Analysis of Soil Retaining Wall from Geosynthetic for Sea Reclamation to Become a New Land in the Beach

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Keywords: Reclamation, Retaining Wall, Geosynthetic, Geobag.

Abstract: Reclamation is a business to get land that was covered by water into dry land and to be used as useful land in accordance with its purpose. This reclamation can be carried out on lands that are on the coast, swamps, and offshore. In this study, land reclamation is intended as a port development area so that land requirements are in accordance with the port development plan on the coast. The location of this research is in the southern area of Ketapang Regency, West Kalimantan, which is 18 km from the Ketapang City Center. This regency does not yet have a coastal port, all of its ports are in the river, which certainly often occurs siltation due to sedimentation. Land reclamation is carried out to pursue the depth of the waters in accordance with the berthing of ships to be anchored so that no trestle construction is needed but by reclaiming it, it can save the cost of building the structure. The research method used in this study, by analyzing wind data as a reference for wave generation and calculating the wave deformation that occurs, bathymetry data as a reference for water depth, tidal data is intended as one in the design of the retaining wall height, estimated loading above the reclamation structure land, and the external forces that occur on the retaining wall. The design of the retaining wall uses geobags in a stacked manner, has a total height of 6.3 m buildups from sea level to the deepest seabed and forms a trapezoidal structure with a trapezoid peak width of 5.09 m (3 geobag lines) and a trapezoid base width 26.47 m (11 lines/stack). The size of Geobag 2 x 1.5 x 0.6 m. Geobag size is obtained from the calculation of the effect of waves on the geobag structure. So that the weight is determined by the required volume size and then the size is further reviewed by the effect of soil pressure due to the embankment for reclamation held by the geobag structure by analysis of overturning, sliding, and bearing capacity permitted exceeded.

1 INTRODUCTION

1.1 Background

Ketapang Regency is one area that has abundant natural resource potential, as a support in the distribution of goods, this area needs a port for goods and passengers loading and unloading facilities. This Regency actually has a port on the Pawan River, but as time goes by, the shipping lanes to and from the port experience siltation due to sedimentation. This area needs a new port that is no longer in a river but on the coast.

Ketapang Regency itself in general has a fairly long coastline, but to be used as a port with a specific ship weight needs to be modified beach conditions. Based on the results of a feasibility study in 2012 with 3 port locations, the selected ones were located in the southern area of Ketapang Regency (KRTD, 2012) but in those areas they have shallow water depths, to obtain appropriate water depths, about ± 1 km from the shoreline. So in this study, to solve the problem we use the option to reclamation the portland because the cost is more economical and materials will be taken from nearby locations.

In this reclamation, geosynthetic is used as one of the structural planning materials. Geosynthetic used is the type of geobag. Geobag is used as a retaining wall of land reclamation. The geobag material used is from NAUE Germany whose geobag output material is SECUTEX®H or SECUTEX® SOFT ROCK

Catherine, L., Pratikto, W., Suntoyo, ., Tua Simatupang, J. and Bachtiar, V.
Analysis of Soil Retaining Wall from Geosynthetic for Sea Reclamation to Become a New Land in the Beach.
DOI: 10.5220/0010287602710280
In *Proceedings of the 7th International Seminar on Ocean and Coastal Engineering, Environmental and Natural Disaster Management (ISOCEEN 2019)*, pages 271-280
ISBN: 978-989-758-516-6

which is a special fiber nonwoven geotextile for hydraulic engineering.

1.2 Formulatiom of the Problem

1. How to determine the dimension of retaining wall?
2. How to determine the dimension of geobag?
3. How does the influence of the stability of the external forces of the geobag as a retaining wall of land reclamation?

1.3 Restricting the Problem

1. Land area for land reclamation plan is 372.417,5 m x 389.011 m
2. Land reclamation location in in the southern area of Ketapang Regency, West Kalimantan, which is 18 km from the Ketapang City Center
3. Planning a retaining wall in the form of geosynthetic geobag types using data:
   a. Wind data was obtained from BMKG Ketapang in the years 2004 - 2013
   b. Bathymetry data of land reclamation area with the direct survey to the field as a reference for water depth
   c. Tidal data was obtained from a 15-day field survey as a reference for the reclamation land retaining wall height
   d. Soil type data were obtained from field samples and examination tests at the Soil Mechanics Laboratory, Faculty of Engineering, Tanjungpura University, as a reference to soil types in filling geobags
4. Does not calculate the strength of the external geobag material used

2 THEORY

2.1 Reclamation

Reclamation is a job/business utilizing areas or land that are relatively useless or still empty and watery into useful land by draining. For example in coastal areas, swampy areas, offshore / in the sea, in the middle of a wide river, or in a lake. Reclamation is carried out following the procedures since the planning stages (pre), implementation and development (process), and its use (post) both above and or below the reclaimed land (PWD, 2008).

The reclamation of large amounts of land in the future may be needed to meet the food and adequate space requirements of the developing population. Land reclamation for housing, industry, or recreation requires ecological, hydrological, and geological data in addition to technical analysis. Geologists can contribute to the planning of reclamation of floodplains, wetlands, landmines, and geologically dangerous areas. Geological data can be used to predict the environmental impacts deposited by a reclamation project (McComas, 1972). From a commercial perspective, reclamations have been used for airport expansions and new airports as well as port expansions and new ports. Residential and recreational developments along waterfronts have been successfully constructed on reclaimed land (Duan et al, 2016).

2.2 Retaining Wall

Retaining walls are structures used to provide stability for earth or other materials at their natural slopes. In general, they are used to hold back or support soil banks and water or to maintain a difference in the elevation of the ground surface on each of the wall sides. Also, retaining walls are often used; in the construction of buildings having basements, roads, or bridges when it is necessary to retain embankments or earth in a relatively vertical position. Retaining walls are commonly supported by soil (or rock) underlying the base slab, or supported on piles; as in case of bridge abutments and where water may erode or undercut the base soil as in waterfront structures.

The conventional retaining walls can be divided into four types, gravity, semi-gravity, cantilever, and counterfort retaining walls. Stability analysis of retaining wall is influenced by loads which burden the structures. This load in the mechanic analysis can be known as force. This force mainly can be divided into two kind, lateral pressure and vertical pressure. Lateral pressure itself comprises of soil and water pressure. There are two types of lateral soil pressure, namely active and passive pressure. The active pressure commonly located behind the retaining wall as the slope which wants to retain. On the other hand, the passive pressure in front of the retaining wall is an additional force on the retaining wall to maintain the slope from collapse. If there is no soil in front of the retaining wall, there will not any passive pressure. Moreover, the lateral pressure also includes water pressure if there is water existence in slope. Furthermore, the vertical pressure of retaining wall structure is influenced by the load above the slope (Sari et al, 2020). Design Considerations of Gravity as follows ; Scope, Limit State Design, Partial Loading and Material Factors, Load Combinations and Factors for Stability, Load Combinations and Factors for Strength of Components, Live Loads, Earthquake Loads, Wind Loads, Hydraulic Loads, Drained v Undrained Parameters, Capacity Reduction Factors, Soil Analysis Model, Active Pressure, Pressure at Rest, Passive Pressure, Bearing Failure, Sliding Failure, Overturning, Global slip, Foundation Material, Lean Back (CMAA, 2013)

2.3 Geosynthetic

Geosynthetics can be defined as planar products manufactured from polymeric material, which areused with soil, rock, or other geotechnical engineering-related material as an integral part of a manmade project, structure, or system. Geosynthetics are widely used in many geotechnical, environmental, and hydraulic applications related to groundwater quality and control. Geosynthetic types include ; Geotextiles, Geomembranes, Geogirds, Geosynthetic Clay Liners, Geocomposite Sheet Drains, Geocomposite Strip (Wick) Drains, Geocells. (Zornberg and Christopher, 2007).

NAUE geosynthetic is geosynthetic materials from Germany (NAUE, 1967). The innovations of NAUE are leading the geosynthetic industry into the future. We offer project-specific product development, geotechnical engineering support, and provide solutions to complicated challenges, simplifying your project. Geosynthetic types, among others:

- Geosynthetic Clay Liner Bentofix® – the “Bentonite liner”
- Secutex® multifunctional geotextile
- Geomembrane CARBOFOL® the HDPE liner
- Secugrid® geogrids for soil stabilisation and reinforcement
- Combigrid® geogrids with integrated nonwoven geotextile component
- Secumat® erosion control mat
- SECUDRAIN® WD
- SECUTEX® SOFT ROCK

2.4 Geobag

Geotextile bag or geobag, a geosynthetic product made of polyester; polypropylene or polyethylene has been used world wide for protecting riverbanks and hydraulic structures from severe scouring and erosion. The use of sand filled geobags underwater in erosion protection work is being popular due to its cost-effectiveness, availability, and easier implementation. Some recent studies support that its technical efficiency is similar or sometimes better than the use of hard material (Wahed et. al, 2011).

A durable and effective alternative is a scour protection system with sand-filled geotextile containers Secutex® Soft Rock. The dynamic interaction between waves and waterfront soils and structures complicates hydraulic engineering. Beachfront requires longterm protection, and the solutions must be flexible, durable, and minimize the impact on marine environments. Lightweight, robust nonwoven geotextiles enable these engineered installations to encapsulate sand (including local fill) for the creation of long-term performing bags, containers, and tubes. The impact of a sand container solution made of Secutex® Soft Rock with respect to the lifecycle consideration is only a fraction of the impact of a conventional solution in an offshore scours protection system. Secutex® nonwovens are filter-stable and extremely robust. A special two-layered nonwoven composite is available, which features an integrated surface protection layer made from rough fibers for exposed or covered designs. The available sizes and mass per unit area of Secutex® nonwoven geotextile containers enable flexibility in infill selection and installation methods. Bag size and arrangement depending on the application and expected hydrodynamic conditions. Secutex® Soft Rock standard design approaches are available. Secutex® Soft Rock Applications:

- Sea walls, beach and dune revetments
- Groynes
- Submerged breakwaters and jetties
- Scour protection for waterfront structures, walls, bridge piles and offshore wind turbines
- Offshore cable protection
- Erosion control in flowing waters
- Filling of washed out material in dams
- Soil stabilisation in dams (NAUE, 1967)

3 METHOD

1. Analyze wind data on land from BMKG of Ketapang Regency Airport:

   a. Calculate wind speed at 10 m elevation

$$U_{(10)} = U_y \left(\frac{10}{y}\right)^{1/7} \quad (1)$$

   b. Calculate the wind factor

   c. Calculates the percentage of wind direction and is made into windrose

   d. Calculating Wind Tension Factor

The wind tension produces a wave generator at sea with a comparative approach to existing wind data on land (converting wind on land to wind at sea):

$$U_A = 0{,}71U^{1{,}23} \tag{2}$$

e. Calculating Effective Fetch (Feff)

$$F_{eff} = \frac{\sum Xicos\alpha}{\sum cos\alpha} \tag{3}$$

where :
F_{eff} = Fetch average effective
X_i = the length of the fetch segment measured from the wave observation point to the final of the fetch
α = deviation on both sides of the wind direction, using an increase of 6^0 to an angle of 42^0 on both sides of the wind direction

f. Calculate the wind reset period
g. Calculate periods and wave heights in the deep sea

2. Analyze Wave Deformation
   a. Calculate the value of H_0
   Determine H_0 based on Hs obtained from previous calculations.
   b. Calculate wave period (T)
   Determine the Period (T) also based on previous calculations that have been carried out a repeat period with the approximating method
   c. Calculate the length of a wave in the deep sea (L_0)

$$L_0 = 1{,}56T^2 \tag{4}$$

   d. Calculate the value of the coefficient of refraction (Kr)

$$K_r = \sqrt{\frac{cos\alpha_0}{cos\alpha}} \tag{5}$$

   e. Calculate the value of the Shoaling coefficient (Ks)

$$K_s = \sqrt{\frac{n_0.L_0}{nL}} \tag{6}$$

   f. Calculate wave height (H'_0)

$$H'_0 = K_s.K_r.H_0 \tag{7}$$

   The concept of sea wave height in this equivalent is used in the analysis of breaking waves which include the height and depth of the breaking waves
   g. Calculate the slope of the seafloor (m)

$$m = \frac{s}{d} \tag{8}$$

   where :
   s = distance from deep shoreline
   d = deep sea
   h. Calculate the breaking wave height and depth on formula and graphs

$$H_b = \frac{d_b}{1{,}28} \tag{9}$$

3. Analyze the average high and low tide for 15 days and plot it into the elongated figure, according to the area of land and the depth of the waters from the bathymetry survey results.
4. Analyzing load on land reclamation
5. Analyzing the dimensions of the geobag
   a. The weight of the geobag content, using the calculation of the stability of the protective stone with the Hudson formula
   b. The geobag dimension uses the volume weight formula with a trial and error process

   Wall height is known from the depth of the waters to be reclaimed to the height of the original land. The slope of the retaining wall is adjusted to the determination of the contents of the geobag grains against waves. Geobag heaps from the bottom of the waters to the height of the plan. Can be the width of the top (a) and bottom width (B), the retaining wall of the soil. Apply to AutoCAD to make it easier to adjust the installation/stacking of geobags.
6. Analyzing Soil Pressure around the site
   a. Calculate the coefficient of active soil pressure (Ka) (Bachtiar, 2010) :

$$K_a = \tan^2\left(45 + {}^{\phi}/_{2}\right) \tag{10}$$

   b. Calculate soil pressure due to load on the structure

$$\sigma = q.K_a \tag{11}$$

   c. Calculate soil pressure without ground water level

$$\sigma = \gamma_d.H.K_a \tag{12}$$

d. Calculate soil pressure for ground water level

$$\sigma = \gamma_s . H . K_a \qquad (13)$$

e. The active forces on retaining walls:

1. Due to the load on the structure (distributed load)

$$P_a = H . \sigma \qquad (14)$$

2. Due to the presence and absence of ground water level

$$P_a = \frac{1}{2} H . \sigma \qquad (15)$$

f. The force center point:

1. Due to the load on the structure (distributed load)

$$\frac{H}{2} \qquad (17)$$

2. Due to the to the presence and absence of ground water level

$$\frac{H}{3} \qquad (18)$$

g. Calculate the height and distance at each midpoint of each geobag layer from the base to the top and determine the number of geobags of each layer.

h. Calculate each force in each layer, in each plane due to soil pressure. The force due to the load on the structure (distributed load)

$$F = P_a \qquad (19)$$

7. Analyze the stability of external forces (Bachtiar, 2010) :

a. Overturning

$$FS_{overturning} = \frac{\sum M_R}{\sum M_0} \geq 2 \qquad (20)$$

b. Sliding

$$FS_{sliding} = \frac{(\sum F_R)}{\sum F_d} > 1{,}5 \qquad (21)$$

c. Bearing Capacity Failure

$$FS_{bearingcapacity} = \frac{q_{ult}}{q_{maks}} > 3 \qquad (22)$$

4 RESULT AND DISCUSSION

The results of the image as an area that will be reclamation in the form of breadth and depth of water. The area to be reclamation is adjusted to the land plan for multipurpose buildings, warehouses, offices and container land, which is 37,241, 75 m x 38,885 m. The depth of the waters at the far end of the land area is approximately 6 m below the highway elevation. (Figure 1)

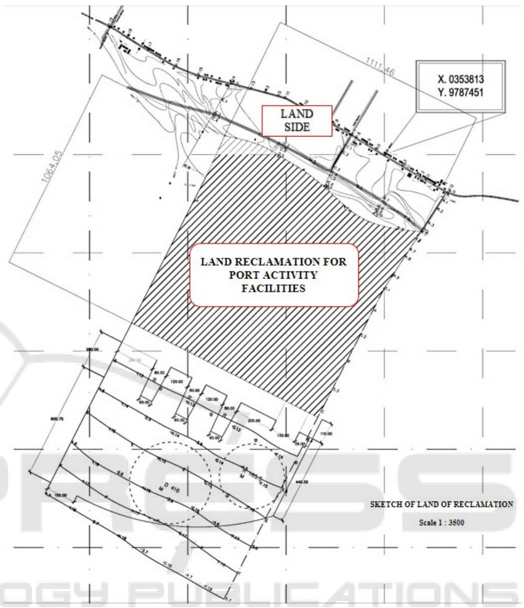

Figure 1: Land Reclamation Plan.

4.1 Wind Data

Analysis of wind data on land from BMKG Ketapang Airport with a height of 9 m above sea level. In planning structures at sea must use wind data above the sea. Therefore, the data is reprocessed to get the largest wind speed direction in the percentage scale, effective fetch, period, and wave height from the deep sea (Figure 2).

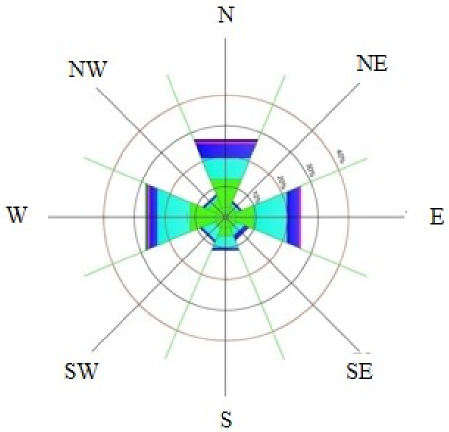

Figure 2: Windrose.

Table 1: Percentage of Speed and Direction of Wind.

Direction	North	North East	East	South East
0 - 10	0,00%	0,00%	0,00%	0,00%
10 - 20	10,00%	0,83%	6,67%	0,83%
20 - 30	7,50%	0,83%	11,67%	2,50%
30 - 40	5,00%	0,83%	4,17%	1,67%
40 - 50	0,83%	0,00%	0,83%	0,00%
50 - 60	0,00%	0,00%	0,00%	0,00%
60 - 70	0,00%	0,00%	0,00%	0,00%
70 - 80	0,00%	0,00%	0,00%	0,00%
80 - 90	0,00%	0,00%	0,00%	0,00%
90 - 100	0,83%	0,00%	0,83%	0,00%
Σ	24,17%	2,50%	24,17%	5,00%
South	South West	West	North West	Σ
0,00%	0,00%	0,00%	0,00%	0,00%
3,33%	0,83%	9,17%	3,33%	35,00%
4,17%	4,17%	11,67%	0,83%	43,33%
0,83%	0,83%	2,50%	0,83%	16,67%
0,00%	0,00%	0,83%	0,00%	2,50%
0,00%	0,00%	0,00%	0,00%	0,00%
0,00%	0,00%	0,00%	0,00%	0,00%
0,00%	0,00%	0,83%	0,00%	0,83%
0,00%	0,00%	0,00%	0,00%	0,00%
0,00%	0,00%	0,00%	0,00%	1,67%
8,33%	5,83%	25,00%	5,00%	100,00%

So, the biggest wind direction comes from the West by 25%, after that from the north and east by 24.17% as given in Table 1 and Figure 2).

Measurement of wind data is carried out on land at the airport. The measurement of the wind is not yet suitable for wave forecasting, then the wind data needs to be corrected. After that, it is converted into a wind stress factor every year as given in Table 2.

Table 2: Wind Tension Factor Average (knots).

No	Year	X (U_A)
1	2004	25,02
2	2005	23,32
3	2006	35,92
4	2007	20,32
5	2008	19,91
6	2009	23,87
7	2010	27,83
8	2011	22,00
9	2012	30,65
10	2013	27,28

The determination of waves with certain return periods requires wave data in a long enough measurement period. Representative data for several years of wind observation can be used to estimate the expected wave is equaled or exceeded once in T years and the wave is known as the return wave period, T or annual wave period , T (Pratikto et al., 2014). There are 3 methods used to calculate the wave return period, namely Normal, Gumbell and Log Person distribution as given in Table 3.

Table 3: Wave Return Period.

	2 year	5 year	10 year	
Normal	25,61	29,78	31,96	Knots
Gumbell	4,27	9,99	13,78	Knots
Log Person Type III	16,04	3,04	1,72	Knots
Average (U_A)	15,31	14,27	15,82	Knots
Average (U_A)	7,87	7,33	8,13	m/d
Duration	4	4	4	jam
Wave Height (Hs)	0,65	0,59	0,68	m
Wave Period (T)	3,75	3,55	3,75	s
Fetch	27	26	27	km
Wave Length (L_0)	21,97	19,69	21,97	m
d/L_0	0,8194	0,9143	0,8194	m

4.2 Wave Deformation

Calculation of wave deformation is done to get the wave breaking from the deep waters towards to the shoreline, the calculation results is given in Table 4, Table 5 and Table 6 for the 2 years, 5 years and 10 years return periode prediction, respectively.

Table 4: Wave deformation calculation results for the 2 years wave return period.

d(m)	H_0(m)	T(s)	L_0(m)	Kr	Ks	H_0'(m)	m(slope)	H_0'/gT^2
20	0.65	3.75	21.98	1.00	1.00	1.54	0.001	0.011
18	0.65	3.75	21.95	1.00	1.00	0.65	0.093	0.005
16	0.65	3.75	21.91	1.00	1.00	0.65	0.074	0.005
14	0.65	3.75	21.86	1.00	1.00	0.65	0.056	0.005
12	0.65	3.75	21.78	1.00	0.99	0.65	0.186	0.005
10	0.64	3.75	21.61	1.00	0.98	0.65	0.048	0.005
8	0.62	3.75	21.24	0.99	0.95	0.65	0.053	0.005
6	0.59	3.75	20.39	0.98	0.90	0.65	0.085	0.005

Table 5: Wave deformation calculation results for the 5 years wave return period.

d(m)	H_0(m)	T(s)	L_0(m)	Kr	Ks	H_0'(m)	m(slope)	H_0'/gT^2
20	0.59	3.55	20.00	1.01	1.01	1.71	0.001	0.014
18	0.60	3.55	20.00	1.00	1.00	0.60	0.093	0.005
16	0.60	3.55	20.00	1.00	1.00	0.60	0.074	0.005
14	0.60	3.55	19.99	1.00	1.00	0.60	0.056	0.005
12	0.60	3.55	19.98	1.00	1.00	0.60	0.186	0.005
10	0.60	3.55	19.93	1.00	0.99	0.60	0.048	0.005
8	0.59	3.55	19.76	1.00	0.97	0.61	0.053	0.005
6	0.57	3.55	19.22	0.99	0.92	0.62	0.085	0.005

Table 6: Wave deformation calculation results for the 10 years wave return period.

d(m)	H_0(m)	T(s)	L_0(m)	Kr	Ks	H_0'(m)	m(slope)	H_0'/gT^2
20	0.68	3.75	21.98	1.00	1.00	0.68	0.001	0.005
18	0.68	3.75	21.95	1.00	1.00	0.68	0.093	0.005
16	0.68	3.75	21.91	1.00	1.00	0.68	0.074	0.005
14	0.67	3.75	21.86	1.00	0.99	0.68	0.056	0.005
12	0.67	3.75	21.78	1.00	0.98	0.68	0.186	0.005
10	0.65	3.75	21.61	1.00	0.96	0.68	0.048	0.005
8	0.63	3.75	21.24	0.99	0.93	0.67	0.053	0.005
6	0.58	3.75	20.39	0.98	0.88	0.66	0.085	0.005

The wave deformation analysis involved the shoaling, the refraction and the breaking waves. Then, the relationship among the deep-sea wave height (H'_0), the incident angle of the wave (α), and the wave height in the deep sea (H = 0.78d) is used to determine the breaking wave.

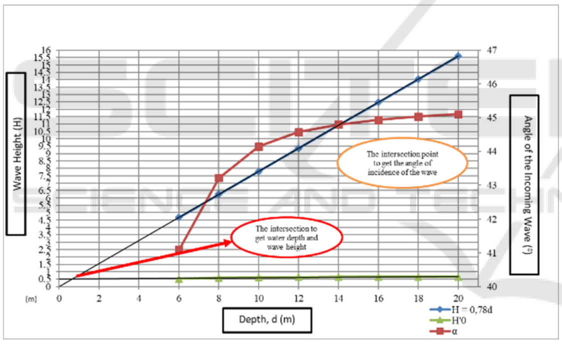

Figure 3: The relationship among the deep-sea wave height (H'0), the incident angle of the wave (α), and the wave height in the deep sea (H = 0.78d) for the 2 years of wave return period.

Figure 3 showed the results of the conditions in which waves propagate from the deep sea and break with wave height approaching the coastline, producing a value; sea depth (d) = 0,7 m, wave height (H_0 ') = 0,5 m and angle of the incident wave (α) = 42^0 for the 2 years of wave return period.

For the 5 years of wave return period prediction condition, waves propagate from the deep sea and break with wave height approaching the coastline within the water depth (d) = 0,2 m, wave height (H_0 ') = 0,2 m and angle of the incident wave (α) = 46^0, while within the water depth (d) = 0,9 m, wave height (H_0 ') = 0,6 m and angle of the incident wave (α) = $42{,}5^0$, for the 5 years of wave return period prediction condition as given in Figure 4 and Figure 5, respectively.

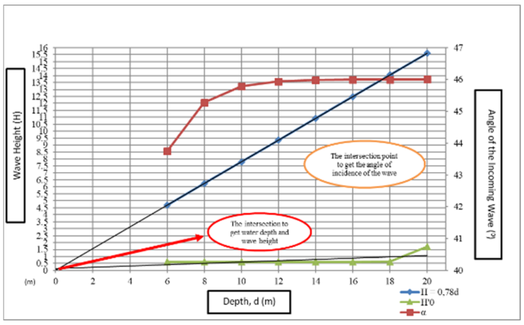

Figure 4: The relationship among the deep-sea wave height (H'0), the incident angle of the wave (α), and the wave height in the deep sea (H = 0.78d) for the 5 years of wave return period.

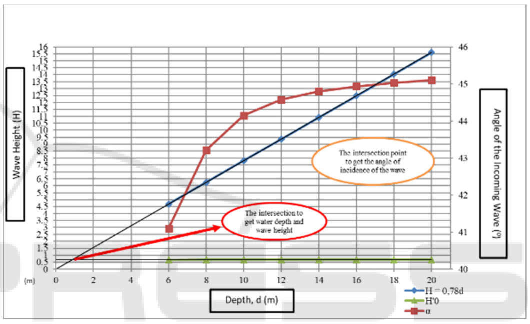

Figure 5: The relationship among the deep-sea wave height (H'0), the incident angle of the wave (α), and the wave height in the deep sea (H = 0.78d) for the 10 years of wave return period.

Table 7: The calculation results of the structural load on the reclamation area.

1	Live Load of Container 6 @30,480 kg (uk.13,716 x 2,438 m2)				=	6,58	kg/m2	=	2,70	kg/m
	A	=	33,44	m2						
	W	=	30,48	kg						
	Wide	=	2,44	m						
2	Live Load of Container Truck 45 (W=45000kg, A = 2,75 x 9,0 m2)				=	1.818,2	kg/m2	=	661,16	kg/m
	A	=	24,75	m2						
	W	=	45.000	kg						
	Wide	=	2,75	m						
3	Live Load off Mobile Crane (W=79560 kg, A=5,79 x 5,79 m2)				=	2.376	kg/m2	=	410,35	kg/m
	A	=	33,52	m2						
	W	=	79.650	kg						
	Wide	=	5,79	m						
4	Live Load of Building Structure				=	3.050	kg/m2	=	3.050	kg/m
	Live Load of Office Floor (@3 tingkat)	=	250	kg/m2	=	750	kg/m2			
	Live Load of Floor and Meeting Room	=	400	kg/m2						
	Live Load of Ladder	=	300	kg/m2						
	Live Load of Warehouse, Tools Room and Archive	=	400	kg/m3						
	Live Load Parking Floor Building Lower	=	800	kg/m2						
	Live Load Parking Floor Building Level Other	=	400	kg/m2						
5	Dead Load of Paving Block (Rectangle 10x10,5x21, W =3,7kg)				=	167,80	kg/m2	=	1.598,10	kg/m
	A	=	0,02	m2						
	W	=	3,70	kg						
	Wide	=	0,11	m						
6	Dead Load for Heap Sand Paving Block				=	91,06	kg/m2	=	0,09	kg/m
	γsand	=	1.517,72	kg/m3						
	Thick of Heap	=	0,06	m						
	Wide of Land Heap	=	1.061,00	m						
	TOTAL				=	8.259,53	kg/m2	=	5.722,39	kg/m

Source of Value : (ILRB, 1983)

4.3 Tidal

Based on the tidal observations data, it can be obtained the characteristics of water level in the form of a formzal value related to the highest tides and lowest tides that occur. The elevation of the original land in the form of a highway is used as a benchmark for an elevation of 0.00 meters. From the tide analysis, it is obtained that the higest water level is -1.00 m and the lowest water level is -3.20 m. So that the height of the reclamation pole can be planned to be parallel to or higher than the elevation of the highway because the highest tidal elevation is still 1 meter below the road elevation.

4.4 Load

This reclaimed land will be used as land for the construction of containers, offices, warehouses and passenger waiting rooms. In planning for the construction of the structure, a total load on the soil is required so that the structure does not collapse. The structural load planning to be built on the reclamation area is given in Table 7.

4.5 Geobag

The geobag material used is the German NAUE type Secutex® Soft Rock (NAUE, 1967). To determine the dimensions of the geobag, the type of soil used to fill into the geobag should be known in advance. In this paper, the type of soil is given in Table 8 obtained from the laboratory analysis of Soil mechanics laboratory belong to Engineering Faculty, Tanjungpura University. After that, the grain weight of the geobag is calculated using the stability of the protective stone.

Table 8: Type of soil.

Subsoil	Depth (m)	ϕ^0	γ_d (vol.kering)		γ_{sat}	
			(t/m^3)	(kg/m^3)	(t/m^3)	(kg/m^3)
3	3 - 3,5	11,31	1,23	1.116	1,673	1.517,72

A classic formula for the stability of rocks/stones under breaking waves at a sloping surface is given by the Hudson formula. The weight of geobag grain content calculation steps are given, as follows:

1. γ_r, obtained from the density of geobag fillers, namely the type of soil (sand) on the seabed. The data was obtained from the laboratory, which is 1,517.72 kg / m^3
2. γ_a, obtained from the specific gravity of seawater 1.025 kg/m^3
3. H, is the wave height of the plan
4. K_D, is the Stability Coefficient depending on the shape of the protective stone. Obtained from the table and used the number is 1.1
5. $S_r = \frac{\gamma_r}{\gamma_a}$

   $S_r = \frac{1.517,72}{1025} = 1,48$
6. θ, is the angle of slope of the retaining wall. Enter data according to the desired angle or with the "trial and error" technique
7. $\cot\theta = \frac{1}{\tan\theta}$

   $\cot\theta = \frac{1}{\tan(38)} = 3,223$
8. $W = \frac{\gamma_r . H^3}{K_D.(S_r-1)^3 \cot\theta}$ (Pratikto, et.a., 2014)

   $W = \frac{1.517,72 \text{ x } 0,6}{1,1.(1,48-1)^3 \cot(38)} = 2.674,5 \text{ kg}$

According to the results of the data above, the weight of the contents of one geobag uses (W) = 2.674,5 kg as given in Table 9 and the geobag dimension size is shown in Figure 6.

Table 9: Weight of Geobag grain content.

W(kg)	γ_r (kg/m3)	γ_a (kg/m3)	H (m)
-2683,01	1.517,72	1.025	0,6
-2678,62	1.517,72	1.025	0,6
-415,50	1.517,72	1.025	0,6
-35,62	1.517,72	1.025	0,6
2605,36	1.517,72	1.025	0,6
2674,50	1.517,72	1.025	0,6
-1915,39	1.517,72	1.025	0,6
-1564,88	1.517,72	1.025	0,6
1473,76	1.517,72	1.025	0,6
K_D	Sr	θ	cot θ (1/tan θ)
1,1	1,48	25	-7,489
1,1	1,48	28	-3,553
1,1	1,48	30	-0,156
1,1	1,48	33	-0,013
1,1	1,48	35	2,111
1,1	1,48	38	3,223
1,1	1,48	40	-0,895
1,1	1,48	43	-0,667
1,1	1,48	45	0,617

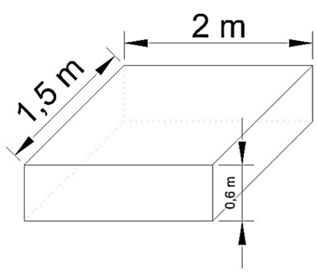

Figure 6: Geobag dimension size.

The height, width and length of the geobag size are determined from the height requirements of the retaining wall that are planned for the geobag stacking or stacking place. Therefore, the size of this geobag is determined using the "Volume Weight Formula" with the "trial and error" technique until the volume weight above is in accordance with or slightly larger than the volume weight plan.

4.6 The Earth Pressure and Gravity Retaining Walls

To obtain structural resistance, the active earth (soil) pressure coefficient and the forces acting on each layer of geobag that will be stacked can be obtained so that the height and width of the structure are in accordance with the dimensions planned. The calculation results of the soil pressure and is given in Table 10, while the working force on the geobag layer is given in is given in Table 11. The diagram of soil pressure and the cross-section of retaining wall are given in Figure 7 and Figure 8, respectively. The top view of geobag formation used to construct the retaining wall is given in Figure 9.

Table 10: Soil pressure calculation results.

No	H (m)	Ka	Pressure σ (Kg/m2)	Pa (Kg/m)	Point of Force (m)
1	6.3	0.67	3845.88	24229.07	3.15
2	6.3	0.67	4724.55	14882.33	2.10
3	5	0.67	5100.12	12750.31	1.67

Table 11: The working force on the geobag layer.

Geobag Layer			The working force of each geobag layer due to load is evenly distributed (kg/m)	The working force of each dry soil geobag layer (kg/m)	The working force of each wet soil geobag layer (kg/m)
Height (m)	Distance (m)	Total			
0.3	0.3	13	24229.07	15626.45	13564.16
0.9	0.6	12		17362.72	15549.16
1.5	0.6	11		19533.06	18214.73
2.1	0.6	10		22323.50	4207.60
2.7	0.6	9		10630.24	6502.66
3.3	0.6	8		12756.28	8797.71
3.9	0.6	7		14882.33	11092.77
4.5	0.6	6		17008.38	13387.83
5.1	0.6	5		19134.43	15682.88
5.7	0.6	4		21260.47	17977.94
6.3	0.3	3			
Total			24229.07	170517.86	124977.43

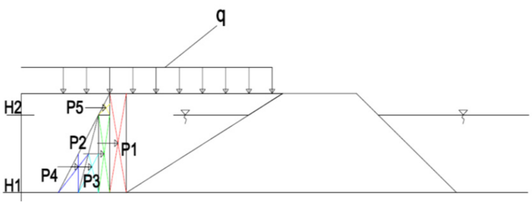

Figure 7: Diagram of Soil Pressure.

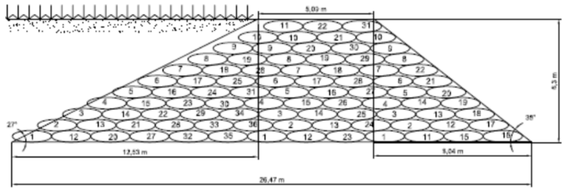

Figure 8: Retaining Walls.

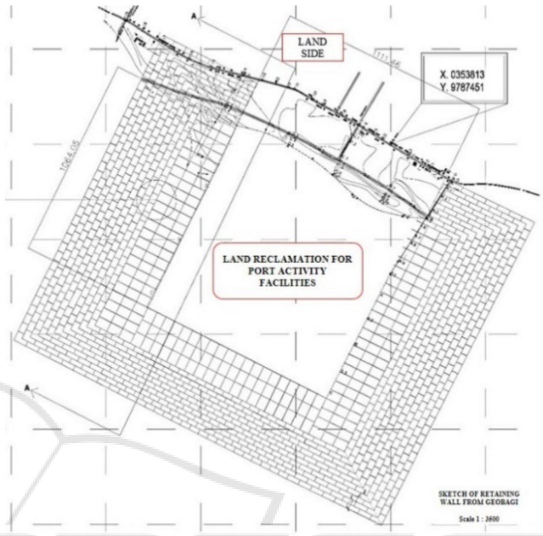

Figure 9: Top View of Geobag Formation.

The height of the retaining wall is determined by the deepest point from the coastline to the length of the reclaimed land and the width of the retaining wall depending on the geobag stacking pattern adjusted to the ground level.

4.7 Stability of External Forces

a. Overturning

Moment of prisoner due to own heavy construction $(\sum M_R) = 2.423.370$ kg.m

Overturning moment due to active force $(\sum M_0) = 589.210$ kg.m.

$$\mathbf{FS_{overturning} = 4,11 \geq 2 \quad OK\,!}$$

Retaining Wall Design is safe against collapse due to overturning.

b. Sliding Failure

where :

$\Sigma F_R = 240,33$

$\Sigma F_D = 128,825$

$$\mathbf{FS_{sliding} = 1,87 > 1,5 \quad OK\,!}$$

Retaining Wall Design is safe against collapse due to sliding.

c. Bearing Capacity Failure

Where :

q_{ult} = 34.774 kg

e = 5,61 < 4,4

q_{maks} = 9.084 kg

$$\mathbf{FS_{bearingcapacity} = 4,41 > 3 \quad OK\ !}$$

Retaining Wall Design is safe against collapse due to bearing capacity failure.

5 CONCLUSION

The dimensions of the retaining wall are determined based on the water depth from the results of the bathymetry and tide surveys. Meanwhile, the material of filled geobag can be obtained from the results of the type of soil that will be filled as geobag filling material dan dimension use trial and error technique until the volume weight above corresponds to or is slightly greater than the volume weight plan. From the results of the calculation of the strength of the geobag retaining wall, the following points can be concluded:

1. The height of the retaining wall is taken from the deepest point of bathymetry, which is 6.3 m and the break wave height per 10 year return period is 0.6 m. It's width is adjusted by the geobag stacking to the height of the retaining wall until it forms a trapezoidal shape of 26.47 m. This retaining wall has 11 geobag layers with the most bottom layer are 13 geobags and the top layer are 3 geobags. The slope of the angles on the left and right sides are different, on the left side which attaches to the land which is 27^0 and the right side on the seafront is 38^0.
2. Geobag dimensions are 2 x 1.5 x 0.6 m using trial and error until the weight is in accordance with the grain weight of the protective stone.
3. Geobag retaining walls are strong against external force stability due to overturning, sliding, and bearing capacity. The result exceeds the standard threshold value.

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