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Analysis Foundation Planning Bored Pile Pier P1 Sta 8+442 Project Toll Road Depok – Antasari Section Ii

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Abstract

The purpose of this study is to plan a construction stability of the upper and lower structures in the construction of the Depok - Antasari toll road section II, especially in the planning of a foundation. The foundation used in pier p1 is the foundation in the bored pile type. In planning the foundation, it is necessary to take into account the load force acting on the pier, the bearing capacity of the foundation piles, and the settlement. Analysis of bridge loading calculation (Badan Standarisasi Nasional, 2008) and (Badan Standarisasi Nasional, 2008) using a software program, namely SAP 2000 v.20. The purpose of this loading analysis is to find the value of the pier bearing reaction force to the working forces, both from the fixed load force and the environmental action load. In order for the purpose of this study to be achieved, literature studies from various sources both from the Indonesian National Standard and various other sources discuss the planning of foundation calculations, namely the AASHTO, Kullhawy, Vesic and Reese Wright methods. The results of this study explain that it must be paid attention to planning a foundation that meets the parameters and structures that are safe against earthquakes and other loads, it is also necessary to take into account the momentary reaction force, bearing capacity of the pile and land subsidence according to national standards.

Keywords
Bearing Capacity, Foundation Planning, Settlement, SAP 2000

1. Introduction

The Toll Road Development Project is one of the infrastructure developments that functions to progress in the construction sector and the economic sector. Some important things from development include the socio-economic field of society, memudahkan masyarakat untuk bisa melakukan especially in transportation. The government has carried out various developments in order to make it easier for the community to be able to carry out their maximum mobility both in the economic and social fields Based on data from the Jakarta Transportation Statistics, from 2012 to 2019 the growth of traffic in Jakarta has an average growth of 5.3 persen. The number of motorbikes in 2019 is said to have reached 14.74 million units. Compared to the circulation of passenger cars in the same period, the average growth was smaller, namely 3.99 million units. However, this growth was not accompanied by the development of supporting infrastructure, especially roads, while the annual increase in road area was only 0.01% throughout Jakarta, so it can be estimated that in about 10 years Jakarta will be totally congested which will affect economic growth and development in Jakarta, which is the center. Indonesia's economic pace. These losses can be in the form of decreased work productivity due to wasted time on the road and wasted fuel (Badan Pusat Statistik DKI Jakarta, 2018)

The construction of the Depok - Antasari (Desari) elevated toll road is an alternative due to the limited availability of land in the city of South Jakarta as well as a connection to the city of Depok and its surroundings. The construction of the elevated toll road construction must meet the stability of the construction in terms of the upper structure and the sub-structure. Experience the impact of performance in the field in the procurement of equipment at the project location. In addition, the contractor also has difficulty implementing the tool procurement flow quickly, easily & efficiently. To pass the load from the upper structure to the soil layer below it until it reaches the desired carrying capacity, a sub structure is needed. which is called the foundation. The foundation to be used in the Depok - Antasari toll road construction project on pier P1 sta 8 + 442 is the inner foundation, namely the tipebor pile.

2. Study of Literature

(Hary Christady Hardiyatmo, 2010) explains that the foundation is the lowest structural component of a building that transmits the load of the building to the soil or rock underneath. The foundation is made into a solid building block under construction. The foundation can be defined as the bottom part of a strong and stable construction (solid).

A bored pile foundation is a deep foundation whose construction is carried out in the following stages :

Drilling until hard soil layers. To find out the depth of hard soil, it can be done by using the sondir test or Standard Penetration Test (SPT).

Insertion of fabricated reinforcement into boreholes and,

Casting.There are several types of drill poles

according to how to transfer structural loads to subgrade (Das, 2011), namely :

1. Straight Pole Drill
   The drill pole is made straight through the soft soil layer and the tip lies in the hard soil layer. The bearing capacity of this foundation lies in the end resistance and friction resistance between the surface of the drill pile and the ground.
2. Drill Pole with enlarged tip
   The end of the foundation is enlarged to form a dome or trapezoid. Judging from the shape, the overall bearing capacity of this foundation comes from the end of the pile. However, in some cases, the friction resistance between the blanket and the ground is also taken into account.
3. The Drill Pole goes straight into the rocky layer
   The end of the drill pile can enter into the rocky layer. For the calculation of the bearing capacity in a case like this, the end of the pile and the friction between the rock and soil along the pile can be taken into account. The three types of drill piles described above are illustrated in Figure 2.1

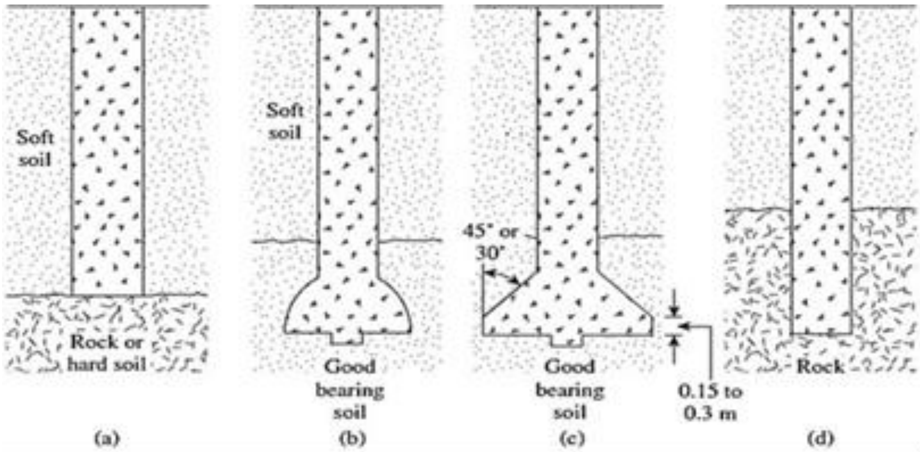

Figure 1. Drill Pole Type
Source : Das, B.M. 2011

3. Results and Analysis

This planning study will be carried out with a data analysis procedure which is divided into several stages, including:

1. Taking into account the value of loads based on (Badan Standarisasi Nasional, 2008) for earthquake loading and (Bambang Dewasa, 2016)for loading on bridges.
2. Modeling of foundations, in this stage modeling is carried out with the help of the SAP 2000 V.20 program, the output produced by the program is the amount of load received by the foundation in the form of vertical, horizontal, and moment force bearing capacity of the foundation piles.
3. Comparison of the results of the calculation of carrying capacity with the results of the PDA (pile driving analyzer) test to find the value of the vertical bearing capacity of the pile based on N-SPT data.
4. Analyze bearing capacity for drill pile using AASHTO method
5. The equation for finding the value of the lateral (horizontal) bearing capacity using the Broms Method.
6. Analysis to obtain the allowable reduction according to the plan data uses the Vesic Method equation.

Loading calculation analysis refers to the Loading Regulation (Bambang Dewasa, 2016)concerning Loading for bridges. The purpose of this loading analysis is to find the reaction force of the pier support against

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the working forces, both the force originating from the fixed load, namely the structure's own weight and the live load in the form of a vehicle and environmental action consisting of wind, earthquake and vehicle collisions with using the SAP 2000 v.20 program (Bambang Dewasa, 2016)

3.1 Dead Load

Table 1. Calculation of Additional Dead Load

URAIAN	DIMENSI		Ac	Volume	Berat	Jumlah	Faktor Beban	Total
	P (M)	Dia						
Paraphet	41		0,06	2,46	5,9	2	2	23,62
Pipa Sparing	41	0,12	0,0011	0,05	0,36	2	2	1,42
Planter Box	41		0,06	2,46	19,31	2	2	77,24
Pile Cap	6,7		11,725	78,56	188,54	1	1,2	226,25
Timbuhan Tanah	6,7		6,7	44,89	71,82	1	1,2	86,19
							Total Beban	414,72

source : SNI-1725:2016

BJ Concrete : 2,4 tons/m3
BJ Land Fill : 1,6 tons/m3
BJ Iron / Steel : 7,85 tons/m3

3.2 Life Load

1) Lane Load

Line load (BGT) with an intensity P is taken as P = 49 kN / m or P = 4.9 tons/ m.

a. The sock factor

Load P is increased by the correlation on the shock load reference diagram (D), as in Figure 4.1 below

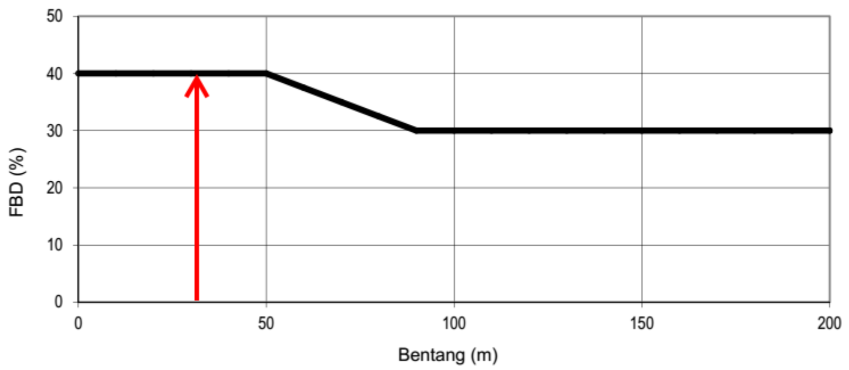


Figure 2. Shock load reference diagram

Based on the diagram with a span length of 41 m, the dynamic load factor is 40% or the multiplier factor = 1.4 for the intensity P.

b. The line load of large vehicles (P) with shock loads (TTD) with a length of 41 m.
D = P x soc factor = 4,9 t/m x 1,4 = 6,86 t/m

c. Spread the load D in the transverse direction
Styles that work 100% as wide:
D100% = n lane x 2.75 m = 3 x 3.25 1 = 9.75 m
= 100% x PLL = 100% x 6.86 = 6.86 t / m
Style that works 50% as wide :
D50% = lane width - 8.25 m = 16 m - 9.75 m = 6.25 m
= 50% x PLL = 50% x 6.86 = 3.43 t / m

3.3 Environmental Action Expenses

1. Wind Load (TEW)

   Calculating the design wind speed (Bambang Dewasa, 2016)

   VDZ = 2,5.Vo . (V10/VB). In(Z/Z0)

   = 2,5 x 19,3 (90/90) x In (11300/2500)

   = 72,79 Km/hour

   Calculating the planned wind pressure (Bambang Dewasa, 2016)

   PD = PB (VDZ/VB)2

   = 0,0024 (72,79/90)2

   = 0,002 MPa

   Based on(Bambang Dewasa, 2016), the wind force of 4.4 kN / mm is used

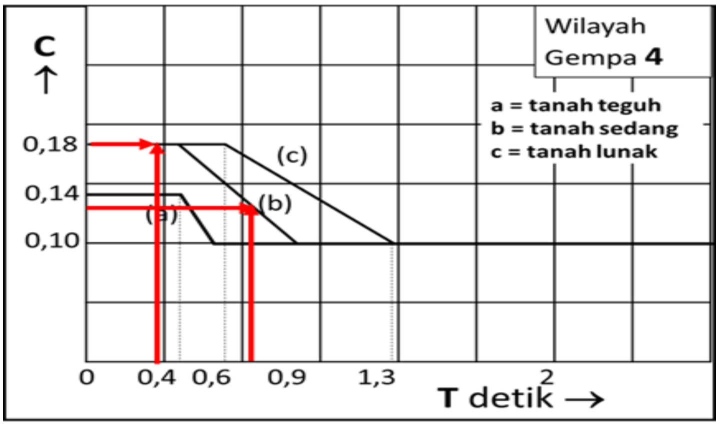
2. Earthquake Load

$$T_{trans} = 2\pi \sqrt{\frac{W_{TP}}{g.K_p}} = 2\sqrt{\frac{1383,37}{9,81x37448,53}}$$

= 0,39 second

$$T_{long} = 2\pi \sqrt{\frac{W_{TP}}{g.K_p}} = 2\pi \sqrt{\frac{1383,37}{9,81x12027,14}}$$

= 0,68 second



.Figure 3. Determining the basic shear coefficient (C) for static shear analysis

a. Earthquake Load (TEQ) in Transverse Direction

   With Ttrans = 0.39,

   then the value of C = 0.13 is obtained

   TEQ = 0.15 x 1.0 x 1.225 x 1383.37 tons

   = 220,3 ton

b. Earthquake Load (TEQ) in Longitudinal Direction

   With Tlong = 0.68,

   then the value of C = 0.18 is obtained

   TEQ = 0.15x 1.0 x 1,225 x 1383.37 tons

   = 305 ton.

Output The reaction forces generated based on the input loading acting on the construction are presented in the table below:

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Table 2. Reaction Style Resume

				GAYA REAKSI (Output SAP 2000)			
				H (t)		Momen (tm)	
NO	URAIAN	ID	V (t)	Arah x	Arah y	Arah x	Arah y
1	Beban Tetap						
a	Beban Mati	DL	413,35				
b	Beban Hidup	LL	200,47				
2	Aksi Lingkungan						
a	Beban Angin	TEW			-8,09	64,83	
b	Beban Gempa	TEQTRANS			-0,61	5	
		TEQ LONG		-41,86			-465,34
	Jumlah		613,82	-41,86	-9,07	69,83	-465,34

Recapitulation of Loads below:

a) Total Vertical Force Working
$\sum V$ = Vertical Load (SAP) + Additional Dead Load
$\sum V$ = 613,82 + 414,72 = 1028,54 ton

b) Horizontal Force
Hx = -41,86 ton
Hy = -9,07 tons

c) Momen Style
Mx = 69,83 tonsm
My = -465,34 tonsm

Table 3. Recapitulation of vertical and horizontal bearing capacity calculations

Vertikal					Horizontal		
Tunggal				Group	Tunggal		Group
Qujung (ton)	QSelimut (ton)	Qultimate (ton)	Qizin (ton)	Qg izin (ton)	Qultimate (ton)	Qizin (ton)	Qg izin (ton)
329,55	50,99	380,54	126,85	1745,39	25,92	8,64	138,24

Based on the calculation results, the amount of vertical force that can be accepted by the foundation of Pier P1 Sta 8 + 442 of the Depok - Antasari Section II Toll Road Project is 1745.39 tons. Meanwhile, the horizontal force that can be accepted by the foundation of Pier P1 Sta 8 + 442 of the Depok - Antasari Section II Toll Road Project is 138.24 tons.

3.4 Settlement

Decrease settlement calculation using metode *vesic* :

a) Derating due to deformation of single pile action
L = length of poles buried in the ground = 12.00 m
Ap = pile tip area = 0.283 m2
Ep = modulus of elasticity of the pile
= 33167848,00 kN/m2
α = 0,67

$$Ss = \frac{(Q_p + \alpha . Q_s).L}{A_p . E_p}$$

$$Ss = \frac{(707{,}00kN + 0{,}67.109{,}4kN).12{,}00m}{0{,}283m^2 .33167848{,}00\, kN/m^2}$$

= 0,0002m = 0,020 cm

b) Drop from the Tip of the Pole
Cp = 0,005

qp = 3295,51 kN/m2
Qp = 707,00 kN
D= 0,6 m

Sp = $\frac{C_p.Q_p}{D.q_p}$

Sp = $\frac{0,05.707,00kN}{0,6m..3295,51 kN/m^2}$

Sp = 0,01788 m
Sp = 1,788 cm

Derating due to Loads Transferred Along the Mast
Qs = 109,4 kN
p = 1,884 m
L = 12,00 m
Es = 12500 kN/m2
vs = 0,2
Iws = 3,565

Sps = $\left(\frac{Q_s}{p.L}\right).\frac{D}{E_s}.(1-v_s^2).I_{WS}$

Sps = $\left(\frac{109,4kN}{1,884m.12,00m}\right).\frac{0,6m}{12500 kN/m^2}.(1-0,6^2).3,565$ Sps = 0,0008 m

Sps = 0,08 cm

Based on the reduction in pile deformation, the ends of the pile and the load evenly distributed along the pile, a value for immediate settlement can be obtained:

Se = Ss + Sp + Sps
Se = (0,02+1,78 +0,08)cm
Se = 1,89cm

Based on the calculation results, an immediate reduction for single pile Pier P1 on the Depok - Antasari Highway (Section II) is 1.89 cm..

Sg = $S\sqrt{\frac{B_g}{D}}$

Sg = $0,0189m\sqrt{\frac{6,7m}{0,6m}}$

Sg = 0,0631 m = 6,31 cm

Based on the calculation results, an immediate reduction for the Pier P1 pile group on the Depok - Antasari Highway (Section II) is 6.31 cm..

e) Consolidation Decline
ΔH = 1
E o = 2,2
P ‘c = 79
P ‘o = 58
Δp = 21
Cr = 0,046
Cc = 0,72

Sc = $\left[\frac{0,046x1}{1+2,2}xlog\left(\frac{58+21}{58}\right)\right]$
= 0,030 m
= 3,00 cm

f) Decreased Permit

Derivation of Permits based on (A.W & Macdonald, 1955) ie:

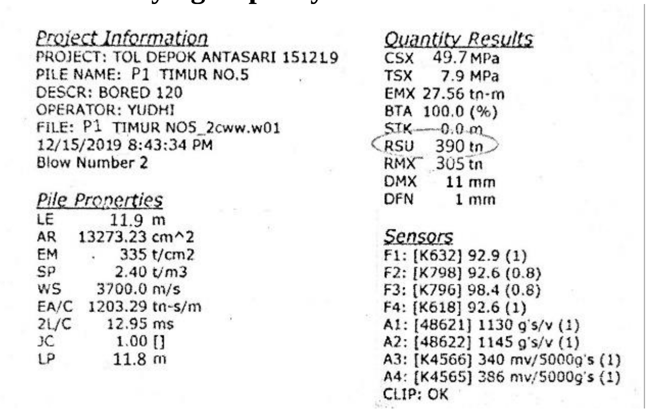
Table 4. Limits for Decreasing the Skempton and Macdonald Licenses 1955

Jenis Pondasi	Batas Penurunan Maksimum (mm)
Pondasi terpisah pada tanah lempung	65
Pondasi terpisah pada tanah pasir	40
Pondasi rakit pada tanah lempung	65-100
Pondasi rakit pada tanah pasir	40-65

Sumber : Hardiyatmo, H. C, 2002, *Teknik Pondasi I*, Penerbit PT. Beta Offset, Yogyakarta.

The maximum allowable drop is 10 cm, so based on the total value of the decline that occurs is 9.31 cm (6.31 cm + 3 cm) the foundation used is still safe.

3.5. Comparison between the Carrying Capacity of the Plan and the results of the PDA Test


Project Information
PROJECT: TOL DEPOK ANTASARI 151219
PILE NAME: P1 TIMUR NO.5
DESCR: BORED 120
OPERATOR: YUDHI
FILE: P1 TIMUR NO5_2cww.w01
12/15/2019 8:43:34 PM
Blow Number 2

Pile Properties
LE 11.9 m
AR 13273.23 cm^2
EM 335 t/cm2
SP 2.40 t/m3
WS 3700.0 m/s
EA/C 1203.29 tn-s/m
2L/C 12.95 ms
JC 1.00 []
LP 11.8 m

Quantity Results
CSX 49.7 MPa
TSX 7.9 MPa
EMX 27.56 tn-m
BTA 100.0 (%)
STK 0.0 m
RSU 390 tn
RMX 305 tn
DMX 11 mm
DFN 1 mm

Sensors
F1: [K632] 92.9 (1)
F2: [K798] 92.6 (0.8)
F3: [K796] 98.4 (0.8)
F4: [K618] 92.6 (1)
A1: [48621] 1130 g's/v (1)
A2: [48622] 1145 g's/v (1)
A3: [K4566] 340 mv/5000g's (1)
A4: [K4565] 386 mv/5000g's (1)
CLIP: OK

Figure 4. PDA Test result data in the field

Based on the results of the PDA Test above, it can be compared with the results of the calculation of the carrying capacity of the plan, shown in Table 4.3 below:

Table 5. Recapitulation of Comparison of Carrying Capacity Plan with Supporting Data of PDA Test Results

Daya Dukung Vertikal (Rencana)	**Tunggal**	Q_{ujung}	329,55 Ton
		$Q_{selimut}$	50,99 Ton
		$Q_{ultimit}$	380,54 Ton
		Q_{izin}	126,85 Ton
	Group	Q_{gizin}	1745,39 Ton
Daya Dukung Horizontal (Rencana)	**Tunggal**	$Q_{tunggal}$	25,92 Ton
		Q_{izin}	8,64 Ton
	Group	Q_{gizin}	138,24 Ton
Daya Dukung Vertikal (Hasil *PDA Test*)	Tunggal	$Q_{ultimit}$	390 Ton

It can be seen in table 4.3 that the carrying capacity of the plan is still safe, namely 380.54 tons below the maximum value of carrying capacity with the PDA Test 390 tons.

4. Conclussion

The following are the conclusions of the Bored Pile Foundation Planning Analysis at Pier P1 STA 8 + 442 at the Depok - Antasari Toll Road Project Section II:

1. Based on the calculation of the loading that works on the upper structure of Pier P1 STA 8 + 442 in the Depok - Antasari Toll Road Project Section II, namely structural dead loading, additional dead loading, wind load and vehicle earthquake load with the total reaction value:

Vertical force = 1028,54 tons
Maximum horizontal force = 41,86 tons
Maximum moment force = 465,34 tonm

2. Based on the results of the calculation of the vertical bearing capacity and horizontal bearing capacity of the bored pile pier foundation P1 STA 8 + 442 In the Depok - Antasari Toll Road Project Section II, the vertical bearing capacity is 1745.39 tons and the horizontal bearing capacity is 138.24 tons, based on calculations the carrying capacity obtained from the bored pile foundation dimensions 6700 mm x 6700 mm and the number of foundation piles for 1 pile cap is 16 points.
3. Based on the comparison of the vertical bearing capacity with the vertical force and the horizontal bearing capacity with the maximum horizontal force, the bored pile foundation is able to withstand vertical forces (vertical bearing capacity = 1745.39 tonnes is greater than vertical force = 1028.54 tonnes) and horizontal forces (bearing capacity horizontally = 138.24 tonnes greater than the maximum horizontal force = 41.86 tonnes). The results of these calculations are still safe
4. Based on the results of the calculation of the reduction in the foundation of the bored pile pier P1 STA 8 + 442 In the Depok - Antasari Toll Road Project Section II, it was found that the amount of immediate decline that occurred was 6.31 cm deep and the consolidation decline was 3.00 cm so that the total foundation settlement was 9.31 cm is still below the allowable drop of 10.00 cm.
5. Based on the results of the PDA Test, it was obtained Ru 390 tons for 1 pile and the ultimate vertical bearing capacity of the single pile analyzed obtained 380.54 tons

5.Suggestion

Suggestions for research on titles related to Bored Pile Foundation Planning Analysis at Pier P1 STA 8 + 442 in the Depok - Antasari Toll Road Project Section II further, namely:

1. For further research, it is necessary to pay attention to supporting the planning data analysis on the load of the toll laying road plan required loading test data.
2. To find the lateral bearing capacity, it is expected to use Lpile or Plaxis 3D programs.

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