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DESIGN OF *PRESTRESS* BRIDGE PT LIFERE AGRO KAPUAS SUNGAI BELIDA ESTATE SUKA MAJU VILLAGE MANTANGAI DISTRICT KAPUAS REGENCY CENTRAL KALIMANTAN PROVINCE

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ABSTRACT

PT. Lifere Agro Kapuas (LAK) is a Malaysian foreign company engaged in oil palm plantations. Located in Suka Maju Village, Mantangai District, Kapuas Regency, Central Borneo Province. At that location, there is a river that divides the two production lines of PT LAK. On the river, a temporary bridge made of wood was built, and the condition was quite precarious, but traffic was forced to pass with a tonnage load exceeding the bridge's capacity, and the small dimensions of the bridge caused traffic flow for production facilities to be hampered because they had to pass through the bridge alternately, as a result of technological developments resulted in a concept that is different from the concept of ordinary reinforced concrete. The combination of high compressive strength concrete with steel with high tensile strength result in the concept of Prestressed Concrete, which can handle heavy loads. Loading planning refers to SNI 1725-2016 standard. Floor slab planning uses the Bittner method and is considered a one-way slab so that the largest forces are used between the two methods. In the design of girder beams using reinforced concrete material with an fc' quality of 40 MPa. Tendon type Uncoated seven super wire strands ASTM A-416 grade 270 totaling four tendons each girder. The axial resistance of piles is taken based on the smallest value of the strength of the material, soil drilling data, CPT, or N-SPT. At the same time, the lateral resistance of the Pile is taken from the smallest value of the maximum moment. Based on the results of the analysis, a PCI-Girder H 170 section was chosen with a loss of prestress is 29,8%. The tensile strength of the tendons is 1860 MPa. Floor slab fc' quality 35 MPa with thick 30 cm D29-200 main reinforcement and D16-200 dividing reinforcement. Backrest fc' 25 MPa. The lower structure uses fc' 25 MPa quality concrete. With fabricated pile foundations from PT. Wika Beton type PC Spun Pile B class with 50 cm diameter with 18 piles each abutment..

Keywords: Bridge, prestressed

1. INTRODUCTION

PT. Lifere Agro Kapuas (LAK) is one of Malaysia's foreign companies engaged in oil palm plantations in the Kapuas Regency of Central Kalimantan Province. Located in Suka Maju Village is a village located in the Mantangai district, Kapuas

Regency, Central Kalimantan Province. In the village, there is a river that divides two production lines of PT. LAK. The line is vital because it concerns the company's production access. On the river, a temporary bridge made of wood was built, and the condition was quite vulnerable but still forced to pass traffic with a tonnage load that exceeded the capacity of the bridge. The small impact of the bridge caused the traffic flow of the production facilities to be hampered because they had to pass the bridge in turn. To facilitate access to the company's production, it is necessary to upgrade the bridge from a bridge that was originally wooden to a concrete structure bridge which is expected to provide a solution that can overcome problems in the long term. The chosen bridge structure is a prestressed bridge with a pile foundation..

2. THEORETICAL STUDY

Common

A bridge is a building that connects physically for the purposes of transportation services from one end to the other that is blocked by natural conditions or other buildings.

Prestressed, Prestressed Cables, and Loss of Prestress

Prestress can be defined as the administration of a force or ordinary also in the form of a predetermined moment to an element of the structure in such a way that the combination of the stress due to the total load and the stress due to the prestressed force will be within the limit of a certain desired stress. Prestressed steel or prestressed cable has a higher quality than ordinary reinforcing steel. According to ASTM A 416, prestressed cables have two grades or grades, namely, grade 250 (G 250) and grade 270 (G 270). The prestressed force in concrete undergoes a progressive reduction process (gradual reduction) from the moment the initial prestressed force is applied, so the stages of the prestressed force need to be determined at each stage of loading, namely from the stage of transfer of the prestressed force to the concrete to the various stages of prestress that occur under workload conditions until it reaches the ultimate state. Basically, the value of each loss of prestressed force is small, but when added together, it can cause a significant decrease in the jacking force, which is ± 15% - 25%.

Bridge Head (Abutment)

The structure under the bridge is in the form of an abutment that can be assumed to be a retaining wall of soil. The functions of abutment include: As the placement of bridge beams or beams, the placement of a treading plate, a successor to the forces acting on the upper structure to the foundation, and resistance to active ground pressure. An abutment is the fulcrum of the bridge girder at the end of the concrete or the load given to the abutment from the top. The load of the bridge is devolved to the foundation beneath it, which is then passed to the ground.

Pile Foundation

The pile foundation serves to support the building on a strong layer of soil that is located very deeply. Pile foundations are used to support buildings that withstand upward lifting forces, especially in high-rise buildings that are affected by rolling forces due to wind loads. Bearing capacity analysis studies the soil's ability to support foundation loads from structures located on it. Carrying capacity expresses the shear resistance of the soil to resist the decline due to loading, i.e., the shear resistance that the soil can deploy along its shear planes. Shearruins and excessive descent should be considered in the foundation design. For this reason, it is necessary to meet two criteria, namely: stability criteria and decrease criteria.

3. RESEARCH METHOD

3.1 Design Location

The design is located in Sungai Belida Estate Sukamaju Village, Mantangai District, Kapuas Regency, Central Kalimantan.

Figure 1. Research Location

3.2 Preparatory Stage

Doing a field survey at the location to be designed. Furthermore, collecting theoretical study resources that will be used in work on this final project, namely applicable regulations, journals, or books. The regulations used include SNI 8640-2017 about Geotechnical Design Requirements, SNI 1725-20 16 about Loading For Bridges, and SNI 2847-2019 about Structural Concrete Requirements For Buildings.

4. RESULTS AND DISCUSSION

4.1 Plate Planning

Type of slab planned using One Way Slab with specifications: Plate thickness = 30 cm, Concrete quality fc' = 3 5 Mpa, Quality of steel reinforcement fy' = 320 Mpa, Distance between beams (s) = 155 cm, Span (L) = 30 m, Specific gravity of reinforced concrete (Y_c) = 2400 Kg/m 2, Specific gravity of asphalt (Y_a) = 2200 Kg/m^2 , Specific gravity of rainwater (Y_w) = 1000 Kg/m^2, D Main reinforcement = 29 mm, there is also the following loading of se bag: Own weight of the plate = 0,30 . 1. 2500 = 0.75 t/m. Asphalt weight = 0.0 7 .1. 2200 = 0.142 t/m'. Rainwater weight = 0.05 . 1. 980 = 0.049 t/m'

$M_{MS}^{T} = \frac{1}{12}$. Q . s 2 = . 7.5 . 1.85 2 = $\frac{1}{12}$2.13 kNm

$M_{MS}^{L} = \frac{1}{24}$. Q . s 2 = . 7.5. 1.85$\frac{1}{24}^{2}$ = 1.06 kNm

4.2 Girder Moments

Account Moment girder uses the *simple method Beam* as next:

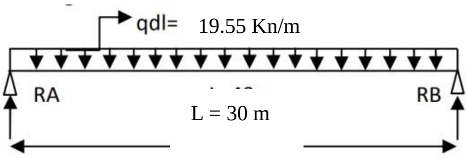

Figure 2. Simple Beam

M_{MS} = 1/8 . Q_{MS}. L^2 = 1/8 . 19.55. 30^2 = 2199.4 kNm

M_{MA} = 1/8 . Q_{MA}. L^2 = 1/8 . 1.6. 30^2 = 180 kNm

4.3 Prestressed Force Occurring

The prestressed force occurs as follows:

a. When Transferring/Jacking

fca= -Pt/A + (Pt . es)/Wa – M_{beam}/Wa

= -(6757.36)/0.6835 + (6757.36 . 0,718)/(0,29207) - 1960,79/(0,29207)

= 15.03 kPa

The stress is below σc, 0.6. FCI':

fcb= -Pt/A - (Pt . es)/Wb + M_{beam} /Wb

= -(6757.36)/0.6835 - (6757.36 . 0,718)/0,28822 + 1960,79/0,28822

= -19920 kPa

fcb = -19920 kN/m2 $\leq$ -0.6 x fci' = -19920 kN/m2 (safe)

b. Loss of Prestress

Loss of Prestress is caused by the process of anchoring, shrinkage & creep, tendon friction, and others. Planned a loss of prestress is 30% of the initial prestress.

Table 1 Recapitulation Loss of Prestress

Style	(kN)	Loss of Prestress	% UTS
Pj	7949,84	Anchorage Friction	69,84%
Po	7711,34	Jack Friction	67,74%
Px	7151,95	Elastic Shortening	62,26%
Pi	6508,77	Relaxation of Tendons	58,56%
Peff	5575,88		50,71%
	Loss of Prestress =	29,8%	

4.4 Tendon

The types and specifications of prestressed cables or tendons used are as follows below. Strand type = Uncoated seven wire super strand ASTM 416 grade 270, Nominal diameter = 12.7 mm, Cross-sectional area = 100 mm2, Ultimate tensile strength = 1860 Mpa, Melting stress (fpy) = 1580 MPa, Number of strand wires = 19 strand/tendon wires..

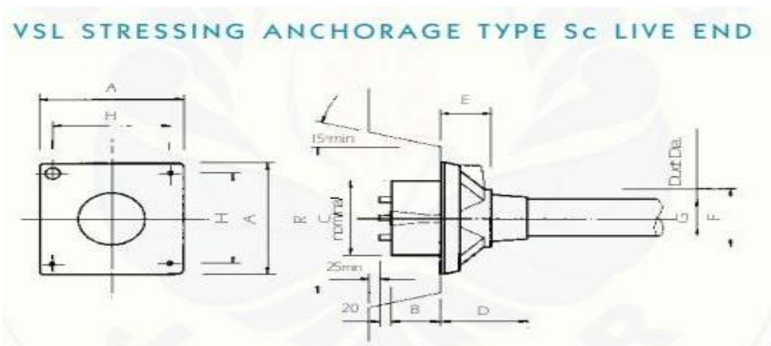

Figure 3. Live Shuttle VSL Type 19 Sc

4.5 Tendon Trajectory

Arranging the position of the Tendon in the form of the trajectory of the Tendon is parabolic, and to find out the exact position of the Tendon, use the curve equation. The calculation is reviewed half the span with an interval distance of every 1 m:

Y = 4 . f . X / L2. (L – X)

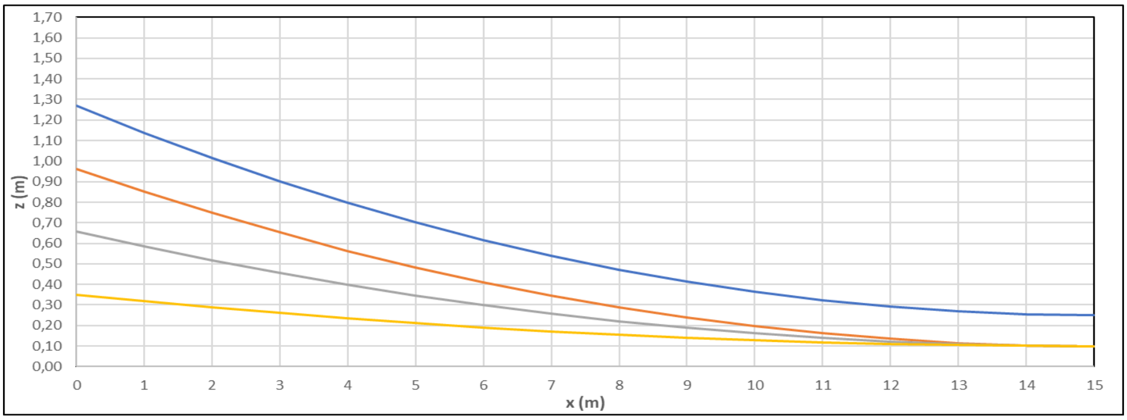

Figure 4. Tendon Trajectory

With a description of where: Y = Ordinates of the Tendon under review, X = Abscissa of the studied Tendon, L = span length, f = maximum parabolic apex height.

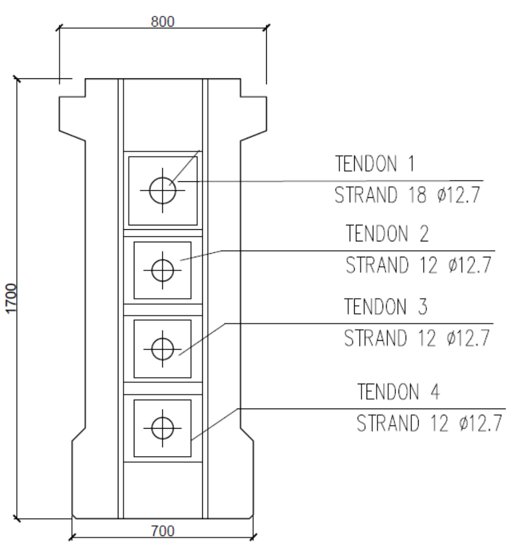

Figure 5. Tendon Position At the end and in the middle of the span

4.6 Lower Structure

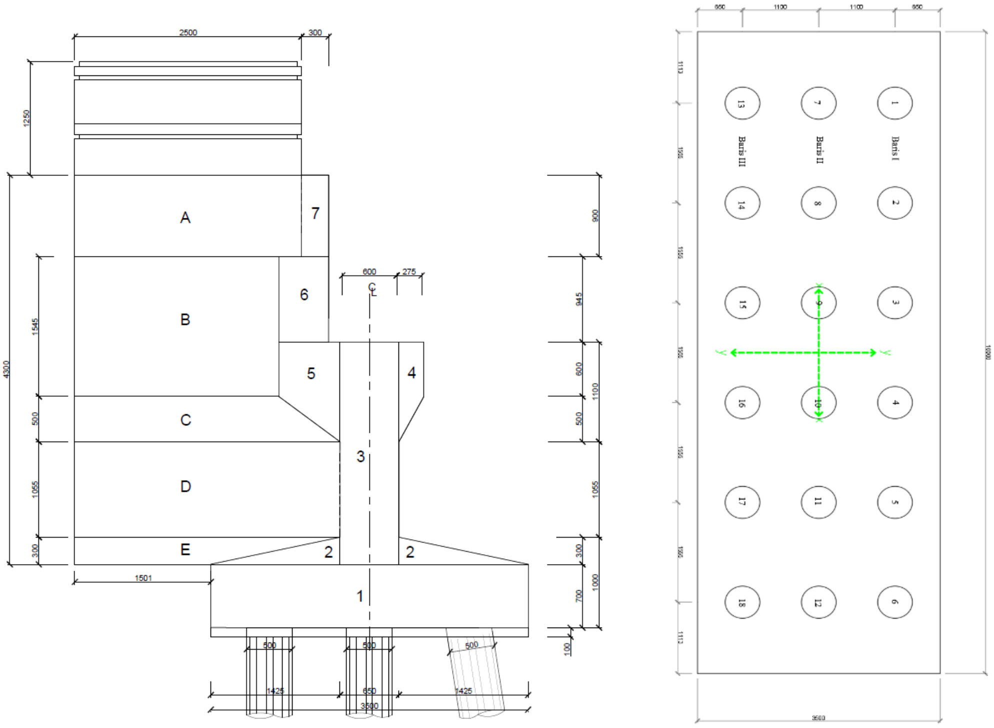

Figure 6. Abutment Segment And Pile Foundation Plan

Table 2 Recapitulation of Loading That Occurs In Abutments

Action/Load	Code	Vertical Load	Horizontal Load (x)	Horizontal load (y)	Moment of Direction x Against CL	Moment of Direction y Against CL
		(kN)	(kN)	(kN)	(kNm)	(kNm)
Fixed Action						
Own Weight	*MS*	3.854,8				-390,4
Additional dead load	*MA*	94,9				0,0
Ground Pressure	*TA*					
- Normal State			753,3			1276,3
- State of the Earthquake			828,6			1403
Transient Action						
Lane load "D."	*TD*	204,8				
Pedestrian Load	*TP*	0,0				
Brake Load	*TB*		16,0			108,5
Friction Force	*BF*		100,2			324,7
Wind Load Structure	EW_S			13,0	68,7	
Vehicle Wind Load	EW_L			2,2	13,6	
Special Action						
Earthquake Load	*EQ*			385,6	530,5	

The calculation of the force acting on the poer is taken from the table of combinations of Strong I loading as follows, then: Vertical (V) / centric load = 5503 kN, Horizontal (H) / lateral load = 1070.5 kN, Moment (M) / moment load = 1607.8 kNm.

The load that occurs is channeled into the rows of Piles so that the following results are obtained:

Table 3 Vertical, Horizontal, and Axial Forces Working On Piles

Combination	Styles That Work									
	P (Ton)	Row I (Inclined Pile)			Row II (Upright Pile)			Row III (Upright Pile)		
		Vi (kN)	Ai (kN)	Hi (kN)	Vi (kN)	Ai (kN)	Hi (kN)	Vi (kN)	Ai (kN)	Hi (kN)
Strong I	5.503,20	427,54	429,02	65,41	305,73	305,73	46,74	183,93	183,93	46,74
Strong II	5.421,28	422,99	424,45	65,35	301,18	301,18	80,31	179,38	179,38	80,31
Strong III	5.134,56	407,06	408,47	65,13	285,25	285,25	78,90	163,45	163,45	78,90
Strong IV	5.134,56	407,06	408,47	65,13	285,25	285,25	78,90	163,45	163,45	78,90
Strong V	5.134,56	407,06	408,47	65,13	285,25	285,25	78,90	163,45	163,45	78,90
Extreme I	4.215,90	356,02	357,26	64,42	234,22	234,22	80,44	112,41	112,41	80,44
Extreme II	4.052,06	346,92	348,12	64,29	225,11	225,11	81,23	103,31	103,31	81,23
Service power I	4.154,46	352,61	353,83	64,37	230,80	230,80	81,74	109,00	109,00	81,74
Service power II	4.215,90	356,02	357,26	64,42	234,22	234,22	82,04	112,41	112,41	82,04
Service power III	4.113,50	350,33	351,55	64,34	228,53	228,53	81,53	106,72	106,72	81,53
Service power IV	3.949,66	341,23	342,41	64,21	219,43	219,43	80,72	97,62	97,62	80,72
Fatigue	153,60	130,34	130,79	61,28	8,53	8,53	0,76	-113,3	-113,3	0,76

Used spun pile piles from PT. Wika Beton with a diameter of 500 mm (50 cm). The ultimate capacity of the Pile can be calculated empirically from the N value of the N- SPT test result (Meyerhof, 1956).

- **Support Capacity**

$Q\ b = A_b.\ 4.\ (N_1)_{60}\ .\ \leq 40.\ \frac{Lb}{d}(N_1)_{60}.\ A_b = 0.196.4.\ 36.05\ .\ \frac{3,5}{0,5} \leq 40.\ 36.05.\ 0.196$

$= 1981.25\ kN \leq 2358.6\ kN$

$Q_{all} = \frac{Qu}{SF} = \frac{1981,25}{3} = 660,4\ kN$

So, the carrying capacity of a single Pile for abutment is obtained based on NSPT data.

$Q_{all} = 660,4\ kN \quad > \quad P = 427\ kN$ (OK!!)

- **Lateral Capacity**

No	Description of the Lateral Prisoners of the Pile	$\varphi * H_n$	
1	Based on maximum Pile deflection (Broms)	52,37	
2	By maximum moment (Brinch Hansen)	84,96	
	Lateral resistance of the mast, $\varphi * H_n$ =	52,37	Kn

Taken lateral resistance piles, → $\varphi * H_n =$ 50,00 Kn

H_{all} = 50 kN

The safe conditions for carrying capacity are as follows:

$H_{all} \geq H_{force}$

50 kN ≥ 10,9 kN (OK!!)

$$Eg = 1 - \frac{(n-1).m+(m-1).n}{90 . m.n}. \ \theta = 1 - . \frac{(6-1) . 3 + (3-1) . 6}{90. 3 . 6} 17.87 = 0.70216 = 70.2 \%$$

From the calculation of efficiency using the *Converse-Labarre* formula, an efficiency of 70.2% was obtained. So it gets:

$P_{netto} = Q_{all.\ E.g.}$, = 660.4. 0.70216 = 463.719 kN

Safe requirements for carrying capacity:

$P_{netto} > P_{force}$

463,719 kN > 427 kN (OK!!)

5. CONCLUSION

From the results of the calculation and planning of the Prestress Concrete Bridge of PT Lifere Agro Kapuas with the PCI-Girder H170 type, the following results were obtained:

1) Planning of a Class A bridge (1-7-1) girder type PCI-Girder H 170, span length 30 m. K-350 floor slab concrete quality (fc' 35 Mpa), K-250 backrest concrete quality (fc' 25 Mpa), lower structure concrete quality K-300 (fc' 30 Mpa), U-32 main reinforcing steel quality (fy 320 Mpa), U-24 divider and shear reinforcing steel quality (fy 240 Mpa). Control over plate deflection f = 0.0572 mm < f allowable = 7.7 mm. Take four pieces of Tendon and a loss of prestress 29,8%.
2) As for the lower structure, it has abutments with dimensions of 5 m in height, a tread width of 3,5 m, and a length of 10 m. The pile foundation uses a B-class Spun Pile type with a diameter of 500 cm with a depth of 40 m in the depth of hard soil. The budget plan for the construction of the PT Lifere Agro Kapuas prestresses bridge is Rp7.870.260.000,00- or numbered as Seven Billion Eight Hundred and Seventy Million Two Hundred and Sixty Thousand Rupiah.

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