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Alternative Design of Drive Pile and Floating Foundation of Bridge Structure over Soft Soil (Case Study : Muara Tahai Bridge Sta. 0+100 Kabupaten Pulang Pisau, Center Kalimantan)

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ABSTRACT

One of the PSN progarm is the improvement of Muara Tahai Bridge that located in Kabupaten Pulang Pisau. The existing design of the substructures uses steel piles with a diameter of 50 cm and a depth of 28 meters due to soft soil condition. After a few trial, the effective design using piles can be done with the depth 20 meter with Pmax control of 34.65 tons < P allowed for group piles of 41.81 tons. An alternative design as a substructure is using floating foundation, which is concrete foundation using floaton material in it. The floating foundation dimension is 10 meter long, 3.2 meter width and 1,5 meter thick. The bearing capacity of the floating foundation using Terzaghi theory is 5,02 Ton/m^2.

Keyword : Soft soil, bearing capacity, floating foundation

INTRODUCTION

Indonesian government has been launched a program to support social economy for it's people using PSN (Proyek Strategis Nasional) that carried out in the infrastructure sector. One of the program that has been run is Food Estate Area in Kabupaten Pulang Pisau and Kabupaten Kapuas, Center Kalimantan. This project goals is to improve the quality of road and the connectivity between national road and the improvement area of Food Estate. This program is run and become task for PUPR Ministry through Direktorat Jenderal Bina Marga. One improvement project that will be discussed in detail is the Muara Tahai Bridge which is located at Sta. 0+100 on Janas – STI Simpang Tiga (Sp.3) Section with a span of 50 m.

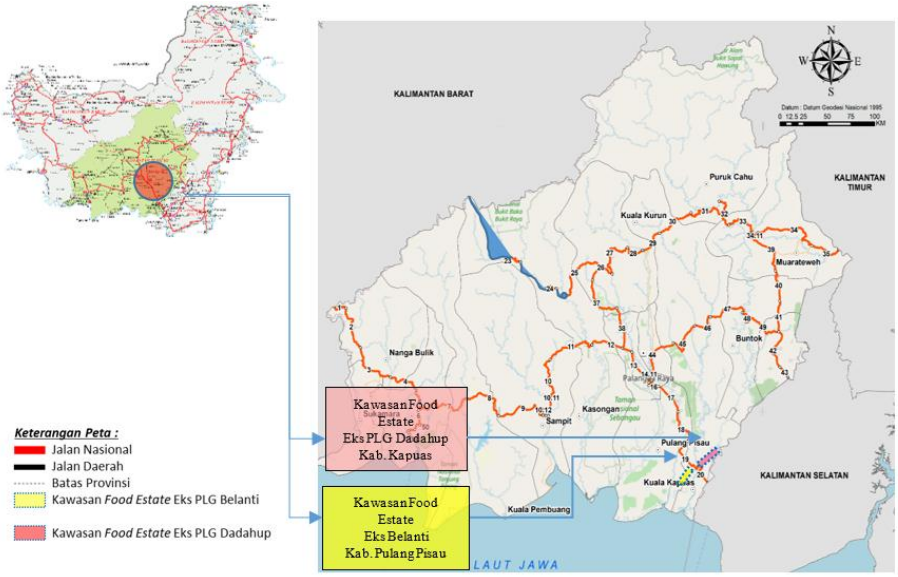


Figure 1. Location of Food Estate Area Ex-PLG Belanti, Kabupaten Pulang Pisau and Food Estate Area Ex-PLG Dadahup, Kabupaten Kapuas, Center Kalimantan
(Source: KPIJ Balai Pelaksanaan Jalan Nasional, Center Kalimantan)

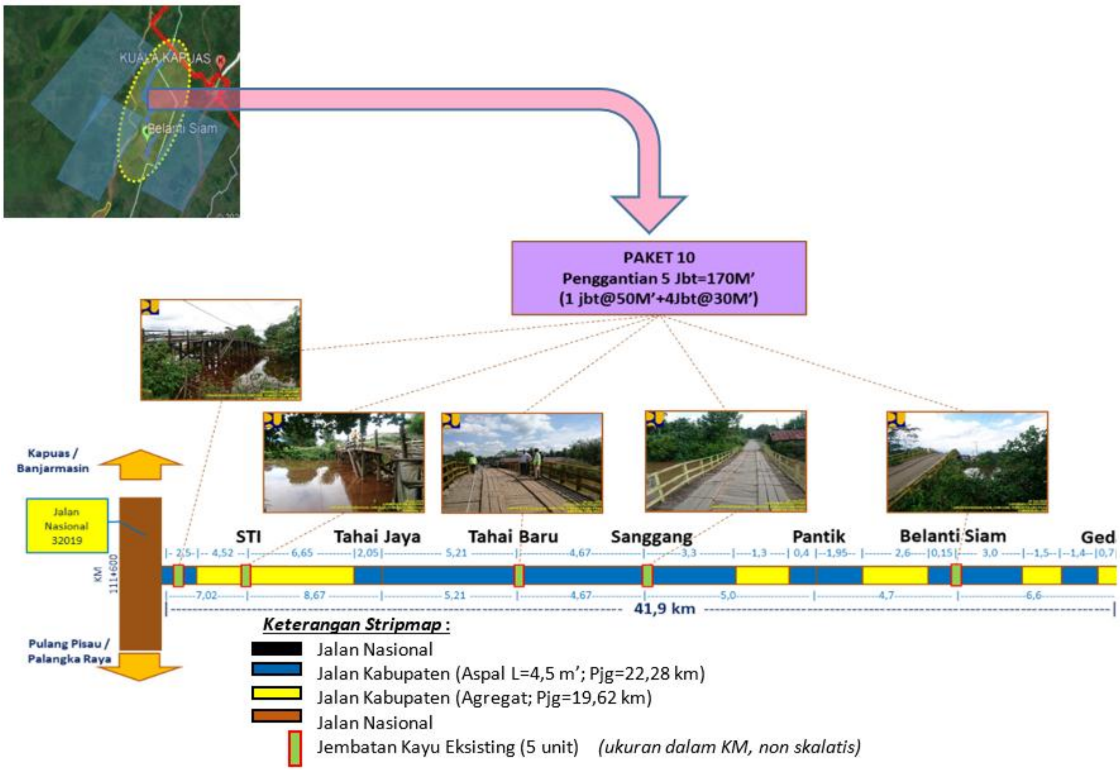


Figure 2. Location of Bridge Improvement Food Estate Area Ex-PLG Belanti, Kabupaten Pulang Pisau, Center Kalimantan
(Source: KPIJ Balai Pelaksanaan Jalan Nasional, Center Kalimantan)

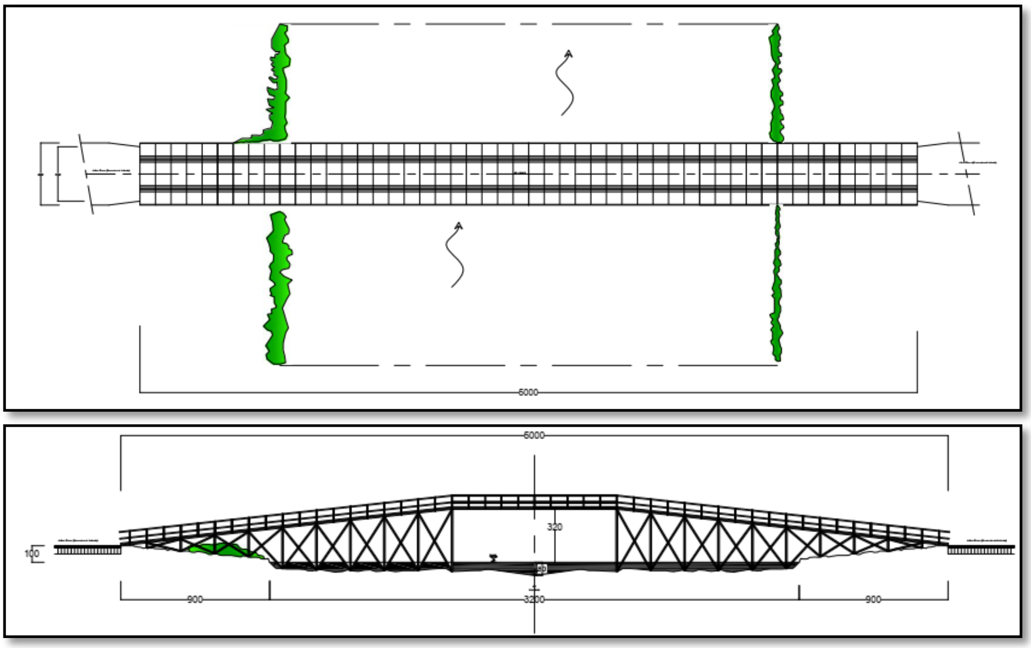


Figure 3. Top View and Longitudinal View Muara Tahai Bridge, Sta. 0+100
(Source: KPIJ Balai Pelaksanaan Jalan Nasional, Center Kalimantan)

The main focus of this project is the condition of the existing soil, which is very soft soil. This challenge is quite risky, where the land is the main basis for the establishment of a building. So the strengthening of the structure under the bridge structure is needed. In general condition, the soil bearing capacity at the Muara Tahai Bridge project is soft soil with a gray silty clay soil type with soft soil condition until 20 meters depth.

Therefore, based on these conditions, Muara Tahai Bridge require an improvement to increase road facilities by noticing the capacity of bottom structure. This journal will focus more on discussing the comparison between the carrying capacity of existing and alternative pile foundation and alternative design using floating foundations.

LITERATURE REVIEW

Soft Soil

Based on Geotechnical Guide 1 Formation Process and Basic Properties of Soft Soils (2002), the USCS System divides soils into three main groups namely coarse-grained soils, fine-grained soils and soils with a high organic content.

Table 1. Classification of Fine Grained Soil Based on Organic Content

Organic Content	Soil Classification
> 75%	Peat
25% - 75%	Organic Soil
< 25%	Soil with Low Organic Content

(Source: Geotechnical Guide 1 Formation Process and Basic Properties of Soft Soil, 2002, p. 46)

Soft soil contains clay minerals and contains a high water content. Generally, a layer of soil called a soft layer is clay or silt which has a standard penetration test value (N) of less than 4 or organic soils such as peat which have a very high natural moisture content. The term "soft soil" refers to soils in which if not carefully identified and investigated, may cause long term instability and intolerable problems due to their low shear strength and high compressibility according to Geotechnical Guide 1 Formation Processes and Basic Properties of Soft Soils (2002).

Pile Foundation

Piles are widely used in Indonesia as building foundations which have relatively heavy loads. The basic consideration of using pile foundation are the presence of a large load so that shallow foundations cannot be used, and the type of soil at the construction site is relatively soft, so that direct foundation are not economical to use. For these conditions, the use of pile foundations has several advantages, there are:

1. Production costs that are more expensive become cheaper when converted to the power produced..
2. Easier to use.
3. The equipment used is easily available..
4. Workers in Indonesia are skilled enough to carry out buildings using pile foundations.
5. Relatively faster execution time.

Generally pile foundations are used when the base soil does not have sufficient bearing capacity to carry the weight of the building and the load on it, and also when the location of hard soil that has sufficient bearing capacity to carry the weight of the building above is located in a very deep position.

Floating Foundation

The bearing capacity of the subgrade foundation is based on the Terzaghi formula for square foundation foundations on soil:

$$qu = 1{,}3\, c\, Nc + q\, Nq + 0{,}4\, \gamma t\, B\, N\gamma \qquad \ldots(1)$$

For Nc, Nq and Nγ is a bearing capacity factor whose value depends on the value of the angle of shear in the soil (φ) can be seen in Table 2.

Table 2. Table of Bearing Capacity Factors based on Terzhaghi

φ	General Shear Collapse		
	Nc	**Nq**	**Nγ**
0	5,7	1	0
5	7,3	1,6	0,5
10	9,6	2,7	1,2
15	12,9	4,4	2,5
20	17,7	7,4	5
25	25,1	12,7	9,7
30	37,2	22,5	19,7
34	52,6	36,5	35
35	57,8	41,4	42,4
40	95,7	81,3	100,4
45	172,3	173,3	297,5
48	258,3	287,9	780,1
50	347,6	415,1	1153,2

Source: Herman,1999

Information :

c = Soil Cohession

q = γt x Df

B = Width Foundation

DATA COLLECTION

Soil Data in Study Location

Soil data that will be used as the basis for planning in this discussion uses SPT data in Borelog BH-02 contractor and BH-01 consultant.

Kedalaman (m)	(BH-02) B			Paraemter Tanah dasar										
				Rekapitulasi Data										
	Nilai SPT, N	Jenis Tanah Borelog	Data Borelog Pelaksana (BH-02)	Wc (%)	γsat (kN/m³)	Gs	e dengan rumus γ	Sr	LL	PL	IP	Cc	Cs	Cv (cm²/det)
0 - 1	0	Lempung	Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	59.30			0.90	0.1282	0.0011
1 - 2	0	Lempung berlanau abu - abu	Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	59.30					
2 - 3	0		Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	59.30					
3 - 4	0		Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	59.30					
4 - 5	0		Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	59.30					
5 - 6	0	Lempung berlanau coklat	Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	59.30					
6 - 7	0		Sangat Lunak (very soft)	85	13.000	2.300	2.273	100	56.00			0.88	0.1254	0.0012
7 - 8	0		Sangat Lunak (very soft)	85	16.04	2.56	1.955	100	50	33.97	57.72	0.67	0.0953	0.0016
8 - 9	0	Lempung berlanau abu - abu	Sangat Lunak (very soft)	85	16.04	2.56	1.955	100	50	33.97	57.72	0.67	0.0953	0.0016
9 - 10	6		Sedang (medium stiff)	57.	16.04	2.56	1.508	100	49.00	33.97	57.72	0.46	0.0657	0.002
10 - 11	6	Lempung merah	Sedang (medium stiff)	57.	16.04	2.56	1.508	100	49	33.97	57.72	0.46	0.0657	0.002
11 - 12	5		Sedang (Medium stiff)/Lunak (soft)	57.	16.04	2.56	1.508	100	49	33.97	57.72	0.46	0.0657	0.002
12 - 13	5		Sedang (Medium stiff)/Lunak (soft)	57.	16.04	2.56	1.508	100	49	33.97	57.72	0.46	0.0657	0.002
13 - 14	4	Lempung abu - abu	Lunak (soft)	65	16.04	2.56	1.636	100	48	33.97	57.72	0.51	0.0723	0.0021
14 - 15	5	Lempung merah	Sedang (Medium stiff)/Lunak (soft)	55	16.04	2.56	1.476	100	48	33.97	57.72	0.44		0.0021
15 - 16	6		Sedang (Medium stiff)	60	16.00	2.65	1.650	100	46.50			0.48	0.0688	0.0022
16 - 17	3	Lempung abu - abu keputihan	Sangat Lunak (very soft)	60	16.00	2.65	1.650	100	46.50			0.48	0.0688	0.0022
17 - 18	7	PASIR HALUS CAMPUR KASAR	Sangat Lepas (Very Loose)	55	16.6	2.6	1.428	100.000	46					0.0023
18 - 19	7	ML-OL Lempung Coklat	Sedang (medium stiff)	55	16.6	2.65	1.474	100.000	46			0.43	0.0612	0.0023
19 - 20	7		Sedang (medium stiff)	55	16.6	2.65	1.474	100.000	46			0.43	0.0612	0.0023
20 - 21	10		Sedang (medium stiff)	55	16.6	2.65	1.474	100.000	46			0.43	0.0612	0.0023
21 - 22	16		kaku (stiff)	40.78	17.1	2.43	1.001	100.000	45.4901	29.532	15.9585	0.27	0.0390	0.0024
22 - 23	20		kaku (stiff)											
23 - 24	38	PASIR HALUS PUTIH	Padat (dense)											
24 - 25	40		Padat (dense)											
25 - 26	57		Padat (dense)	24.65	1.84	2.52			Sampel berbutir					
26 - 27	40		Padat (dense)											
27 - 28	43		Padat (dense)											
28 - 29	50		Padat (dense)											
29 - 30	58		Padat (dense)											

Source: Central Kalimantan BPJN Calculation and Data Analysis

Figure 4. Stratigraphy of the results from cotractor's Soil Investigation

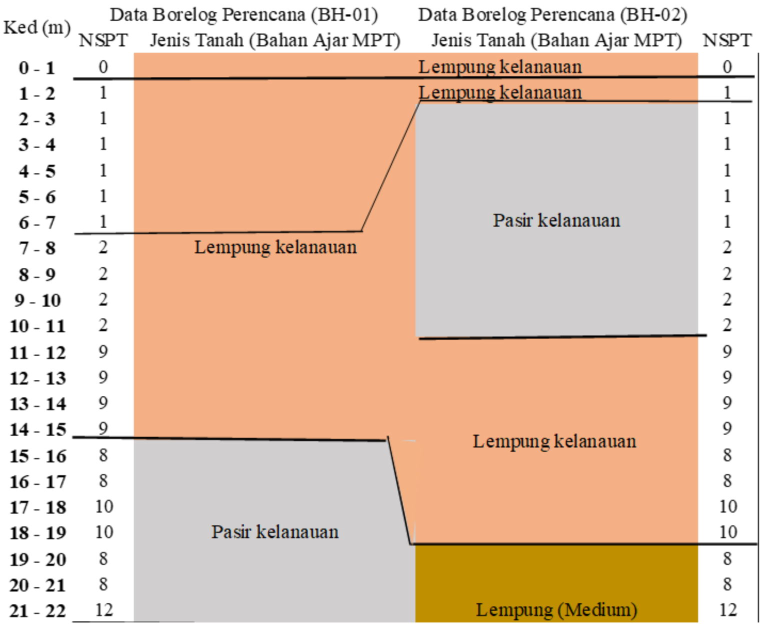
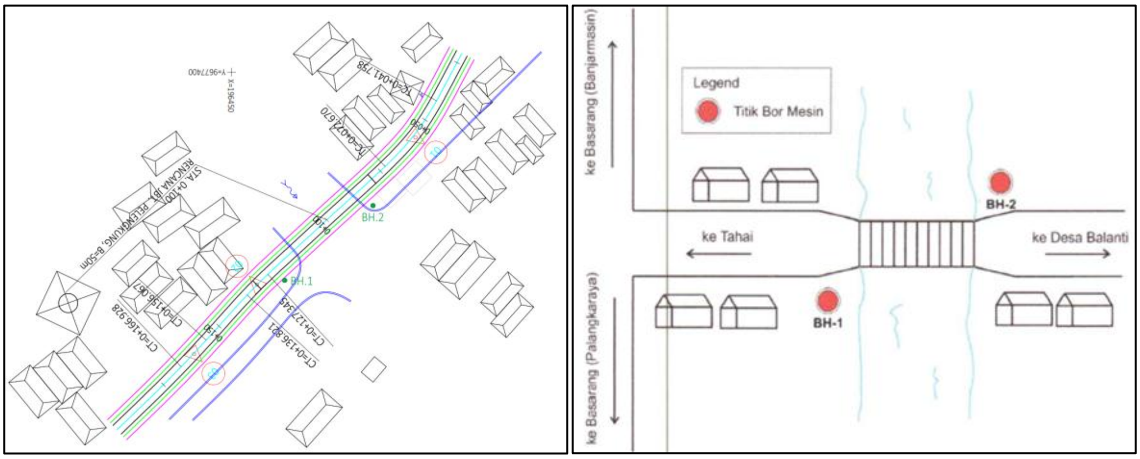


Figure 5. Stratigraphy of soil investigation results



(a) (b)

Figure 6. Location of soil investigation, (a) Consultant's soil boring layout; (b) Consultant's soil boring layout

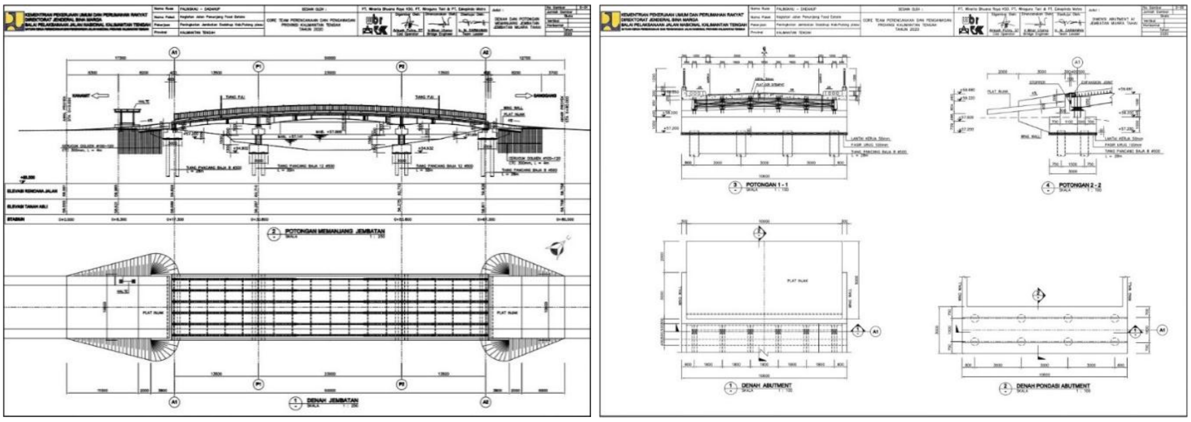
Table 3. Laboratory Test Results for Consultant Soil Data

Name	Depth	Water content	Unit Weight	Dry Density	Specific Gravity	Void Ratio
	(m)	Wn (%)	γ (gr/cm3)	γd (gr/cm3)	Gs (gr/cm3)	e
BH-01	7.0-7.5	56.43	1.604	1.025	2.562	1.499
BH-02	11.0-11.5	51.81	1.631	1.074	2.579	1.4

Table 4. Laboratory Test Results for Contractor Soil Data

Name	Depth	Water content Wn	Unit Weight γ	Specific Gravity Gs
	(m)	(%)	(gr/cm3)	(gr/cm3)
BH-01	9.50-10.00	87.8	1.38	2.43
	19.50-20.00	46.19	1.16	2.06
BH-02	21.50-22.00	40.78	1.71	2.43
	25.50-26.00	24.65	1.84	2.52

Structure Design



(a) (b)

Figure 7. (a) Plans and longitudinal sections of the Muara Tahai bridge; (b) Muara Tahai bridge abutment dimensions
(Source: BPJN Kalteng)

RESEARCH ANALYSIS

PILE FOUNDATION DESIGN

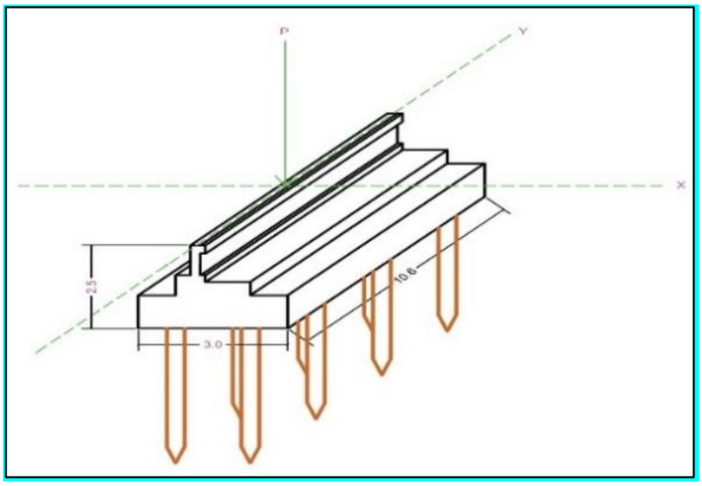


Figure 8. Illustration of the existing pile group perspective design

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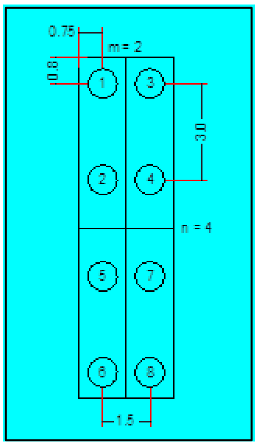

Figure 9. Top View existing design of Pile Group Design

Bearing Capacity of Existing Pile Design

Analysis of the bearing capacity of the piles on the abutment foundation of the bridge pile foundation using 8 point steel piles with a diameter of 500 mm x 28 meters using a combination of 1 abutment loading.

Pile Cap Lenght	= 10,60 m
Pile Cap Width (B)	= 3,00 m
Tux	= 30,22 Ton
Tuy	= 0,00 Ton
Mx	= 45,33 Ton.m
My	= 0,00 Ton.m

Table 5. Recap of the Load Distribution of Existing Pile Design

No	X	Y	X^2	Y^2	
1	-0,75	4,50	0,56	20,25	
2	-0,75	1,50	0,56	2,25	
3	0,75	4,50	0,56	20,25	**Max**
4	0,75	1,50	0,56	2,25	
5	-0,75	-1,50	0,56	2,25	**Min**
6	-0,75	-4,50	0,56	20,25	
7	0,75	1,50	0,56	2,25	
8	0,75	4,50	0,56	20,25	
	Total		4,50	90,00	

Source : Calculation Analysis

$$\text{Pmax} = \frac{\Sigma V}{n} \pm \left(\frac{My}{\Sigma x^2}\right) + \left(\frac{Mx}{\Sigma y^2}\right) \qquad \text{...(2)}$$

$$\text{Pmax} = \frac{2910{,}3 \text{ x } 0{,}102}{8} + \left(\frac{0}{0{,}56+0{,}56}\right) + \left(\frac{45{,}33}{20{,}25+2{,}25}\right)$$

$$= 39{,}12 \text{ ton}$$

$$\text{Pmin} = \frac{\Sigma V}{n} \pm \left(\frac{My}{\Sigma x^2}\right) + \left(\frac{Mx}{\Sigma y^2}\right) \qquad \text{...(3)}$$

$$\text{Pmin} = \frac{2910{,}3 \text{ x } 0{,}102}{8} - \left(\frac{0}{0{,}56+0{,}56}\right) - \left(\frac{45{,}33}{2{,}25+20{,}25}\right)$$

$$= 35{,}09 \text{ ton}$$

Foundation Data

Type	= Steel Pipe
Pile Diameter, d	= 0.5 m
Pile Lenght, L	= 28 m (According to plan)
Distance Between Piles, s	= 3 m
Start	= 1.2 m (MAT)
End	= 29.2 m
Point Drill Overview	= Drill BH-1 N-SPT
Circumference	= 1.57 m
Pipe Thickness	= 0.00516 m
Area	= 0.2 m2
SF	= 3
Steel Density	= 7.85 ton/m3
Melting Stress (Fy)	= 23536.8 Ton/m2
Steel Allowance Stress	= 11768.4 Ton/m2

Converse Labarre Efficiency:

$$Eg = 1 - (\text{arc tg}\ \frac{d}{s})\ x\ \frac{(n-1)m+(m-1)n}{90mn} \qquad \ldots(4)$$

$$= 1 - (9{,}46)\ x\ \frac{(4-1)\ x\ 2+(2-1)\ x\ 4}{90\ x\ 2\ x\ 4}$$

$$= 0{,}87$$

The steel pile strength is calculated as follows:

P_{ijin} = Steel Allowance Stress x (Area Pipe Thickness)

= 47,7 Ton

Pmax	≤	P_{Allow} x Eg	
39,12	≤	47,7 x 0,87	
39,12	≤	41,23	**OK**

End Bearing Existing Design

Qp = Ap x qp

Where:

Qp = End Bearing (ton)
Ap = Area Section (m2)
qp = Unit End Bearing (t/m2)

Because the soil at the tip of the NSPT is sandy soil:

$$qp = 40 \times NSPT_{av} \qquad \ldots(5)$$
$$= 40 \times 24{,}31$$
$$= 972{,}32 \text{ t/m2}$$

$$Qp = Ap \times qp \qquad \ldots(6)$$
$$= (1/4 \times 22/7 \times 0{,}5^2) \times 972{,}32$$
$$= 190{,}99 \text{ ton}$$

$P_{Single\ Allowance}$ = Qp/SF
= 190,99/3
= 63,66 ton

$P_{Group\ Allowance}$ $= P_{Single\ Allowance}$ x Eg
= 63,66 x 0,87
= 55,3 ton

End Bearing Control :

Pmax	≤	$P_{Group\ Allowance}$	
39,12	≤	55,3	**OK**

Bearing Capacity of Alternative Pile Design

Analysis of the bearing capacity of the piles on the abutment foundation of the bridge pile foundation using 8 point steel piles with a diameter of 500 mm x 20 meters using a combination of 1 abutment loading.

Pile Cap Length = 10,60 m
Pile Cap Width (B) = 3,00 m
Tux = 24,55 Ton
Tuy = 0,00 Ton
Mx = 36,82 Ton.m
My = 0,00 Ton.m

Table 6. Recap of the Load Distribution of Alternative Pile Design

No	X	Y	X^2	Y^2	
1	-0,75	4,50	0,56	20,25	
2	-0,75	1,50	0,56	2,25	
3	0,75	4,50	0,56	20,25	**Max**
4	0,75	1,50	0,56	2,25	
5	-0,75	-1,50	0,56	2,25	**Min**
6	-0,75	-4,50	0,56	20,25	
7	0,75	1,50	0,56	2,25	
8	0,75	4,50	0,56	20,25	
	Total		4,50	90,00	

Source: Calculation Analysis

$$\text{Pmax} = \frac{\Sigma V}{n} \pm \left(\frac{My}{\Sigma x^2}\right) + \left(\frac{Mx}{\Sigma y^2}\right) \quad \ldots(7)$$

$$\text{Pmax} = \frac{2589{,}01 \text{ x } 0{,}102}{8} + \left(\frac{0}{0{,}56+0{,}56}\right) + \left(\frac{36{,}82}{20{,}25+2{,}25}\right)$$

= 34,65 ton

$$\text{Pmin} = \frac{\Sigma V}{n} \pm \left(\frac{My}{\Sigma x^2}\right) + \left(\frac{Mx}{\Sigma y^2}\right) \quad \ldots(8)$$

$$\text{Pmin} = \frac{2589{,}01 \text{ x } 0{,}102}{8} - \left(\frac{0}{0{,}56+0{,}56}\right) - \left(\frac{36{,}82}{2{,}25+20{,}25}\right)$$

= 31,37 ton

Foundation Data

Type = Steel Pipe
Pile Diameter, d = 0,45 m
Pile Length, L = 20 m
Distance Between Piles, s = 3 m
Start = 1,2 m (Sesuai MAT)

End	= 21,2 m
Point Drill Overview	= Bor BH-1 N-SPT
Circumference	= 1,41 m
Pipe Thickness	= 0,00516 m
Are	= 0,16 m2
SF	= 3
Steel Density	= 7,85 ton/m3
Melting Stress (Fy)	= 23536,8 Ton/m2
Steel Allowance Stress	= 11768,4 Ton/ m2

Converse Labarre Efficiency:

$$Eg = 1 - \theta \times \frac{(n-1)m+(m-1)n}{90mn} \quad \ldots(9)$$

$$= 1 - (\text{arc tg } \frac{d}{s}) \times \frac{(n-1)m+(m-1)n}{90mn}$$

$$= 1 - (8{,}53) \times \frac{(4-1) \times 2+(2-1) \times 4}{90 \times 2 \times 4}$$

$$= 0{,}88$$

The steel pile strength is calculated as follows:

P_{ijin} = Steel Allowance Stress x (Area Pipe Thickness)
= 11768,4 x 0,0036279
= 42,7 Ton

Pmax	≤	P_{Allow} x Eg	
34,65	≤	42,7 x 0,88	
34,65	≤	37,64	**OK**

End Bearing Existing Design

$$Qp = Ap \times qp \quad \ldots(10)$$

Where:

Qp = End Bearing (ton)
Ap = Area Section (m2)
qp = Unit End Bearing (t/m2)

Because the soil at the tip of the NSPT is sandy soil:

q_p = 40 x $NSPT_{av}$
= 40 x 22,36
= 894,25 t/m^2

Q_p = A_p x q_p
= (1/4 x 22/7 x $0,45^2$) x 894,25
= 142,28 ton

$$P_{Single\ Allowance} = \frac{Q_p}{SF}$$

$$= \frac{142{,}28}{3}$$

= 47,43 ton

$P_{Group\ Allowance}$ = $P_{Single\ Allowance}$ x Eg

= 47,43 x 0,88

= 41,81 ton

End Bearing Control:

Pmax	$\leq$	$P_{Group\ Allowance}$	
34,65	$\leq$	41,81	**OK**

Floating Foundation Design

The material that used as filler of floating foundation is a floaton material that shaped square (50 cm x 50 cm x 40 cm), floaton material was one of light material. Floaton form of polymer material (100% High Density Polyethylene), with 24 Kg/m^3 max wight. The principle of floating foundation is to flatten and equalize the bridge load to the soil base, so that it will cause zero settlement of the structure.

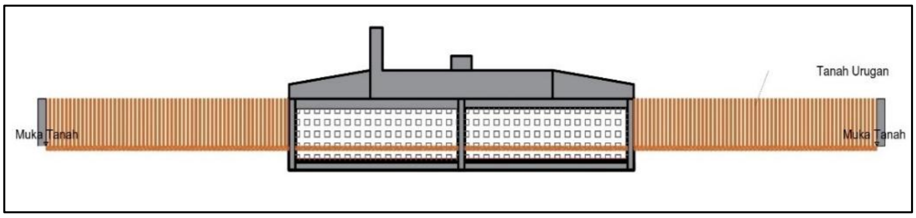

Figure 10. Alternative design of Floating Foundation on Bridge Abutment

The following is the foundation plan used:

Floating Foundation Specification:

Floaton Weight floating (W)	= 6 kg
Floaton Width (B)	= 0,5 m
Floaton Length (L)	= 0,5 m
Floaton Heigth (H)	= 0,4 m
Floaton Volume (V)	= L x B x H
	= 0,5 x 0,5 x 0,4
	= 0,10 m^3
Volume Weigth (γ)	$= \frac{W}{V}$
	$= \frac{6}{0,10}$
	= 60 kg/m^3
Concrete Density (γ)	= 2400 kg/m^3 = 2,4 ton/m^3
Dead Load,	= 444,44 kN
Live Load,	= 771,58 kN
Total	= 444,44 + 771,58
	= 1216,01 kN
	= 124,03 ton
Floaton Weight	= 3,168 ton
Vertical Restaint Weight Y-axis	= 10,098 ton
Lateral Restraint Weight	= 25,344 ton
Lateral Restaint Weight X-axis	= 10,8864 ton
Floating Foundation Total Weight	= 49,50 ton

Floating Foundation Bearing Capacity

Because the subgrade has very soft soil, the soil conditions are planned as follows:

Undrained Shear Strength, Cu = (take between 0,74 – 1,25 ton/m^2)

Cu = 1 ton/m^2

ϕ = 0°

Table 7. Bearing Capacity Terzaghi Value

φ	General Shear Collapse		
	Nc	**Nq**	**Nγ**
0	5,7	1	0
5	7,3	1,6	0,5
10	9,6	2,7	1,2
15	12,9	4,4	2,5
20	17,7	7,4	5
25	25,1	12,7	9,7
30	37,2	22,5	19,7
34	52,6	36,5	35
35	57,8	41,4	42,4
40	95,7	81,3	100,4
45	172,3	173,3	297,5
48	258,3	287,9	780,1
50	347,6	415,1	1153,2

Because $\phi = 0$, maka $Nc = 5{,}7$; $Nq = 1$; $N\gamma = 0$; $\gamma = 1{,}7$ t/m^3

The bearing capacity of the soil is calculated using the Terzaghi formula for foundation size B x L. Depth is taken, Df = 1.5 meters because the foundation goes into the ground and the fill soil is 1.5 m deep, so:

$$q_{ult} = 1.3.\ Cu.\ Nc + \gamma\ .\ Df.\ Nq + \{f\,(B, L) \times B \times \gamma \times N\gamma \quad \ldots(11)$$

$$q_{Safe} = \frac{1{,}3 \times Cu \times Nc}{SF} + \gamma \times DF$$

$$q_{Safe} = \frac{(1.3 \times 1.0 \times 5.7)}{3} + 1{,}7 \times 1{,}5$$

$$q_{Safe} = 5{,}02 \text{ ton/m}^2$$

Floating Foundation Control

Base area requires for Floating Foundation:

$$A_{need} = \frac{(\text{Total planning load} + \text{P total Floating})}{\text{qsafe}} \quad \ldots(12)$$

$$= \frac{(124{,}03 + 49{,}5)}{5{,}02}$$

$$= 34{,}57 \text{ m}^2$$

$$A_{available} = B \times L$$

$$= 3{,}2 \times 11$$

$$= 35{,}2 \text{ m}^2$$

$A_{need} \leq A_{available}$

$34{,}57 \leq 35{,}2$ difference 1,78% (**OK**)

Based on the planning results above, it can be determine into the form of a planning drawing with the following design:

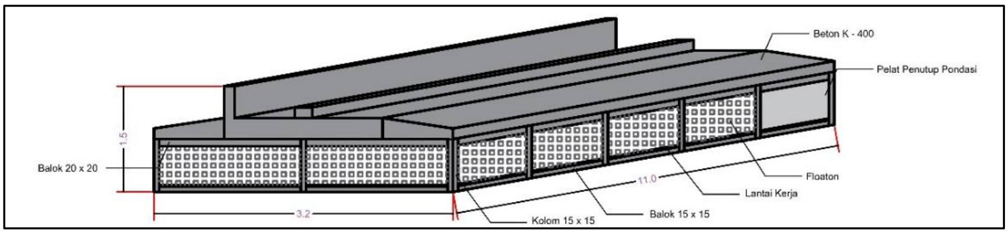

Figure 11. Perspective view of Floating Foundation on Abutment

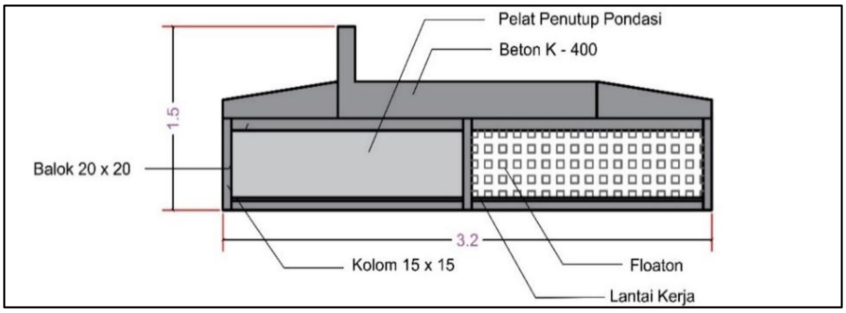

Figure 12. Long view of Floating Foundation on Abutment

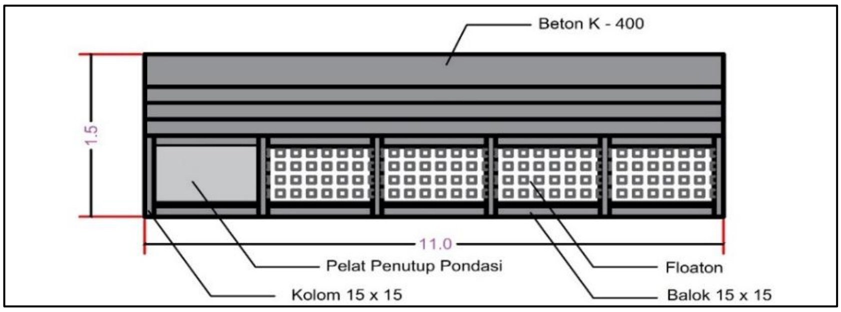

Figure 13. Cross View of Floating Foundation on Abutment

CONCLUSION

Based on the results of discussions that have been carried out on the Muara Tahai Bridge project with a total span of 50 meters and a bridge width of 10.6 meters. Then it can be concluded as follows:

1. The existing design of pile foundation using bearing capacity requires a length of 28 meters with dimensions of 50 cm with a total of 8 piles. Control results shows Pmax 39.12 Tons < $P_{group\ allowance}$ 55,3 Tons (OK)
2. The existing design of pile foundation using bearing capacity requires a length of 20 meters with dimensions of 50 cm with a total of 8 piles. Control results shows Pmax 34,65 Tons < $P_{group\ allowance}$ 41,81 Tons (OK)
3. The alternative design of the foundation structure under the bridge using Floaton. The required foundation dimensions are 11 meters long, 3.2 meters wide and 1.5 meters thick. The bearing capacity of the foundation based on the terzaghi theory is 5.02 T/m2.

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