET measurement data with the Ahmad Yani measurement station Semarang. OGIMET wind data is a measurement wind data that has a duration of 3 hours for 11 years (2007 - 2017), this data can support the calculation of waves to determine the level of wave run-up that will occur in the Wave Breaker building. The bathymetry map is used to find the beach slope value (m). The bathymetry map of Demak waters was obtained from Jratunseluna Water Resources Development and Management, which has now been renamed Pemali Juana River Basin Agency (BBWS). Building detail data used for overtopping analysis is data consisting of building dimension data, building structures and wave break building elevations obtained from the Development and Management of Jratunseluna Water Resources, which is now renamed the Pemali Juana River Basin Center (BBWS).

2.3 Data Processing Methods

Field wave measurement data that has been done, obtained the value of wave height (H) and wave period (T), then the data is processed to obtain significant waves. Significant waves are representative waves that represent the actual conditions using the average of the top 33% of data from existing data. The wind data used in this study is wind measurement data on land, because the study location is at sea, it is necessary to first convert to become wind data at sea (4). The relationship between the wind over the sea and the wind over the nearest land is given by :

$$R_L = \frac{U_W}{U_L} \qquad (1)$$

the graph contained in Figure 2. The graph is the result of research conducted in Great Lake, United States. The graph can be used for other regions, except if the area has very different characteristics. Wind data used for wave forecasting are wind data at sea level at the generation site measured directly above sea level or measured from land close to the location of wave forecasting. Measurement and recording of wind data include wind direction, wind speed, and wind duration (Triatmodjo, 1999).

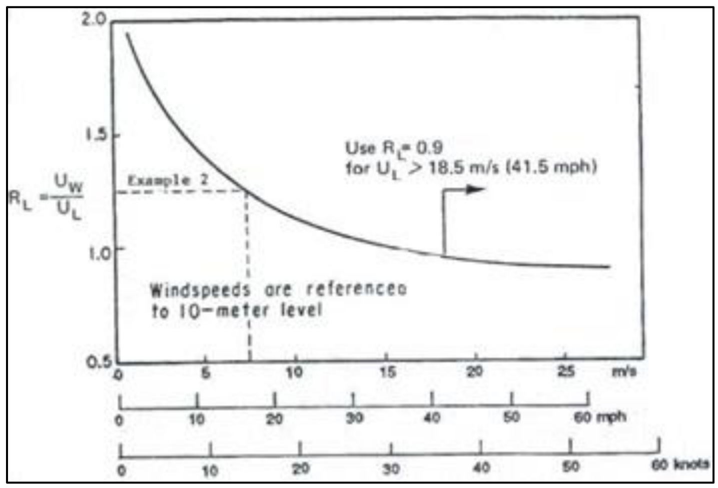

Figure 2. *Relationship between Wind Speed at Sea and on Land (CERC, 1984; Ratu, et al., 2015).*

In wave forecasting using wind data is done using the SMB method. The following are the steps carried out in the SMB method. Calculate the length of fetch on the map RBI to consider the scale. The observation location is at the wave measurement station which is then used as a fetch length reference point (Mulyadi et al., 2015). fetch is an area within a radius of water that surrounds a location where in that area the wind blows constantly from various directions to that point. Fetch directions can come from any direction, the amount of which can be calculated as follows:

$$Feff = \frac{\sum Xicos\alpha}{\sum cos\alpha} \qquad (2)$$

Where is:

Feff : Fetch

Xi : The length of the fetch measured from the wave observation point to the end of the fetch

α : Deviation on both sides of the wind direction, the area represented by one main direction is the area of the stretching -22.5^0 left side of the main direction to $+22.5^0$ right side of the main direction. The magnitude of the interval at each fetch length measured is equal to 5^0.

Calculation of wave height and significant wave period is calculated using calculations:

For wind speeds starting from U> 0 knots :

$$Hs = 0{,}0016\ U2 + 0{,}0406\ U \quad (3)$$

For wind speeds starting from U> 0 knots

$$Ts = 0{,}15\ U + 2{,}892 \quad (4)$$

Where:

Hs: Significant wave height (meters)
Ts: Significant wave period (seconds)
U: Wind speed (knots)

2.4 Validation Data

Data validation is done to compare two or more data. In this

$$CF = \frac{1}{N}\sum_{n=1}^{N}\frac{|D_n - M_n|}{\sigma_D} \quad (5)$$

$$\sigma_D = \sqrt{\frac{1}{N}\sum_{n=1}^{N}(D_n - \bar{D})^2} \quad (6)$$

where :

CF : cost function
σ_D : Deviation Standard
N : amount data
n : data to-n
D : field data
M : simulation data

The performance criteria are used when the CF is less than 1, it can be said very good data, if the CF between 1-2 is good, if the CF between 2-3 still be considered and when the CF more than 3 then, said data deficient (George et al., 2010). Representative wave data Hs and Ts from forecasting results are used to calculate the wave characteristics with the following calculation (CERC, 1984 in Triatmodjo, 1999):

$$H = H0 \times Kr \times Ks \quad (7)$$

where :

H0 : deep sea wave height
H : refraction wave height
Kr : coefficient of refraction
Ks :coefficient of shoaling

The beach slope value (m) can be determined using a bathymetry map, namely by calculating the comparison between the difference in depth with the horizontal distance between 2 points (Triatmodjo, 1999).

$$Slope = (\text{Different in Depth})/(\text{Horizontal distance}) \quad (8)$$

The forecast wave data is then used to calculate the breaking wave height (Hb) and the breaking wave depth (db). the calculation of breaking waves. The results of the calculation of the characteristics of waves and breaking waves, then used to calculate the design water level and calculation of wave run-up in determining the elevation of the building's peak (Ongkosongo and Suyarso, 1989 in Lisnawati et al., 2013).

$$H = Ks \times H'0 \quad (9)$$

Tidal data obtained from Semarang BMKG is then processed using the Admiralty method to obtain tidal harmonic constants which include S0, M2, S2, K1, O1, N2, K2, P1, MS4, and M4. The Admiralty method is a tide data calculation method of 15 or 29 piatan (Ongkosongo and Suyarso, 1989 in Lisnawati et al., 2013). The plan's water level elevation consists of several parameters including tides, tsunamis, wave setups, wind setups and sea level rise due to global warming (CERC, 1984 in Triatmodjo, 1999).

Look for Sea Level Rise (SLR) values in 2017 using graphs. Find the value of the plan for sea level elevation by adding up all parameters of the wave setup, wind setup and SLR calculated from HHWL.

wave setup value (Sw)

$$S_w = 0{,}19\ \left(1 - 2{,}82\ x\ \sqrt{(H_b/gT^2)}\right)H_b \quad (10)$$

wind setup value(Δh)

$$\Delta h = F\,c\,\frac{V^2}{2gd},\ F_y = F \sin\alpha,\ V_y = V \sin\alpha \quad (11)$$

where :

Δh : water level elevation due to wind (m)
F : fetch (m)
F_y : fetch length in the direction perpendicular to the beach (m)
c : constanta ($3{,}5 \times 10^{-6}$)
V : wind speed (m/s)
V_y : wind speed in the direction perpendicular to the beach (m/s)
d : depth (m)
g : acceleration of gravity (9,81 m/s^2)

for wave run-up calculations. The wave run-up calculation uses the Saville approach. The steps in calculating the value of wave run-up are as follows(Triatmodjo, 1999):

1. The wave height at the building location is used in the calculation of Irribaren numbers.
2. The Irribaren number is used to find the run-up value by entering it into the run-up and run-down waveform graphs.
3. Calculation of run-up value is measured from the plan water level on the cross section of the Wave Breaker.

The results of the run-up calculation are then used to study overtopping conditions by using equation (CERC, 1984 in Triatmodjo, 1999).

$$0 \le (h - ds) < Ru \quad (12)$$

where:

h : high breakwater
ds : the depth of the base of the breakwater building
Ru :wave run-up

Determination of overtopping or non-overtopping wave categories, using conditions when the value (h – ds) is greater than the run-up value (Ru), can then be categorized in non overtopping and vice versa if the value (h – ds) is smaller than the run- up (Ru) then categorized as overtopping.

3 RESULT AND DISCUSSION

3.1. Windrose Condition

The rose of the wind serves to make it easier to analyze the direction and speed of the wind. Wind data are interpreted with windrose every season for eleven years (2007-2017). This stage serves to determine the dominant wind direction and grouping based on direction and speed. That maximum daily wind data for 11 years serves to calculate the height and wave period that occurs in the waters (Fagherazzi et al, 2009). Wind measurements are taken at land, while the formula used, is for aquatic wind conditions, so wind data will be transformed from land wind data to sea surface wind data (Cardone, 1969). Based on the results of the analysis, it can be seen that in the west season, the dominant wind comes from the northwest, while in the transition season I, the east season and the transition season II .wave a dominant direction from the southeast. Even though in the east season, the transition season I and the transition season II have the same dominant direction, the frequency of wind events from each season is different. These results are consistent with Sugianto, et al (2019) with those who state that the wind speed blowing in the west season will be stronger compared to the other 3 seasons. The dominant winds come from the south.

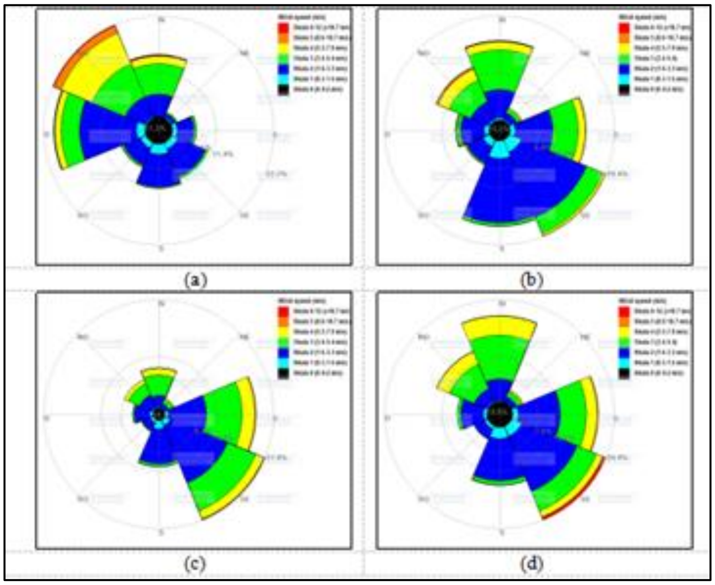

***Figure 3**. Wind roses every season (West Season, East Season, Transition Season I, Transition Season II) from 2007-2017.*

3.2. Wave Forecasting

The results of wave forecasting analysis, obtained values of significant wave height (Hs) and significant wave period (Ts) in each season. Based on wave forecasting using wind data, the values of Hs and Ts are obtained. It is known that in the western season the value of Hs is 0.596 meters with a Ts value of 4.110 seconds. Transition season I Hs value of 0.464 meters with a Ts value of 3.749 seconds. The east season has a Hs value of 0.313 meters with a Ts of 3.203 seconds. Transition season II obtained an Hs value of 0.473 meters with a Ts value of 3.792 seconds. It can be seen that the highest Hs value occurs in the west season and the lowest Hs in the east season. These Hs and Ts values are used for the calculation of the next wave. However, to prove the wave of forecasting results can represent the actual conditions in the field, it is necessary to first validate the field data.

***Table 1.** Significant Wave Height and Significant Wave Period Results of Forecasting of All Seasons*

Season	Hs (m)	Ts (s)
West	0,596	4,110
Transition I	0,464	3,749
East	0,313	3,203
Transition II	0,473	3,792

3.3. Field Wave Measurement

Field wave measurements are carried out to validate the waveform values from the forecasting, whether these values can be used for further analysis or not. Field wave measurements are obtained for wave height (H) and wave period (T) values used to validate forecasting data. Next, a significant wave height (Hs) and a significant wave period (Ts) values are obtained from the field measurements presented in Table 2. Based on the results of the analysis of the wave measurements for 5 days, a significant wave height (Hs) of 0.22 meters with periods significant wave (Ts) of 4.10 seconds. This value is then used as a reference data for validation between forecasting waves and waveform measurements.

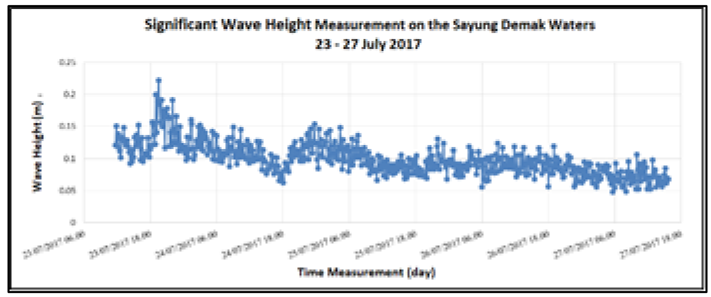

***Figure 4**. Field wave height measurements*

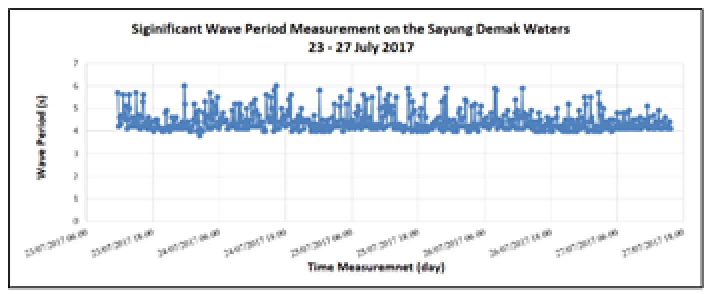

***Figure 5**. Field wave period measurements*

***Table 2**. Significant Wave Height and Period of Significant Wave Results of Field Measurements*

Parameter	Value
Hs (m)	0,22
Ts (s)	4,10

3.4. Validation Data

Data validation aims to determine the suitability of field data with forecasting or model data. If the validation value generated is good, then the forecasting data can represent the actual conditions. George (2010) states that if the value of CF is less than 1, it can be said the data is very good, if the value of CF between 1-2 said well, if the value of CF between 2-3 can still be considered and if the value of CF is more than 3 then , the data is said to be not good. It is known that the CF value of wave height (H) of 0.052 and the value of the wave period (T) of 0,021 this indicates that the data used is very good, because it qualifies the value of CF is less than 1, so that data forecasting results can represent actual field conditions and can be used for further analysis.

***Table 3**. Results of Field Measurement and Forecasting Validation Results*

Parameter	CF	Information
H (m)	0,052	Very Good
T (s)	0,021	Very Good

Figure 7. Tsunami Vulnerability Index Map

3.5. Characteristics of Forecasting Wave

The value of wave height and wave period of each season for eleven years has been validated, then used to calculate wave characteristics. SMB is a method of forecasting waves in the sea, so as to know the wave height at a certain depth, need to pay attention to the effects of refraction and the effects of silting. The wave characteristics forecasts of all seasons are presented in full in Table 4. The direction of incoming deep sea waves (α0) each season is assumed by looking at the dominant wind direction of the windrose. However, in certain seasons the dominant wind direction is from land, so it is assumed to be the direction of the second dominant wind or other dominant wind direction that comes from the sea to determine the direction of the coming waves. The direction of the waves coming will affect the refraction value, that is how much the effect of the refraction on the waves that spread to the beach.

***Table 4**. Wave characteristics of all seasons*

Parameter	All Season Forecasting Data			
	West	Transition I	East	Transition II
d (m)	12	12	12	12
Hs (m)	0,596	0,464	0,313	0,473
Ts (s)	4,110	3,749	3,203	3,792
L0 (m)	26,352	21,926	16,004	22,432
C0 (m/s)	6,412	5,848	4,997	5,916
d/L0	0,455	0,547	0,7498	0,535
d/L	0,458	0,548	0,7499	0,536
Water Classification	Transition	Deep sea	Deep sea	Deep sea
L (m)	26,186	21,882	16,002	22,377
C (m/s)	6,380	5,856	5,003	5,923
sin α	0,274	0,876	0,963	0,876
α (0)	15,919	61,140	74,271	61,140
Kr	0,9998	1,0022	1,0084	1,0022
Ks	0,985	0,994	0,999	0,993
H (m)	0,587	0,462	0,315	0,471

The value of the wave height at a certain depth (H) that has been influenced by the refraction factor and the superficial effect (shoaling) is then used for the analysis of the breaking wave which consists of the height of the breaking wave (Hb) and the depth of the breaking wave (db). In addition, analyzes were also carried out for maximum burst wave depth (db max) and minimum burst wave depth (db min) in all seasons. Based on the results of data processing with a beach slope value of 0.002, it can be seen that at the study site has the characteristics of a breaking wave with a high wave breaking value (Hb) ranging from 0.354 meters to 0.638 meters. Breaking waves occur at depths ranging from 0.417 meters to 0.752 meters. The db max and db min values are used as a reference for the construction of the breakwater, which is between the db max and db min values to function optimally. Max db values range in depth between 0.577 meters to 1.040 meters and db min range in depth between 0.302 meters to 0.544 meters. Thus, it is intended that the building of a breakwater can be built at a depth of between 0.302 meters - 1.040 meters in order to function optimally. According to Jratunseluna Development and Management of Water Resources (2005) breakwater in Bedono waters, Demak is at a depth of 0.6 meters. This value is in the range of depth 0.302 m - 1.040 m, so that the building of a breakwater is considered optimal for breaking waves.

3.6. Tidal

Based on the tidal graph for July 2017 it can be seen that Semarang waters have two tides a day and two tides with a different height and period. This is in accordance with the type of mixed tidal inclines to a double daily (mixed tide prevailing semidiurnal). In addition, an analysis was carried out using the Formzhal value. Based on the calculation of the Formzhal value, a value of 1,127 is obtained so that Semarang waters are a mixed tidal type that tends to double daily.

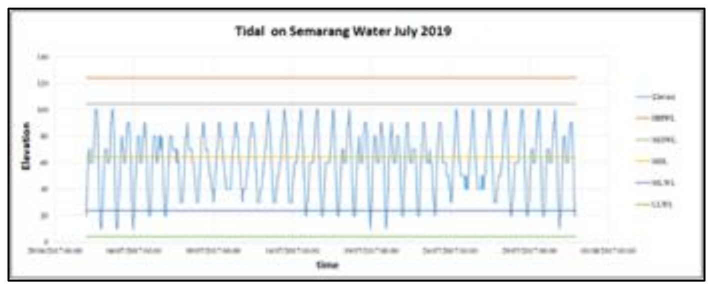

***Figure 6.** Semarang Tides in July 2017.*

3.7. Plan Surface Elevation

Water level calculated by the basic plan HHWL value which is then added to the value of the wave setup (Sw), wind setup (Δh) and sea level rise (SLR). The SLR value is determined for 2017 using an estimated graph of sea level rise due to global warming, which is 0.13 m for each season.

***Table 6**. Plan Surface Elevation Throughout the Season*

Parameter	Plan Surface Elevation			
	West	Transition I	East	Transition II
HHWL (m)	1,24			
Sw (m)	0,12	0,09	0,07	0,10
Δh (m)	0,5			
SLR (m)	0,13			

3.8. Run-up Wave

The plan's water level elevation value, then used as a basis for calculating the wave run-up value. The wave run-up values are obtained by using the Irribaren numbers plotted using the wave run-up and run-down graphs. The next wave run-up value is used as a reference for overtopping condition analysis. Based on the analysis results obtained the value of wave run-up in the west season experienced the largest run-up, which is equal to 0.687 m; followed by the transition season II of 0.577; transition season I of 0.566 m; and the smallest in the east season is 0.388 m. Building depth values (ds) are calculated based on the planned sea level elevation. Based on the results of the analysis obtained the value of h-ds in the west season of 0.153 m; transition season 1 of 0.177; east season of 0.206; and the transition season II of 0.175. The study of wave overtopping applies several conditions, namely if the value of (Ru < h - ds), then there is non overtopping. Conversely, if the value (Ru > h - ds) then overtopping occurs. All seasons, the run-up value is greater than the h-ds value, so it can be seen that the building is overtopping in each season.

***Table 8**. Run-up of Waves and Overtopping Conditions*

Parameter	Plan Surface Elevation			
	West	Transition I	East	Transition II
Ir	3,350	3,453	3,579	3,452
Ru/H	1,170	1,225	1,230	1,225
Ru (m)	0,687	0,566	0,388	0,577
h – ds (m)	0,153	0,177	0,206	0,175
Wave Condition	Overtopping	Overtopping	Overtopping	Overtopping

The wave run-up value is calculated on the basis of the design water level elevation value or DWL (Design Water Level) which consists of several parameters including tides, wave setup, wind setup and water level rise due to global warming (Sea Level Rise). Water level calculated by the basic plan HHWL value. The value is then used as a basis for calculating the run-up value of the wave. The elevation of this important coastal structures used in planning. Buildings on the ground consist of piles of concrete cubes that are not neatly arranged. The structure is almost like a pile of broken stones, so in plotting Irribaren numbers on the run-up and run-down graphs of waves, using charts for broken stones. This neatly arranged concrete cube aims to increase the value of the building's roughness, so that the run-up value can be reduced, and the incoming waves can be broken optimally. Based on the analysis results obtained run-up values ranged from 0.388 m to 0.687 m. The west season experiences the biggest run-up with a value of 0.687 m. This is related to the high wave height in the west monsoon, so that when it comes to coastal protection structures it experiences a quite high run-up. Next wave run-up characteristics are used for overtopping condition analysis. According to the Development and Management of Water Resources Jratunseluna (2005), the elevation of the top of the building contained in the field is at an elevation of +2.10 meters from LLWL or by +2.14 meters from the bottom. Building depth values (ds) are calculated based on the planned sea level elevation. Based on the analysis of calculations, it is known that the Ru value is greater than h - ds in each season, so it can be concluded that the building has overtopping in each season. The condition of overtopping or non overtopping functions for beach building planning, there are some buildings that are allowed to occur overtopping, but some are not allowed to experience overtopping. This will later affect the resilience of the building in protecting the area behind it. If the building is overtopping, the wave energy reduced by the building is less compared to non-overtopping buildings. In addition, if a beach building overtopping, then the reduced waves will be far less than buildings that are not allowed to experience overtopping. So for efficiency problems in reducing waves, the coastal buildings that are not overtopping are more efficient than buildings that are overtopping. However, non-overtopping buildings usually require quite expensive costs compared to buildings that are allowed to overtopping.

3.8. The Peak Elevation Building

The height of the building's peak in the field is at an elevation of +2.10 meters from LLWL in accordance with Jratunseluna Water Resources Development and Management (2005) or as much as +2.14 meters from the bottom.

***Table 9**. Elevation of Building Peak Results Calculation of All Season*

Season	Peak elevation (m)	Plan elevation (m)
West	+2,14	+3,18
Transition I		+3,03
East		+2,82
Transition II		+3,04

The structure of the waveforms with different parameters according to the calculation is shown in Figure 7 to Figure 10. Wave Breaker in Bedono waters experiences overtopping in each season, this will affect the ability of buildings to reduce incoming waves. Thus, need to do a study on peak elevation of the building which should be implemented. Peak elevation of buildidgs are safe to apply to this APO analyzed each season. Peak elevation plan with a high added freedom of 0.5 meters to provide more space in the event of extreme waves. The planned elevation in the west season is +3.18 m; transition season I of +3.03 m; east monsoon +2.82 m; and the transition season II of +3.04 m. The highest elevation value is used as a reference in planning a building as representative of the other conditions. So, it can be concluded that this building will be safe if it is at a peak elevation of +3.18 meters or more

4 CONCLUSION

Based on the research that has been done, the following conclusions can be obtained: The breaking wave height (Hb) in the Bedono Demak waters ranges from 0.354 meters to 0.638 meters. The value of the breaking wave depth (db), ranges from 0.417 meters to 0.752 meters.

1. The value of wave run-up in Bedono Demak waters ranges from 0.388 meters to 0.687 meters.
2. Wave Breaker Building in Bedono Demak waters overtopping in all seasons.

5 ACKNOWLEDGMENT

We would like to thanks to Ministry of Research, Technology and Higher Education which gave us funding from Fundamental Funding of Directorate of Research and Community Services, Directorate of General Research and Development, Ministry of Research, Technology and Higher Education as the agreement letter of Research Implementation assignment.

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