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The Effect of Adding Coconut Coir Fiber on Compressive Strength, Tensile Strength, and Concrete Flexural Strength in Eco-Friendly Tetrapod Planning in Coastal Areas of IKN Supporting Cities

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ABSTRACT

Beaches often experience erosion or abrasion problems caused by various factors, such as climate change which triggers rising sea levels, high waves, human activities such as beach reclamation, and infrastructure construction that is not environmentally friendly, triggering erosion on the coast. In the coastal area of the city that supports IKN, which is located in the Balikpapan area, Manggar Beach, also experiences abrasion which causes land to narrow in that area. The abrasion that occurs erodes the coastal area around 7-8 meters every year. To produce environmentally friendly infrastructure, this research carried out the addition of coconut fiber waste components to tetrapod concrete used for breakwater construction. In this research, variations in the addition of coir used were 0%, 1%, 2%, 3%, 4% and 5%. The aim was to find out how much influence the addition of coconut coir waste to the concrete mixture had on the compressive strength, tensile strength and flexural strength of the concrete in tetrapods. and produce concrete that uses coconut fiber waste as an alternative material for tetrapod concrete as breakwater armor. Based on the analysis results, the quality of the concrete was 23 Mpa. This value was determined based on wave generation analysis. In addition, it is known that variations in coconut fiber affect the slump, compressive strength, flexural and split tensile test values of concrete. Based on the slump test results, it was found that the greater the variation of coconut fiber in the concrete, the lower the resulting slump test value. In testing the compressive, flexural and split tensile strength, it was found that the optimal composition for adding coconut fiber was 3%, in this composition the amount of coconut fiber fiber was able to improve the mechanical properties of tetrapod concrete compared to other compositions.

Keywords: *Abrasion; Coconut Fiber, Waves; Concrete Compression;Tetrapod.*

INTRODUCTION

The coastal area is an area that has many uses, for example as an industrial area, fisheries, settlements, ports, and others. Because of these many advantages, if the beach is not managed properly it will cause other problems, including changes that occur in the morphology of the beach. Coastal changes can occur at any time on a seasonal/annual scale, depending on coastal characteristics such as coastal topography, rocks and conditions of ocean waves, wind, and tides [1]. Beaches often experience abrasion problems caused by various factors, such as climate change that triggers sea level rise, human activities such as beach reclamation, and infrastructure construction that is not environmentally friendly triggering abrasion on the coast. Abrasion is the process by which waves erode land, washing away substrate and reducing its surface area. Strong currents and waves and the number of rivers flowing into the sea can cause abrasion, which can also trigger changes in the coastline [2].

The incidence of abrasion continues to increase in various regions. In the coastal area of the city supporting IKN where one of them, the Manggar Beach area in the city of Balikpapan, also experienced abrasion and caused land narrowing in the area. The abrasion that occurs erodes the beach area about 7-8 meters per year. Damage to the construction of wave breaks on AURI Beach due to abrasion caused the coastline at the location to shift inland between 12-15 meters. Due to waves and sea tides causing abrasion along Tanjung Bayur Beach which causes a shift in the beach area about 150 meters towards land.

One way to solve the problem of abrasion on the Coast is to apply vegetative methods and technical construction. One example of the use of technical construction methods is the use of *breakwater*. Types of *breakwater* such as offshore breakwaters are widely used as coastal defenses to prevent scouring / abrasion, where the *breakwater mechanism* plays a role in dampening the energy waves generated [3]. This is also in line with the plan of the Balikpapan City government and the River Basin Hall to continue to strive to improve infrastructure repairs that have been damaged by abrasion, both in the form of mangrove planting, breakwater and geotube construction.

To produce environmentally friendly infrastructure, this study added a component of coconut husk fiber waste to the *breakwater concrete armor*. Coconut coir fiber is fiber derived from coconut husk waste. These fibers are relatively waterproof and resistant to salt water damage and microbial shrinkage[4]. The addition of coconut husk to concrete can provide several advantages including strength addition, resistance to chemical reactions, crack resistance, added abrasion and corrosion resistance, and environmentally friendly [5]. In addition, the availability of coconut coir fiber itself is very abundant in Balikpapan. Through this research, it is hoped that coconuts will not only be a food ingredient but the waste in the form of coir can provide beneficial values. Currently, the use of coconut waste in the form of shell ash and coconut husk fiber has not been widely used as an additional material in coastal protection buildings. Therefore, it is necessary to investigate the use of coconut husk waste material as a concrete filler for coastal protection structures in the form of tetrapods. In this study, variations were carried out on the addition of coconut husk waste which will be used, namely 0%, 1%, 2%, 3%, 4%, and 5%, this aims to determine how much the addition of coconut husk waste to the concrete mixture in the design of tetrapods can affect the compressive value, tensile strength, and flexibility of concrete on tetrapods, so as to produce environmentally friendly concrete that utilizes coconut husk waste raw materials as an alternative to the mixture concrete.

METHOD

Research Location

This research was conducted in the coastal area of the IKN supporting city which is located on the coast of Manggar, East Balikpapan District, Balikpapan City. Manggar Beach has a width of approximately 50 meters at low tide. Manggar Beach covers about 13,000 meters^2 of clear sea waters in the Makassar Strait. The following is an observation location on Manggar beach in Figure 1.

EISSN: 2622-6774
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http://cived.ppj.unp.ac.id/index.php/CIVED

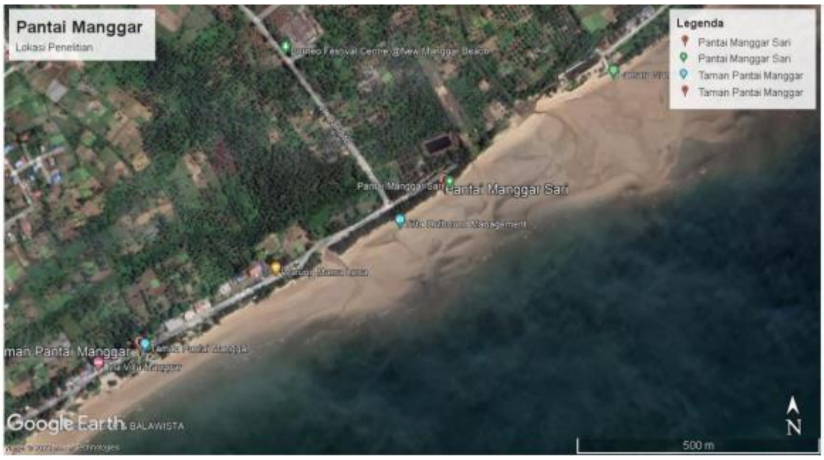

Figure 1: Research Location

The research stages are secondary and primary data collection then continued with wave generation analysis, *Mix Design planning*, making test objects and analyzing the mechanical properties of tetrapod concrete.

Wave Generation

Ocean waves are waves that are usually driven by wind. Wind on the surface of the sea causes the generation of currents and also the main aspect of sea waves. The wind that continues to blow causes more wind energy to be transferred to the surface of the water, which ultimately creates longer and higher waves [6]. Here are the things to analyze in wave generation:

1. Effective fetch analysis

To determine the duration, period and wave height values required a forecasting chart generated from effective fetch analysis. Effective fetch analysis can be achieved by requiring a map at the location of the review using a large map scale, with this it can be known the island or land area around it that can affect the occurrence of the process of wave formation at a particular location. The length of the fetch using the eight cardinal directions as well as the average effective fetch is calculated using Equation 1 below.

$$F_{eff} = \frac{\sum Xi \cos \alpha}{\sum \cos\alpha} \tag{1}$$

Where Feff is the average effective fetch value, Xi is the fetch value calculated from the observation point to the end of the fetch (Long), and α is the value of the deviation angle from both sides between wind directions.

2. *Wave Hindcasting* Analysis

The specific direction, duration and magnitude used in *wave hindcasting* analysis greatly influences the values of the period (T) and height (H) of the wave. So wave forecasting is intended to transform wind data into wave data. In this study, wind data was used in the Balikpapan area for the last 10 years every hour.

3. Tidal Wave Calculation

The tidal data in the Balikpapan area is supported by two sea water masses consisting of the Indian Ocean and the Pacific Ocean that pass through the Makassar Strait. The following is presented a graph of tides on Manggar beach, Balikpapan for 30 days on December 2-31, 2023 in Figure 2 below.

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

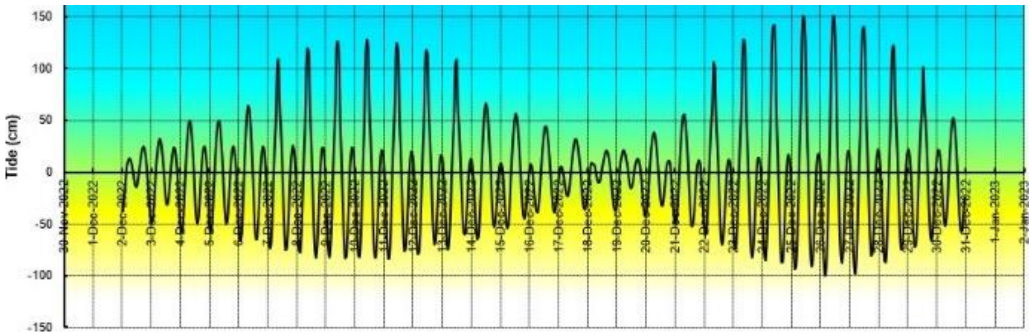

Figure 2: Tidal Graph at Manggar Beach

The tidal data that has been collected is then analyzed using *the Admiralty method* which is processed with the help of MS software. Excel to determine the Formzahl value so as to allow classification of tidal types at the study site.

4. Wave Re-Period Calculation

In the planning of coastal protection infrastructure used analysis of wave re-periods. The repeat period used is the *Fisher-Tippett Type I method*, where the probability value is determined for each wave height according to the following equation 2.

$$P\ (H_s \leq\ H_{sm}) = 1 - \frac{m-0{,}44}{N_T + 0{,}12} \tag{2}$$

Where:

P (Hs ≤ Hsm) = Probability of m-th representative wave height that is not past.

The significant wave heights at different repeat periods are judged by the value of the probability distribution where Â and B are local criteria estimates and the scale is generated from linear regression calculations [7]

$$H_{sm} = \hat{A}Y_r + B \tag{3}$$

$$y_r = \left\{-ln\left\{-\ln P\ \left(1 - \frac{1}{Lt_r}\right)\right\}\right\} \tag{4}$$

$$y_m = -\ln\ \{-\ln P\ (H_s \leq\ H_{sm}\ \} \tag{5}$$

$$H_{sr} = 0{,}197\ y_r + 2{,}529 \tag{6}$$

$$\sigma_{sr} = \frac{1}{\sqrt{N}}[1 + \alpha(y_r + c - \varepsilon lnv)^2]^{1/2} \tag{7}$$

$$\sigma_r = \sigma_{nr}\ \sigma H_s \tag{8}$$

Where:

Hsr = Significant wave height of Tr
Tr = Annual birthday period
K = Yearly length of data
L = Average of all events each year = N_T /K
σnr = Normalized standard deviation from H_{Sr} with Tr
N = Significant amount of wave height data
σr = Standard fallacy of N and Tr
σHs = Standard deviation using significant wave height data = 0.197

5. Tetrapod dimensional planning

The tetrapod dimension planning is calculated based on Bambang Triatmojo, 2010 where the calculation of the dimensions of the hypotenuse breakwater using tetrapod material. Planning of a protective layer of crushed stone material using a tetrapod so that the Kd value is 8 using the Hudson formula according to the following Equation 9:

$$w = \frac{\gamma_r H^3}{K_D(S_r - 1)^3 \cot\theta} \tag{9}$$

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Where:

W = Weight value on grain against protective stone (Tetrapod)
Sr = Weight value on Stone type
γr = Weight value on the type of water in the sea
H = Wave plan height
θ = Side angle slope of the breakwater
Kd = Stability factor

6. Environmental load calculation

a. Wave load

Infrastructure located in coastal areas is directly or indirectly exposed to the burden of waves. The working wave load affects such infrastructure. Waves on the coast occur for several reasons such as wind, earthquake, ship movement, and are influenced by other causes. The wave force acting on the pole structure can be calculated using Morison's equation. The high value of the force of the wave occurs due to the result of drag and inertial forces [8]. The following is Morison's equation.

$$F = fi + fd \tag{10}$$

Where:

F = Total Wave force (length)
Fd = Wave drag force (length)
Fi = Inertial force Wave (unit of length)

Inertial force is the value of the continuous acceleration of the water element, where the assumption of the fluid is ideal. The equation of inertial force can be seen in Equation 11.

$$F_I = C_M \frac{\gamma \pi D^2}{g.4} \frac{\delta u}{gt} \tag{11}$$

Where

CM = Coefficient of inertia
r = Specific gravity of fluid

Drag force is a force caused by the fixed speed of the water element in a structure. The equation of drag force is contained in Equation 12 below.

$$F_D = C_D \frac{1}{2} \frac{\gamma}{g} u|u|D \tag{12}$$

Where

CD = Coefficient of drag force
u = The horizontal velocity of the water element with respect to the pole structure (assumed i.e. cylinder).

In this study, wave generation calculations were carried out by assuming a structure in the form of an inclined pole with pole dimensions obtained from the results of tetrpod planning that had been calculated previously. For inclined cylinders Morison's formula can be used. The rules used in calculating wave strength have been adopted by offshore industries [9] The difference between the inclined plane and the vertical plane is where the vertical plane of acceleration and velocity of fluid elements is only in the horizontal direction, while in the inclined plane the acceleration and velocity are in the horizontal and horizontal directions. Where acceleration and velocity occur in both directions, the velocity will be generated on a pole perpendicular to the axis of the cylinder plane. The polar coordinates Ψ, Φ of the inclined cylinder. The equation of velocity with respect to an inclined cylinder is seen with the following Equation 13 [10].

$$\mathrm{FD} = [\mathrm{u2} + \mathrm{w2} - (\mathrm{cXu} + \mathrm{czw2}] \tag{13}$$

Where:

u = horizontal speed of the mast
w = vertical speed of the mast

cX = sin Ψ Cos Φ
Cy = sin Ψ Sin Φ
Cz = cos Ψ

b. Current load

The current force on the pole structure can be calculated by the following equation 14.

$$F_D = 0{,}5\, C_D D\, \rho\, v^2 \tag{14}$$

Assuming the current velocity as a linear function and the data mentioned above obtained equation 15.

$$V = \frac{z}{3.2} + 0{,}19 \tag{15}$$

Where
The speed of currents at sea level = 0.32 m/s
The speed of currents on the seabed = 0.19 m/s

The current force on the pole can be calculated using the substitution equations Fd and V, so the current load on the structure can be calculated by equation 16.

$$F_D = \int_0^Z 0{,}5 \times \frac{\gamma}{g\cos 15^0} C_D \times D \times \left[\frac{Z^3}{10{,}6} + \frac{0{,}76Z^3}{6{,}4} + 0{,}036z\right] \tag{16}$$

Where
FD = Total force (length)
Cd = drag force factor (for circles with rough surfaces = 0.9)

c. Wind load

The calculation of wind load on structures that are above sea level, the magnitude of the force value on the wind produced is contained in the following Equation 17 [11].

$$F = 0{,}00256 \times V^2 \times C_D \times A \tag{17}$$

Where:
F = Wind force (*Pound*)
Cd = coefficient of drag force.
A = predicted area of structure subject to wind (feet^2)
V = Wind Speed

Eco-friendly Concrete Mix Design

In this study, the quality of concrete was obtained based on the results of the calculation of environmental loads obtained in units of Mpa. In calculating the proportion of mixed material needs or *concrete mix design* , calculations are carried out based on the SNI 2834:2000 reference standard. Environmentally friendly concrete test samples are made by mixing materials with variations in the addition of coconut coir fiber are 0%, 1%, 2%, 3%, 4%, and 5% of the weight of concrete where before mixing coconut coir fiber, coconut husk material goes through several processes, namely the soaking process, cutting fibers along 50 mm then the drying process according to Figure 3 below:

Figure 3: 50 mm coconut husk fiber

CIVED
Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Before making environmentally friendly concrete, material tests are carried out such as testing coarse and fine aggregates in the form of moisture content tests, mud content, land specific gravity, volume, and sieve analysis. Making concrete test objects in this study with procedures used based on SNI reference standards 2493: 2011 where in making concrete test objects, the materials needed include fine aggregate, coarse aggregate, water, cement, and coconut husk fiber. After the concrete mixture is mixed, slump testing is carried out in accordance with SNI 1972: 1990. *The mix design* is then placed into the test mold with a cylindrical shape measuring 15 x 30 cm used for concrete compressive tests. In the flexure test, a test mold with a beam shape measuring 15x15x60 cm is used. After that, the sample is allowed to harden in the mold for 24 hours, then removed from the mold and stored in water or a humid environment until it reaches the test life of 7, 14 and 28 days.

RESULTS AND DISCUSSION

Fetch Analysis

An effective fetch analysis was carried out at the study location using Equation 1, an effective fetch can be produced according to Tabe1 1 as follows.

Table 1: Effective Fetch Recaps

FETCH (m)								
Direction	**N**	**NE**	**E**	**ONE**	**S**	**SW**	**W**	**NW**
Length(m)	0	62970	200000	200000	192805	62403	0	0

Hindcasting *Analysis*

This analysis requires hourly wind speed data for the last 10 years in the Manggar Balikpapan area. This data was obtained from the National Centers for Environmental Information (NCEI) by accessing the website https://www.ncei.noaa.gov/. After calculations are carried out using and *Handbook of Coastal Engineering*, and SPM, 1984, then obtained the height (Hs) and period (Ts) for the last 10 years on the coast of Manggar Balikpapan from 2013-2022 according to Table 2 below.

Table 2: Wave Hindcasting Recapitulation

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Hs	0,723	0,688	0,616	0,607	0,544	0,492	0,771	0,792	0,314	0,358
Ts	5,222	5,084	5,487	5,488	4,564	4,548	5,414	5,195	3,927	4,077

Wave Re-Period Analysis

Analysis of wave recurrence period is performed with *fisher tippett type I method* using re-period of 5, 10, 25, 50 and 100 years, where the 100-year repeat period is 1.43 m according to Table 3.

Table 3 : Calculation of Wave Recurrence Period

Birthday Period (Year)	**Yr**	**Hsr (m)**	**σnr**	**σr**	**Hs-1.28σr(m)**	**Hs+1.28σr (m)**
1	**2**	**3**	**4**	**5**	**6**	**7**
5	1,50	0,79	0,79	0,19	0,54	1,04
10	2,25	0,94	1,03	0,25	0,62	1,27
25	3,20	1,14	1,33	0,33	0,72	1,56

Birthday Period (Year)	Yr	Hsr (m)	σnr	σr	Hs-1.28σr(m)	Hs+1.28σr (m)
1	**2**	**3**	**4**	**5**	**6**	**7**
50	3,90	1,29	1,55	0,38	0,80	1,77
100	4,60	**1,43**	1,77	0,44	0,88	1,99

Tidal Data Analysis

The results obtained from the analysis of water level elevation using sea tide data of Manggar Beach in accordance with Figure 4, it is known that the type of tide waters of Manggar Beach Balikpapan is a *Mixed Tide Prevailling Semidiurnal* or mixed tidal which is more directed to daily double with the resulting formzahl value of 0.8 with 0.26 0.25< f ≤ 1.25. Based on the calculation of tidal data on the coast of Manggar Balikpapan, vertical datum data and other data were obtained in Table 4.

Table 4 : Tidal Data Calculation Results

Vertical Datum			*Other information*		
Information	**Value**	**Unit**	**Information**	**Value**	**Unit**
HHWL	159	Cm	Max Water high	151,4	Cm
MHWS	77	Cm	Min Water high	-100,3	Cm
MHWL	114	Cm	Range Tide	251,7	Cm
M.S.L.	4	Cm	MSL/DT/S0	4,187668	Cm
MLWL	-106	Cm	DTS	-3,9143	Cm
MLWS	-69	Cm	Z0	160	Cm
LLWL	-150	Cm	CD (MLWS)	-155,812	Cm
CD (LAT)	-164	Cm			

For the 1-year model, the maximum water height is 127.7 cm and the minimum water height is -113.3 cm, the tide range is 243 cm and *the low water conditions (for reduction)* are 42.48 cm.

Tetrapod Dimension Planning

Tetrapod planning is carried out to be able to determine the diameter and height of the tetrapod which will later be used as an assumption of the diameter of the structure used in the load analysis of the wave environment. The weight results of tetrapod protection layers are as follows:

$$w = \frac{\gamma_r H^3}{K_D (S_r - 1)^3 \cot\theta}$$

$$w = \frac{2,65 \ \times 3,8^3}{8(1,57)^3 2}$$

$$w = 2,3 \text{ Ton}$$

Based on the calculation above, the weight of the tetrapod protection layer is 2.3 tons, so the dimensions of the tetrapod can be determined in Table 6 and Figure 4 below.

CIVED
Journal of Civil Engineering and Vocational Education
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Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Table 5 : SizeTetrapod Dimensions

v (m^3)	H (m)	A (m)	B (m)	C (m)	D (m)	E (m)	F (m)	G (m)	I (m)	J (m)	K (m)	L (m)	TLL (m)	JBLL (Bh)
0,83	1,44	0,43	0,22	0,69	0,68	0,34	0,93	0,31	0,87	0,44	1,57	1,73	1,96	11,74

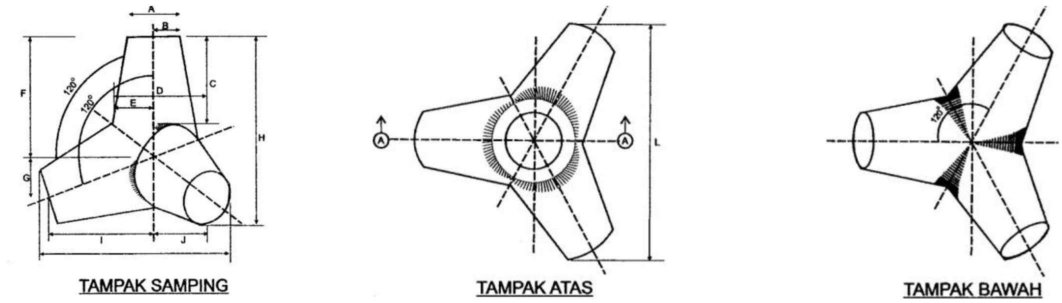

Figure 4 : Tetrapod view

Wave Environmental Load Analysis

Analysis at this stage is used to determine the amount of load that will later be received by the tetrapod structure.

Wave Load Analysis

The wave load analysis used uses Samson's rule which is to assess the integration of drag and inertia forces in an inclined cylinder according to equation 10. So that the total wave load of 105.7 kN is shown in Table 6 below.

Table 6 : Results of wave force calculation with Samson's rule

S	FI	FD	F1	FS	FR(N)	FR (kN)
0,0	3006,3	0,0	3006,3	1,0	4006,3	4,0
0,3	3006,3	4,6	3010,9	4,0	13043,5	13,0
0,6	3006,3	18,2	3024,5	2,0	7049,1	7,0
0,9	3006,3	41,0	3047,3	4,0	13189,4	13,2
1,2	3006,3	73,0	3079,3	2,0	7158,5	7,2
1,5	3006,3	114,0	3120,3	4,0	13481,2	13,5
1,7	3006,3	164,2	3170,5	2,0	7340,9	7,3
2,0	3006,3	223,5	3229,8	4,0	13919,1	13,9
2,3	3006,3	291,9	3298,2	2,0	7596,4	7,6
2,6	3006,3	369,4	3375,8	4,0	14503,0	14,5
2,9	3006,3	456,1	3462,5	1,0	4462,5	4,5
Sum					105749,9	105,7

Current Load Analysis

Analysis of current loads depending on the speed of the current using Samson's rule where in equation 16. So the calculation is produced according to Table 7.

CIVED Journal of Civil Engineering and Vocational Education

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Table 7 : Results of Current Load Analysis Calculation

Z	Fd	Fs	Fd x Fs (N)	Fd x Fs (kN)
0,00	0,00	1,00	0,00	0,00
0,22	0,00	1,00	0,00	0,00
0,44	46,09	4,00	184,36	0,18
0,65	146,81	2,00	293,63	0,29
0,87	320,85	4,00	1283,41	1,28
1,09	586,89	2,00	1173,77	1,17
1,31	963,60	4,00	3854,38	3,85
1,53	1469,66	2,00	2939,32	2,94
1,74	2123,76	4,00	8495,05	8,50
1,96	2944,58	2,00	5889,16	5,89
2,18	3950,80	4,00	15803,18	15,80
Sum			45077.36	45,08

So that the current load produced in this analysis is 45.08 kN

Wind Load Analysis

Wind load analysis is carried out using Equation 15 with the calculation of wind load as follows;

$F = 0{,}00256 \times V^2 \times C_D \times A$

$F = 0{,}00256 \times 44{,}74^2 \times 0{,}7 \times 399{,}91$

$F = 6.380{,}41\ N$

$F = 6{,}38\ kN$

Total Environmental Load

The total environmental load is the sum of the waves, currents and wind so that the total environmental load of 148.8 kN is obtained according to Table 8 below;

Table 8 : Total Environmental Load

Information	Value	Unit
Wave Force	106	Kn
Current Force	45,08	Kn
Wind Force	6,38	Kn
Total Style	**157,46**	**Kn**

Using the concrete tensile strength equation, which is as follows:

$$f'sp = \frac{2p}{\pi LD}$$

$$f'sp = \frac{2 \times 157,,8}{\pi \times L \times D} = 3\ Mpa$$

Obtaining a normal concrete quality value, the following calculations are carried out

$F_c = (f'sp/0{,}63)^2$

$F_c = (3/0{,}63)^2 = 23\ Mpa$

So that based on the environmental load generated in the planning of the tetrapod on the Balikpapan manggar beach, the planned concrete quality is 23 Mpa.

Concrete Test Specimen Manufacturing

From the calculation of the *mix design* calculation, the composition of the normal concrete

Journal of Civil Engineering and Vocational Education
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Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

mixture is 347.46 kg / m3, Water liter / m3, Fine Aggregate kg / m3, and Coarse Aggregate kg / m3. After the concrete mixture is ready to be molded, slump testing is carried out. Based on SNI 7656:2012 the optimum slump value for building construction type concrete is 100 mm with a tolerance value of 20 mm, so the slump value used is 10±2 cm.

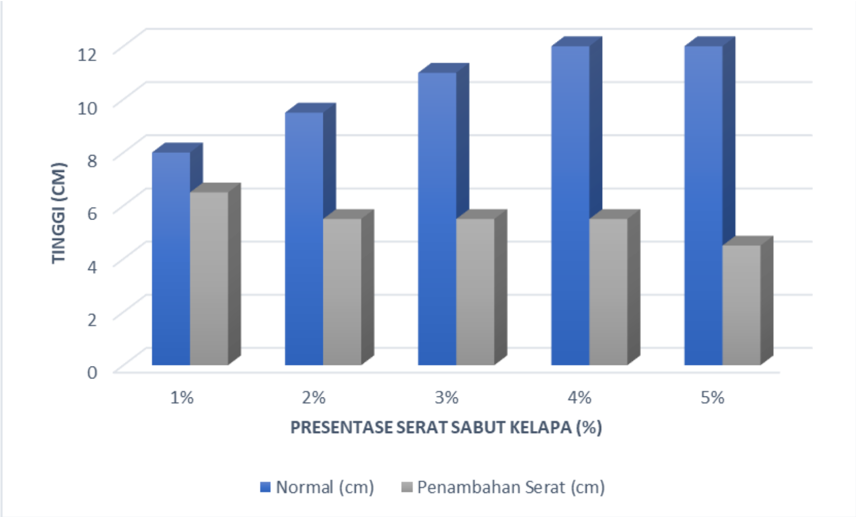

Figure 5 : Slump Test Results

Based on the picture above, it is known that in the 1% variation there is a decrease in the slump value before 19%, this event increases in line with the addition of coconut husk so that with the variation of adding 5% coconut husk fiber to concrete, a decrease in the slump value is obtained by 60%. Therefore, it is known that the greater the variation of coconut husk against concrete, the lower the resulting slump test value. After the slump test, the concrete is printed with cylindrical molds and blocks using the quality plan obtained in the previous analysis. The following is a sample of the specimen used presented in Figure 6.

Figure 6 : Results of Making Test Specimen Samples

Concrete Test Results

In this study, tests were carried out on the bending strength, tensile split, and compressive of normal concrete and concrete with variations of coconut husk made, namely 1%, 2%, 3%, 4%, and 5% presented in Figure 7 as follows.

Figure 7 : Test results of concrete samples

Compressive Strength Test Results

The results of compressive strength testing on normal concrete were carried out for 7 days, 14 days, and 28 days. The average result of concrete compressive strength in 7 days is 16.9 Mpa, the average result of concrete compressive strength in 14 days is 20 Mpa, and the average result of concrete compressive strength in 28 days is 23.7 Mpa. So it is found that the compressive strength of concrete will increase every day and the maximum compressive strength value at 28 days. The following is a graph of the compressive strength of normal concrete according to the following Figure 8.

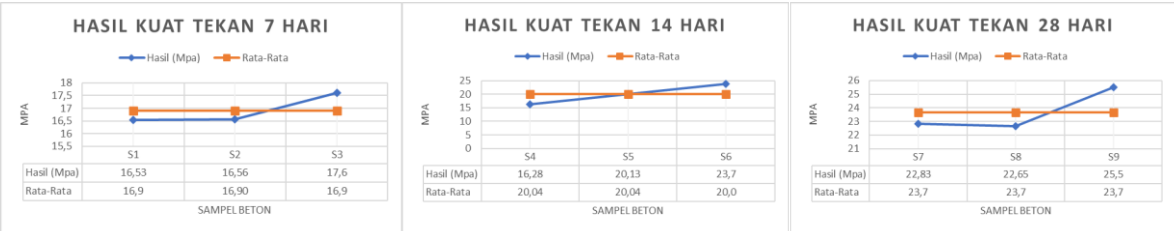

Figure 8 : Compressive Strength of Concrete variation 0%

The compressive strength on the test specimen using variations of coconut husk, namely 1%, 2%, 3%, 4%, and 5% is seen in Table 13 and Figure 9 below.

Table 13 : Compressive Strength Results of Environmentally Friendly Concrete

Kind	**1%**	**2%**	**3%**	**4%**	**5%**
Normal Average	23,79	23,79	23,79	23,79	23,79
Variations	22,00	22,63	28,45	25,20	20,81

The resulting compressive value in the variation of 1% coconut husk is known to be a compressive value of 22.0 Mpa. In the 2% variation of coconut husk, it is known to be 22.63 Mpa. In the 3% variation of coconut husk, it is known to be 28.45 Mpa. In the 4% variation of coconut husk, it is known to be 25.2 Mpa. In the 5% variation of coconut husk, it is known to be 20.81 Mpa. So it can be seen that in variations of 1% and 2% coconut husk against concrete press there is no increase while in variations of 3% coconut husk there is an increase in compressive value, in variations of 4% coconut husk there is an increase in compressive value but the value is not higher than the variation of 3% and in variations of 5% coconut husk obtained the result of the compressive strength value decreases lower than the planned compressive strength. The following is a graph of the results of the compressive test on environmentally friendly concrete using variations of coconut husk in Figure 9.

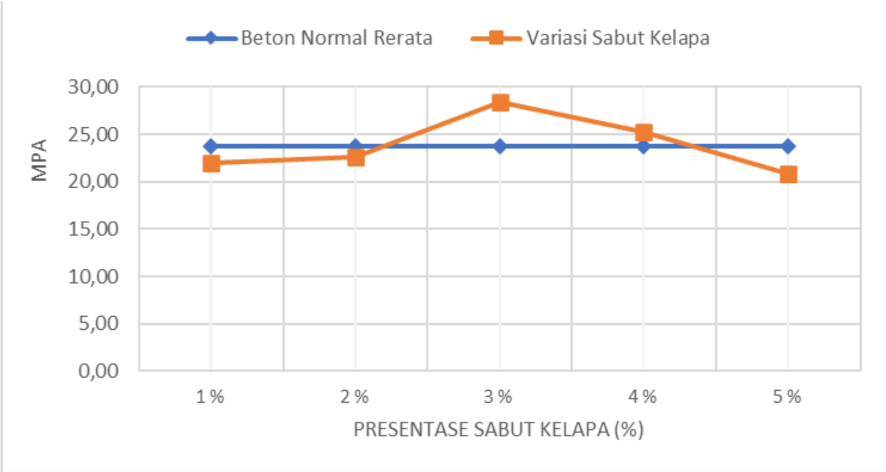

Figure 9 : Graph of Compressive Strength Results of Eco-Friendly Concrete

Flexural Strength Test Results

The results of tests on flexural strength in environmentally friendly concrete are in Table 14.

Table 14 : Flexural Strength Test Results of Environmentally Friendly Concrete

Kind	1%	2%	3%	4%	5%
Normal Average	3,10	3,10	3,10	3,10	3,10
Variations	2,80	3,45	3,58	3,20	2,85

In the variation of 1% coconut husk, it is known to be strong flexible, which is 2.8 Mpa. In the 2% variation of coconut husk, an increase in bending strength was obtained which was 3.45 Mpa. In the 3% variation, coconut husk obtained a flexible strength of 3.58 Mpa. For the 4% variation, coconut husk obtained a flexible strength of 3.20 Mpa. In the 5% variation, coconut husk obtained a flexible strength of 2.85 Mpa. So it can be seen that in the variation of 1% coconut husk, the value of concrete bending strength is produced does not increase, while in variations of 2% and 3% coconut husk, there is an increase in bending value, in the variation of 4% coconut husk, there is an increase in bending value, but the value is not higher than the variation of 3%, and in the 5% variation, the addition of coconut husk fiber, the compressive value decreases lower than the average bending value of normal concrete. The following is a graph of the results of the flexural strength test on environmentally friendly concrete using variations of coconut husk fiber.

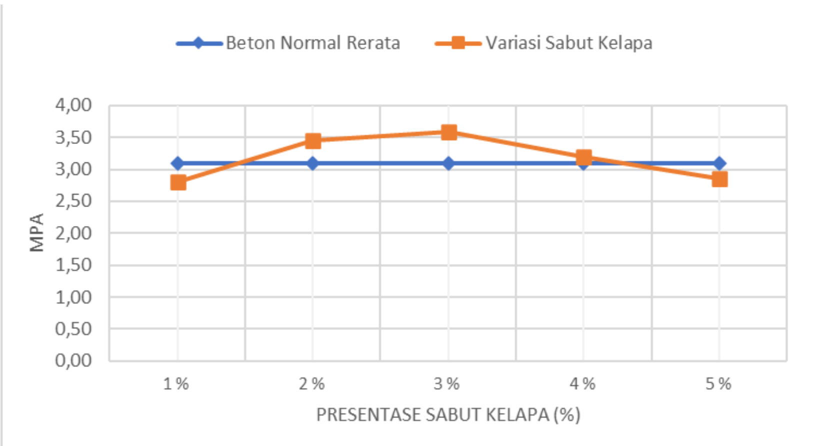

Figure 10 : Graph of Environmentally Friendly Concrete Flexural Strength Test Results

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Tensile Strength Test Results

In this study, tests were carried out on the tensile strength of concrete on test specimens with the test results presented in Table 15 below.

Table 15 : Strong test results of environmentally friendly concrete tensile

Kind	1%	2%	3%	4%	5%
Normal Average	2,57	2,57	2,57	2,57	2,57
Variations	2,70	3,08	3,00	2,69	2,19

In the variation of 1% coconut coir produced which is 2.7 Mpa, in the variation of 2% coconut coir produced which is 3.08 Mpa, in the variation of 3% coconut coir produced which is 3.0 Mpa, in the variation of 4% coconut coir produced which is 2.69 Mpa, in the variation of 5% coconut coir produced which is 2.19 Mpa. Based on the results of tensile strength tests on environmentally friendly concrete, it is known that variations in coconut coir affect the tensile strength of concrete, it can be seen that the tensile value produced with environmentally friendly concrete at variations of 2% and 3% has increased quite large and is the most effective variation to increase the tensile value in concrete and at variations of 4% and 5% the tensile value decreases to below the strength value of Tensile and Split plan. The following is a graph of the results of tensile tests on concrete using variations of coconut husk presented in Figure 11 below.

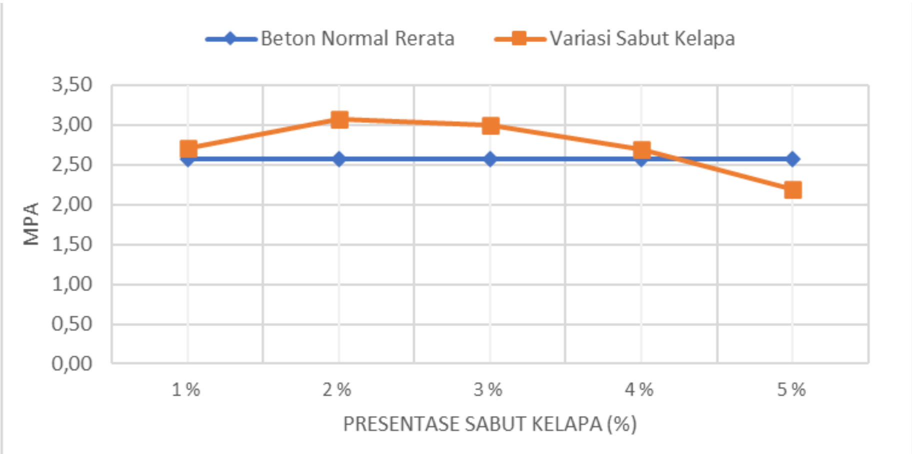

Figure 11 : Graph of Tensile Strength Test Results of Eco-Friendly Concrete

CONCLUSION

Based on the analysis, the quality value of concrete in the planning of environmentally friendly tetrapods on the coast of Manggar Balikpapan is 23 Mpa, the value is determined based on the analysis of wave generation at the research site. In addition, it is known that variations of coconut husk in environmentally friendly concrete mixing affect the test value of slump, compressive strength, bending and tensile against concrete. Where the results of the slump test show that the greater the variation of coconut husk fiber in the test concrete, the lower the resulting slump test value will be. In tests of compressive strength, bending and tensile strength, it is known that the composition of adding the most optimal coconut husk fiber is in a variation of 3%, in this composition the amount of coir fiber is able to improve the mechanical properties of tetrapod concrete compared to other compositions.

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