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REDESIGN OF CORE GROYNE USING NATURAL MATERIALS

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ABSTRACT

Coastal abrasion is one of the serious problems with shoreline change. In addition to natural processes, such as wind, currents and waves. One method for overcoming coastal abrasion is the use of coastal protective structures, where the structure functions as a wave energy damper at a particular location. Coastal buildings are used to protect the beach against damage due to wave and current attacks. Groyne is a coastal safety structure that is built protrudes relatively perpendicular to the direction of the coast, the importance of built coastal security with a groyne structure on the Jetis beach is as a flood control infrastructure that is as a final disposal of floods in the Ijo Watershed system, addressing coastal abrasion in detail. So we get the design drawings of sediment control buildings to reduce sedimentation / siltation from the direction of the sea into the river mouth, material structure costs and time schedule.

Keywords: Abrasion, Groin, Material, Cost, Time Schedule.

INTRODUCTION

Research Background

The problem at the Jetis beach is a estuary sedimentation, so that the flood discharge and economic activities of the people who use the river estuary channel as their fishing boat route are disrupted. Jetty or Groin which was built for the purpose of protecting the channel protrudes towards the sea to a distance of 300 m, with such conditions the river mouth is expected to get optimal protection. To improve the quality of protection and security from siltation of the estuary, it is necessary to make a building for controlling or retaining coastal sediments, namely groyne. On that basis, in the process of groyne design calculation in the planning, the core groin has not been discussed with natural materials and the cost and time are not calculated. So that it can be known the cost and time comparison of groynes with artificial stone cores using natural stone/materials.

Problems

Based on this background, the problems to be examined are:

1. What is the design alternative to groyne damage?
2. What is the material requirements needed to redesign the groyne?
3. What is the difference between the esisting design cost and the redesign cost?
4. How much time difference between the existing schedule and the redesign schedule?

Groyne

Groyne is a coastal security structure built protruding relative to the direction of the beach. Construction materials are generally wood, steel, concrete (concrete pipes), and stones. The installation of groins interrupts the flow of coastal currents so that the sand is trapped on the "upcurrent side," while on the "downcurrent side" erosion occurs, due to the continuous movement of coastal currents.

a. Building Planning from Natural Materials
    i. Building Slope

The slope of the building is an element that is very instrumental in determining the elevation of buildings and stone stability. The lower the slope of a building the lower the run up and the higher the stability.

ii. Toe Protection Elevation

Toe protection is fundamental that supports the stability of the building from the effects of tides, especially the movement of sand during low tide. To overcome scouring at the foot of the building, toe elevation is placed at +0.00 so that scouring can be overcome (scouring is not possible at elevation below the LWL).

iii. Revetment Peak Elevation

As explained in the previous section, the elevation of the planned building will not be lower than the highest water level accumulation + run up + guard height

iv. Stability Stone (Armor Stone)

• Rock weight used (Weight of Armor Rock)

Analysis of rock armor stability using the Hudson Formula, as follows:

$$W = \frac{\gamma_r . H^3}{K_D .(S_r - 1)^3 . Cot\theta} \qquad S_r = \frac{\gamma_r}{\gamma_w}$$

RESEARCH METHOD

Data Collection Technique

To provide optimal results, the researcher will carry out an inventory of secondary data. Functionally, secondary data is a data series that is useful for the accuracy of work results because it is a long data series. The following secondary data series are needed in connection with the implementation of the work:

1. Map of Earth, Scale 1: 25,000 from Bakosurtanal.
2. International Cross-Sea Map, Scale 1: 50,000 from Dishidros.
3. Regional Geological Map, Scale 1: 100,000 from the Ministry of Mines and Energy.
4. Maximum daily wind data, Local BMKG (minimum of the last 10 years)
5. Hourly wind data
6. Tidal forecasting data.
7. High tide forecast data
8. Climatology and hydro oceanographic data
9. Data relating to coastal safeguards, including reports or studies that have been carried out around the location of activities.

Budget plan

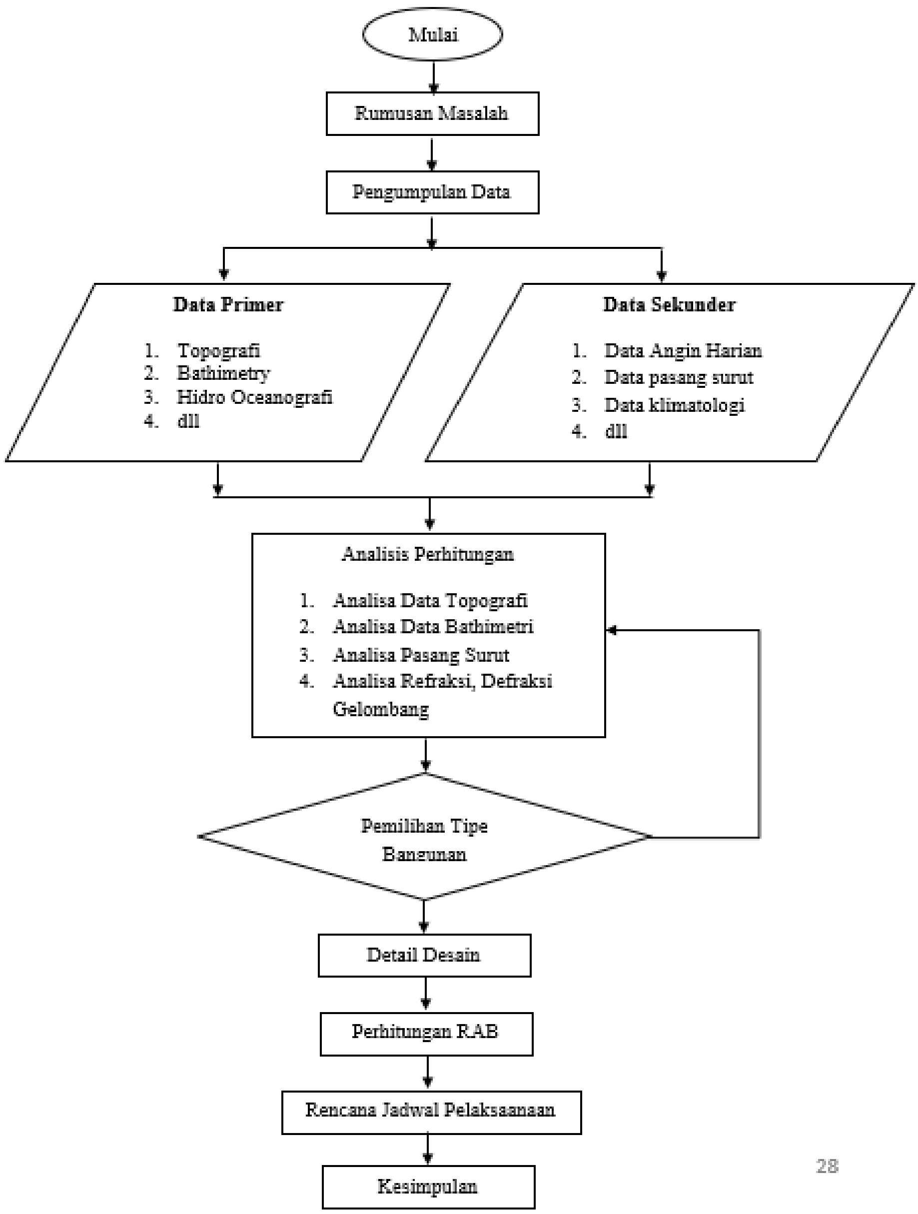
The budget plan for a building or project is the calculation of the amount of costs required for materials and wages and other costs associated with implementing the building or project (Ibrahim, 2007). Cost budget calculations usually consist of 5 main points, namely:

1. Calculate the amount of material used and the price
2. Calculate labor hours (number and price) required
3. Calculate the type and number of equipment
4. Calculate unexpected costs that need to be incurred
5. Calculate the percentage of profit, time, place and type of work

a. Time Schedule

Project scheduling is one element of the results of planning that contains the performance of resources in the form of costs, labor, equipment and materials as well as the project duration plan and the progress of time to complete the project. Scheduling or scheduling is the allocation of time available to carry out each work in order to complete a project until optimal results are achieved by considering the limitations that exist.

b. Flow Chart



RESULTS AND DISCUSSION

Run Up Waves / Seawater Plan

Wave run-up is the sea level rise that hit the surface of a building calculated using the following:

DWL = HHWL + (SS or WS) + SLR = + 2.00 + 0.60 + 0 = + 2.6 m

Structure Elevation

Breakwater or revetment structure in the design of PPI Gili Ketapang is a type of structure that is not overtopping (non-overtoping structure). Breakwater height (H) = Peak elevation - Sea floor elevation

Puncak Peak Elevation = HHWL + Ru + Pg + Hu

Peak Elevation = 2.6 + 4.6 + 0.3 = 7.5 m

 Breakwater Height = Peak Elevation + Seabed Elevation

Breakwater height = 7.5 + (-7.5) = 15 m

Determine the Weight of the Armor Unit

In planning this groynes will use a protective layer of natural broken stone. In accordance with the previous explanation the availability of natural stone in the Cilacap area was very sufficient

Based on Hudson's research (1953) (in Triatmojo, 1990) in the South American army laboratory (USACE, waterway experiment station, Vicksburg, Mississippi) a formula was developed to determine the weight of the protective layers. The form of the formula is as follows:

$$W = \frac{\gamma_b H^3}{K_D \Delta^3 Cot(\theta)}$$

Information:

W = minimum stone weight (tons)

H = plan wave height (m)

KD = stability coefficient (Table 5.4)

θ = slope angle of the Groin structure

$\Delta = \frac{(\gamma_b - \gamma_w)}{\gamma_w}$

γ_b, γ_w = the weight of the protected layer stone unit, the weight of the seawater unit

Layer 1

For protection from tetrapod

- For breakwater arms:

$W = \frac{\gamma_b H^3}{K_D \Delta^3 Cot(\theta)}$

$W = \frac{2{,}4\ ton/m^3\ x\ (2)^3}{7(2{,}33-1)^3 x\ 2}$

$W = \frac{300}{32.937}$

W = 9.108 Ton, rounded to Tetrapod 9 Tons

- For breakwater ends:

$W = \frac{\gamma_b H^3}{K_D \Delta^3 Cot(\theta)}$

$W = \frac{2{,}4\ ton/m^3\ x\ (5)^3}{5{,}5(2{,}33-1)^3 x\ 2}$

W $= \frac{300}{25,879}$

W = 11,592 Ton, rounded to Tetrapod 11.5 Tons

Layer 2

W $= \frac{\gamma_b H^3}{K_D \Delta^3 Cot(\theta)}$

W $= \frac{2.65\ ton/m^3\ x\ (2)^3}{2(2,58-1)^3 x\ 2}$

W $= \frac{21.200}{15,777}$

W = 1,343 ton = 1343 kg, rounded to 1300 kg

Layer 3

W_2 $= \frac{W1}{10}$

W_2 $= \frac{1343}{10}$

W2 = 134,3 Kg, rounded to 130 kg

Determine the Stone Diameter

Daiameter armor based on the manual on the use of rock in coastal and shoreline engineering (1991) can be shown in the following equation:

Volume of protective granules:

V = W / γr

V = 134.3 / 2600

V = 0.052 m3

The shape of natural stone is considered a sphere, then the diameter can be found by the equation:

V = 1/6. πd3

V = 0.052

0.052 = 0.523 d3

d3 = 0.099

d = 0.462 m, rounded to 0.5 m

Volume of protective granules:

V = W / γr

V = 1343/2600

V = 0.517 m3

Determine the Crest Width and Thickness of the Rock Armor Layer

The width of the peak depends on the runoff allowed. Under permissible runoff conditions, the minimum peak width is equal to the width of the three protective stone items arranged side by side. For buildings without runoff can be smaller than that. In addition, the peak width must also adjust the equipment operating requirements when implementing maintenance.

For the width of the tetrapod peak

B $= n\ KA\ (\frac{W1}{Wr})^{1/3}$

B1 $= 2 \times 2\ (\frac{11500\ kg}{2400\ kg/m3})^{1/3}$

B1 = 6,74 m

But the planned width of the 7.5 m tetrapod peak as access to heavy equipment and maneuvers for the installation of armor units

For the width of the top of the broken stone layer 2

B $= n\ K_A\ (\frac{W1}{Wr})^{\frac{1}{3}}$

B_1 $= 3 \times 1.15\ (\frac{1343\ kg}{2400\ kg/m3})^{1/3}$

B_1 = 2,751 m = 3 m

For the width of the top of the broken stone layer 3

B $= n\ K_A\ (\frac{W1}{Wr})^{\frac{1}{3}}$

B_1 $= 3 \times 1.15\ (\frac{134{,}3\ kg}{2400\ kg/m3})^{1/3}$

B_1 = 1,28 m = 1,5 m

Thick layers of breakwater protection

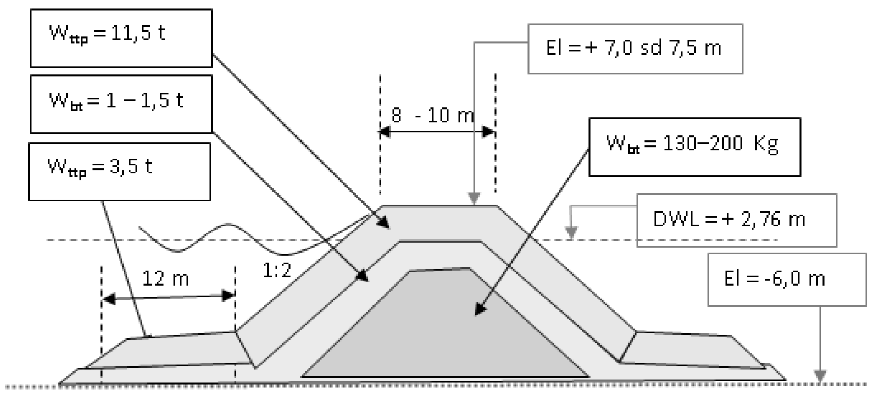
t $= n\ K_A\ (\frac{W1}{Wr})^{1/3}$

Layer 1 thickness for broken stone

t $= 2 \times 1.15\ (\frac{1343\ kg}{2650\ kg/m3})^{1/3}$

t = 1.83 m = 2 m

Cross Section



Redesign Cost

No	Uraian Pekerjaan	Volume	Satuan	Harga Satuan	Jumlah
I	Pekerjaan Persiapan				
1.1.	Mobilisasi & Demobilisasi Alat	1	Ls	Rp. 218,740,000.00	Rp. 218,740,000.00
1.2.	Perbaikan dan Pemeliharaan Jalan kerja tanah ada dengan sirtu	1	Ls	Rp. 65.400.000,00	Rp. 65.400.000,00
1.3.	Pengukuran Kembali (Uitset, MC 0%)	1	Ls	Rp. 27.067.083,00	Rp. 27.067.083,00
1.4.	Pagar, Direksi Keet, Los Kerja, Gudang dan Pembersihan Lahan	1	Ls	Rp. 1.107.400.000,00	Rp. 1.107.400.000,00
II. Pekerjaan Groin					
II.1.	Pekerjaan Beton Pembuatan Lahan Produksi Beton K 100, t : 8 cm	1.491	m^2	Rp. 77.664,00	115,797,024.00
II.2	Pekerjaan Pembuatan				
II.2.1	Pembuatan Tetrapod K 350 (3,5 Ton)	9.947	Unit	Rp. 3.222.898,00	Rp. 32.058.166.406,00
II.2.2	Pembuatan Tetrapod K 350 (7 Ton)	3.325	Unit	Rp. 6.765.676,00	Rp. 22.495.872.700,00
II.2.3	Pembuatan Tetrapod K 350 (9 Ton) + bekisting	1.860	Unit	Rp. 9.459.820,00	Rp. 17.595.265.200,00
II.3.4	Pembuatan Tetrapod K 350 (11,5 Ton)	1.951	Unit	Rp. 12.160.134,00	Rp. 23.724.421.434,00
II.2.5	Pembuatan Block Beton K 350 (1.7x1.7x1.7 m)	2.521	Unit	Rp. 12.226.416,00	Rp. 30.822.794.736,00
II.3	Pekerjaan Lapis inti				
II.3.1	Lapis inti batu layer 1 W10=100-150 Kg	42,807.979	m^3	Rp. 417.615,95	Rp. 17.87.294.990,00
II.3.2	Lapis inti batu layer 2 W10=1000-1500 Kg	25,666.08	m^3	Rp. 417,615,95	Rp. 10.718.562.547,58
II.4	Pekerjaan Besi				
II.4.1	Pekerjaan Pembesian	1,437,528	Kg	Rp. 19,546.00	Rp. 28.097.939.195,29
II.5.	Pekerjaan Pemasangan				

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II.5.1	Pemasangan Tetrapod K 350 (3,5 Ton)	9.947	Unit	Rp. 116.072,00	Rp. 1.154.568.184,00
II.5.2	Pemasangan Tetrapod K 350 (7 Ton)	2.531	Unit	Rp. 173.900,00	Rp. 578.21.500,00
II.5.3	Pemasangan Tetrapod K 350 (9 Ton)	1.860	Unit	Rp. 176.217,00	Rp. 327.763/620,00
II.5.3	Pemasangan Tetrapod K 350 (11,5 Ton)	1.951	Unit	Rp. 187.880,00	Rp. 366.553.880,00
II.5.4	Pemasangan Block Beton K 350 (1.7x1.7x1.7 m)	2.521	Unit	Rp, 192.224,00	Rp. 484.596.704,00
II.6	Pekerjaan Lapis Dasar Pengadaan dan Pemasangan Geotextile	5,033.00	m^2	Rp. 79.971,00	Rp. 402,494,043.00
II.7	Lapis Batu Perata Lapis batu perata tebal 50 cm	1,761.00	m^3	Rp. 259.000,00	Rp. 456.099.000,00
A	JUMLAH TOTAL				Rp.189,894,676,381.41
B	PPn 10%				Rp.18,989,467,638.14
C	Jumlah A+B				Rp. 208,884,144,019.55
D	Dibulatkan				Rp. 208,884,100,000.00

1. Time Schedule Redesign

JADWAL PELAKSANAAN

1-Jan-18

NO	URAIAN PEKERJAAN	SAT	VOLUME KONTRAK	BOBOT	2018												2019							
					Jan	Feb	Maret	April	Mei	Juni	Juli	Agust	Sept	Okt	Nop	Des	Jan	Feb	Maret	April	Mei	Juni	Juli	Agust
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
I.	PERSIAPAN																							
1.1	Mobilisasi & Demobilisasi Alat	Ls	1.00	0.116			0.029	0.029																0.058
1.2	Perbaikan dan Pemeliharaan Jalan kerja tanah ada dengan sirtu	Ls	1.00	0.035																				0.035
1.3	Pengukuran Kembali (Uitset, MC 0%)	Ls	1.00	0.014	0.007									0.007										
1.4	Pagar, Direksi Keet, Los Kerja, Gudang dan Pembersihan Lahan	Ls	1.00	0.587		0.196	0.196	0.196																
				-																				
II.	PEKERJAAN GROIN			-																				
II.1	Pekerjaan Beton			-																				
II.1.1	Pembuatan Lahan Produksi Beton K 100, t : 8 cm	m2	1,491.00	0.061				0.031	0.031															
				-																				
II.2	Pekerjaan Pembuatan			-																				
II.2.1	Pembuatan Tetrapod K 350 (3,5 Ton)	Unit	9,947.00	16.989	-	-	1.144	1.298	1.298	1.196	0.666	1.937	2.260	1.522	2.398	2.260	1.011	-	-	-	-	-	-	-
II.2.2	Pembuatan Tetrapod K 350 (7 Ton)	Unit	3,325.00	11.922	-	-	0.394	0.911	0.911	0.839	0.466	1.355	1.581	1.065	1.678	1.581	1.140	-	-	-	-	-	-	-
II.2.3	Pembuatan Tetrapod K 350 (9 Ton)	Unit	1,860.00	9.325	-	-	-	-	1.504	1.384	0.782	1.263	1.474	0.993	1.564	0.361	-	-	-	-	-	-	-	-
II.2.4	Pembuatan Tetrapod K 350 (11,5 Ton)	Unit	1,951.00	12.573	-	-	-	-	-	1.083	0.670	1.624	1.895	1.276	2.011	1.895	1.856	0.264	-	-	-	-	-	-
II.2.6	Pembuatan Block Beton K 350 (1.7x1.7x1.7 m)	Unit	2,521.00	16.335	-	-	-	1.866	1.944	1.788	1.011	1.633	1.905	1.283	2.022	1.905	0.978	-	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II.3	Pekerjaan Besi			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II.3.1	Pembesian	kg	1,437,528.87	14.891	-	0.659	1.285	2.337	2.331	1.632	1.553	1.843	0.849	0.590	0.824	0.987	-	-	-	-	-	-	-	-
				-																				
II.4	Pekerjaan Pemasangan			-																				
II.4.1	Pemasangan Tetrapod K 350 (3,5 Ton)	Unit	9,947.00	0.612	-	-	0.021	0.042	0.045	0.051	0.035	0.050	0.032	0.038	0.019	0.038	0.037	0.074	0.038	0.037	0.024	0.031	-	-
II.4.2	Pemasangan Tetrapod K 350 (7 Ton)	Unit	3,325.00	0.306	-	-	-	0.011	0.024	0.025	0.021	0.021	0.021	0.019	0.015	0.021	0.021	0.021	0.021	0.021	0.014	0.014	0.016	-
II.4.3	Pemasangan Tetrapod K 350 (9 Ton)	Unit	1,860.00	0.174	-	-	-	-	-	0.028	0.026	0.027	0.026	0.026	0.022	0.014	0.005	-	-	-	-	-	-	-
II.4.4	Pemasangan Tetrapod K 350 (11,5 Ton)	Unit	1,951.00	0.194	-	-	-	-	-	-	0.017	0.019	0.019	0.019	0.019	0.019	0.019	0.010	0.019	0.019	0.015	-	-	-
II.4.6.a	Pemasangan Block Beton K 350 (1.7x1.7x1.7 m)	Unit	2,521.00	0.257	-	-	-	0.007	0.014	0.014	0.007	0.013	-	0.007	0.007	0.007	0.007	0.032	0.037	0.037	0.013	0.037	0.019	-
II.5	Pekerjaan Lapis Dasar			-																				
II.5.1	Pengadaan dan Pemasangan Geotextile	m2	5,033.00	0.213				0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021							
				-																				
II.6	Lapis Batu Perata			-																				
II.6.1	Lapis batu perata tebal 50 cm		1,761.00	0.242					0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020				
				-																				
II.7	Pekerjaan Core Groin			-																				
II.7.1	Pengadaan dan Pemasangan Batu Boulder 100-150 Kg		42,807.98	9.474	-	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	-	-	-
II.7.2	Pengadaan dan Pemasangan Batu Boulder 1000-1500 Kg		25,666.08	5.680	-	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	-	-	-
	Rencana (TerhadapKontrak)			100.000	0.007	1.801	4.016	7.696	9.090	9.028	6.243	10.775	11.049	7.833	11.566	10.076	6.063	1.369	1.082	1.081	1.013	0.082	0.035	0.093
	Rencana Kumulatif (Terhadap Kontrak)			-	0.007	1.808	5.825	13.520	22.611	31.639	37.882	48.657	59.706	67.539	79.105	89.182	95.245	96.614	97.696	98.777	99.791	99.873	99.907	100.000

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2. Cost and Time Comparison of Existing Groin and Re-design Groin

Known Existing cost with a core structure using concrete blocks is Rp. 299,223,800,000.00 with a duration of 750 calendar days. The author has carried out an optimization study on the structure design by replacing the core of groynes using natural stone with W = 1000-1500 Kg, W10 = 100-150 Kg with the following efficiency:

Difference in cost:

= Existing cost – Redesign cost

= Rp. 299,223,800,000.00 - Rp. 207,564,500,000.00

= Rp. 91,659,300,000.00

Cost Comparison Percentage:

= (Cost Difference) / (Existing cost) x 100%

= (91,659,300,000.00) / (299,223,800,000.00) x 100%

= 30,632%

Difference in time

= Duration of the existing cost - Duration of redesign

= 750 days - 608 days

= 142 days

Percentage comparison of project duration:

= (Time Difference) / (Duration of existing cost) x 100%

= (142 days) / (750 days) x 100%

= 18,933%

CONCLUSION

From the observation process to the analysis, it can be concluded that a number of important matters are related to the planning of a beach safety structure in Jetis beach, including:

1. Based on the results of the analysis using wind, wave and tidal data, a coastal safety plan is obtained in the form of a groyne. Groyne was chosen to protect the river mouth in Jetis beach and re-planning was carried out using a natural rock core with layer 1 W = 1000 to 1500 Kg, Layer 2 W10 = 100 to 150 Kg with porosity smaller than 1x1x1 concrete blocks so that the building structure is more sturdy.
2. Based on the analysis results, it is obtained that the groin structure material planning is obtained
   - Tetrapod 3.5 Ton = 9,947 Units
   - Tetrapod 7 Tons = 3,325 Units
   - Tetrapod 9 Ton = 1,860 Unit
   - Tetrapod 11.5 Tons = 1951 Units
   - Concrete Block 1.7x1,7x1,7 = 2,521 Units
   - Stone layer 1 W10 = 100-150 Kg = 42,807.98 m3
   - Stone layer 2 W = 1000-1500 kg = 25,666.08 m3
3. Comparison of costs in the contract budget plan is Rp. 299,223,800,000.00 (Including 10% VAT), For the Revised Budget Plan the cost is Rp. 207,564,500,000.00, where the redesigned cost is more efficient Rp. 91,659,300,000.00 of the existing cost

4. Comparison of the duration of existing time schedule is 25 Months (750 days), for the redesign time schedule is 20 months (608 days). Implementation can be done faster 5 months. (142 days)

REFERENCES

CERC. 1984*. Shore Protection Manual Volume I*. Washington: US Army Coastal Engineering Research Center.

CERC. 1984. *Shore Protection Manual Volume II.* Washington: US Army Coastal Engineering Research Center.

CERC. 1992. *Automated Coastal Engineering System, Book I*. Missisippi: Department of the Army Water-way Experiment Station Corps of Engineers.

Sorensen, Robert M. 2006. *Basic Coastal Engineering*. New York: Springer Science.

Syamsudin and Kardana. 1997. *Coastal / Coastal Zone Rehabilitation.* P3P Department of Public Works.

Triatmojo, Bambang. 1999. *Beach Engineering*. Yogyakarta: Beta Offset.

Triatmojo, Bambang. 2008. *Port*. Yogyakarta: Beta Offset.

Triatmojo, Bambang. 2012. *Beach Building Planning.* Yogyakarta: BetaOffset.

U.S. Army Corp of Engineers. 2002. *Coastal Engineering Manual*. Washington.

Yuwono, Nur. 1992. *Fundamentals of Building Planning Beach*. Yogyakarta: PAU-IT-UGM.

Zweers, Sander. 2009. *Beach Safety Building Design Manual*. Aceh: Sea Defense Consultants.