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Analysis of Bearing Capacity of Bored Pile Foundation: Case Study of Jakarta – Bandung Station, Karawang High-Speed Railway

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ABSTRACT

As the fundamental component of a building, the foundation has to be strong and durable since it will carry the weight of the structure as well as additional loads that will be transferred to the soil layer at a specific depth. Therefore, in order for the building above it to stand securely, it is required to assess the bored pile's bearing capacity in order to determine the right bearing capacity value. In this study, the author examines a single pile's bearing capacity utilizing Boring Log (SPT) data. This data will then be computed using the Reese & Wright (1977) and Meyerhof (1976) methods. Static loading test data is the foundation for bearing capacity analysis, and it is analyzed using the Davisson and Mazurkiewicz methods. An analysis of the bearing capacity of a single bored pile foundation at the Karawang High-Speed Railway Station project using the Meyerhof method and boring log (SPT) data yielded an average bearing capacity value of 674.30 tons. Using the Reese & Wright method, the average bearing capacity value was 713.70 tons. The results of the analysis of the bearing capacity of group piles from the three methods, namely Los Angeles, Converse-Labarre, and Seiler-Keeney, on PC18C (BH-1) obtained an average value of 1,329.41 tons on PC13C (BH-2) obtained an average value of the average value is 1,344.36 tons, in PC2D (BH-4) the average value is 2,611.48 tons. The average bearing capacity value, as determined by the Mazurkiewicz technique and the Davisson method using static loading test data, is 533.19 tons and 594.48 tons, respectively. The PDA test results show an average bearing capacity rating of 673.65 tons.

Keyword: Bored Pile Foundations, Bearing Capacity, NSPT, Static Loading Test

INTRODUCTION

Development to improve national transportation services, the government 2015 built the Jakarta-Bandung High-Speed Railway (KCJB), also known as the Jakarta - Bandung High-Speed Railway, and became one of the complements to the national transportation ecosystem (Yamin & Windymadaksa, 2017). The project, included in the National Strategic Project (PSN), was built to improve national transportation services and as an effort by the government to support development in the Jakarta - Bandung area (Kadarisman, 2018).

KCJB was built by PT Kereta Cepat Indonesia Cina (KCIC), which was formed through a collaboration between two companies, namely Beijing Yawan HSR Co. Ltd which is a Chinese railway consortium, and PT Pilar Sinergi BUMN (PSBI) which is a consortium of Indonesian State-Owned Enterprises (BUMN) with the Indonesia business to business (B2B) scheme in the public transportation sector (Yamin & Windymadaksa, 2017).

The KCJB project is planned to have a 142.3-kilometer-long rail track and several structures, namely an elevated structure type with 82.7 kilometers, and the others are 13 tunnels

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and subgrades. To support the operation of this Fast Train, adequate facilities and infrastructure need to be built. The station is one of the infrastructures used to operate the Jakarta-Bandung Fast Train. KCJB has four stopping stations along its route; the four stations are Halim Station (Jakarta), Karawang Station, Padalarang Station, and Tegalluar Station (Bandung) (Dina et al., 2021).

As reported from the merdeka.com news portal, the Karawang High-Speed Railway Station is projected to accommodate 30,000 passengers per day. With the high capacity requirements of the station, a strong building structure is needed, especially the foundation (Sudrajat et al., 2023a). The foundation, as the basic part of a building, must be strong and sturdy because the foundation will support the load of the building itself and other loads that will be distributed to the soil layer at a certain depth (Liu et al., 2021).

In this study, the author took a case study on the Karawang High-Speed Railway Station Development project, where the foundation used in this project is a bored pile foundation. Bored piles are one type of deep foundation whose function is to channel the building load above it to the soil layer below it by calculating its bearing capacity (Al-abboodi et al., 2020). Therefore, an analysis of the bearing capacity of the bored pile is needed to determine the correct bearing capacity value so that the building above it can stand firmly (Rochmatullah, 2024). In this study, the author will discuss finding the bearing capacity value of a single bored pile foundation based on boring log (SPT) data, which will be calculated using the Meyerhof (1976) and Reese & Wright (1977) methods, then based on the Bi-Directional Static Load Test (BDSLT) results data interpreted using the Davisson (1983) and Mazurkiewicz (1972) methods (Terzaghi et al., 1996).

RESEARCH METHOD

In this study, the author used several methods to complete the research properly. Several things done during the preparation of this research are as follows:

Data Collection

The data used in this research was obtained from PT Wijaya Karya (Persero) Tbk. as the contractor, and some of them are boring log (SPT) field soil investigation data, laboratory soil investigation data for embankment soil, static loading test data, PDA test data (CAPWAP) and detailed engineering design data (Abdila et al., 2020; Sudrajat et al., 2023b).

Data Analysis

The data analysis here is in the form of plotting soil parameters from boring log (SPT) data and laboratory soil investigation data for embankment soil, then reading and analyzing several foundation tests, namely static loading tests and PDA tests, then continuing to read bored pile data from the drawings in the detailed engineering design (Kong et al., 2020).

Meyerhoff Method

The data from the NSPT soil test can be used to calculate the bearing capacity of the pile. In this method, the planning of bored pile foundations with NSPT data can use the following equation (Prakash & Sharma, 1991), is conducted as follows.

$$Qu = Qp + Qs$$

which:
Qu = Ultimate bearing capacity (ton/m^2)
Qp = Ultimate end resistance (ton/m^2)
Qs = Friction Resistance of Cover (ton/m^2)

Ultimate End Resistance:

$Qp = 1/3 \cdot 4 \cdot p_a \cdot N_{60} \cdot A_b$

which:

Qp = Ultimate end resistance (kN/m^2)

Ab = Cross-sectional area of the bored pile (m^2)

N_{60} = Average value of corrected SPT value in the area around the pile point (approximately 10D above and 4D below the pile point)

p_a = Atmospheric pressure = 100 kN/m^2 (Meyerhof, 1976)

Frictional Resistance of Cover:

$Qs = f_{av} \cdot t \cdot As$

$f_{av} = 0{,}02 \cdot p_a \cdot Nb'$

$Nb' = 15 + \{1/2\ (N_{60} - 15)\}$

which:

Qs Cover = Frictional Resistance of Cover

f_{av} = Frictional resistance (kN)

t = Thickness of soil layer

As = Circumference of bored pile cross- section (m)

P_a = Atmospheric pressure (100 kN/m^2) (Meyerhof, 1976)

NSPT Nb' = Correction of NSPT value

N_{60} = Average value of SPT along the soil layer

Reese & Wright Method

The data from the implementation of NSPT soil testing can be used to calculate the bearing capacity of the pile. The planning of bored pile foundation using NSPT data is conducted using the Reese & Wright (1976) method as follows (Susanto et al., n.d.):

$$Qu = Qp + Qs$$

which:

Qu = Ultimate bearing capacity (ton/m^2)

Qp = Ultimate end resistance (ton/m^2)

Qs = Frictional resistance of cover (ton/m^2)

Ultimate End Resistance:

$Qp = 9 \times cu$ (cohesive soil)

$Qp = 7N$ (ton/m^2) $\leq$ 400 (ton/m^2) (non-cohesive soil Which N < 60)

$Qp = 400$ (ton/m^2) (non-cohesive soil Where N > 60)

Frictional Resistance of Cover:

$Qs = 0{,}1 \cdot N \cdot Ap \cdot \Delta l$ (ton) (non cohesive soil)

$Qs = f \cdot Ap \cdot \Delta l$ (ton) (cohesive soil)

$f = \alpha \cdot cu$

$cu = 6 \cdot N$ (Terzaghi & Peck, 1967)

which:

Qu = Ultimate bearing capacity of pile (ton)

Qp = Bearing capacity of pile tip (ton)

Qs = Bearing capacity of pile cover (ton)

Ap = Pile area (m^2)

f = Pile cover reduction factor

α = Adhesion factor based on the graph in Figure 1

Cu = Undrained cohesion (kN/m^2)

N = NSPT value

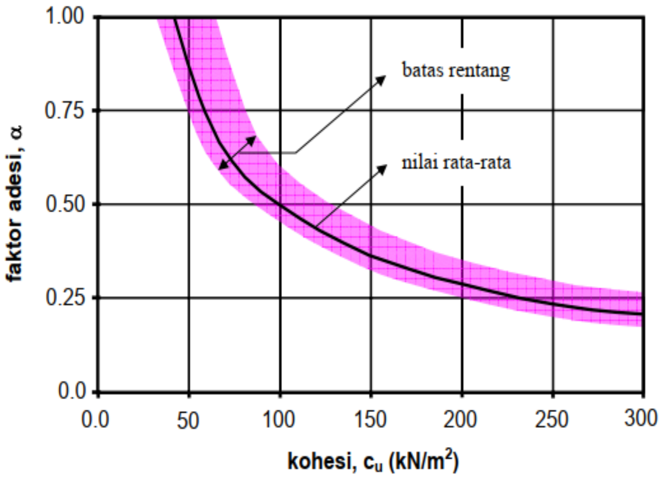

Figure 1. Adhesion versus cohesion factor values of soil

Analysis of Pile Group Bearing Capacity

Quoting from the book by (Susanto et al., n.d.), the efficiency of the pile group bearing capacity can be defined as follows:

$$\eta = \frac{Qg(u)}{\Sigma Qu}$$

which:

η = Pile Group Efficiency
Qg(u) = Ultimate bearing capacity of the pile group
Qu = Ultimate bearing capacity of a single pile

Depending on the distance, the pile group can work in one of two ways: as a beam, with dimensions Lg x Bg x L, or as a single pile. If made as a beam, the friction capacity is:

$$f_{ave}\, p_g\, L \approx Qg\,(u)$$
$$p_g = 2(n_1 + n_2 - 2)d + 4D$$

Similarly, for a pile group made as a single pile:

$$Qu \approx pLf_{ave}$$

which:

Pg = Pile cross-section circumference as a beam
P = Pile cross-section circumference
L = Pile length
f_{ave} = Frictional resistance

Thus:

$$\eta = \frac{Qg(u)}{\Sigma Qu} = \frac{f_{ave}[2(n_1 + n_2 - 2)d + 4D]L}{n_1 n_2 pLf_{ave}} = \frac{2(n_1 + n_2 - 2)d + 4D}{pn_1 n_2}$$

Then,

$$Qg(u) = \left[\frac{2(n_1 + n_2 - 2)d + 4D}{pn_1 n_2}\right]\Sigma Qu$$

From the equation above, if the centre-to-centre distance d is large enough and the value of η> 1, then in that condition, the pile will behave as a single pile. Thus, in practice, if η < 1, then:

$$Qg(u) = \eta \Sigma Qu$$

Then, if $\eta \geq 1$, then:

$$Qg(u) = \Sigma Qu$$

Analysis of Bearing Capacity of Data Interpretation for Bi-Directional Static Load Test

The selected case study conducted field testing using the O-Cell method in this study. In this test, uniform pressure was applied to the O-cell downward and upward (Abdila et al., 2021). Measure its movement using telltale rod and displacement gauge instruments installed on the O-Cell's bottom and top plates. Readings were taken at 15-minute intervals at a load of 5% - 45% and 60 minutes when the load reached 50%. The data from the test were interpreted using the Davisson method and the Mazurkiewicz method to obtain the bearing capacity value of the single-bored pile foundation (Hardiyatmo, 2019).

Comparison between Calculation Results and PDA Test (CAPWAP) Results

After the bearing capacity of the bored pile foundation has been calculated, the bearing capacity value will be compared with the PDA Test (CAPWAP) results obtained from the contractor (Abdila et al., 2020).

RESULT AND DISCUSSION

Technical Data of Bored Pile

Obtaining accurate research results depends on the accuracy of the data used in the test. The data that the author obtained and will be used in this analysis is field data in the form of material data and structural data that are the objects of planning, such as site plans, building structure plans, bored hole soil testing plans, bored pile point plans, bored pile details and also other data needed. The bored pile data used in this analysis are:

a.	Foundation Type	:	Bored Pile
b.	Material	:	Reinforced concrete
c.	Concrete Quality	:	fc' = 30 MPa
d.	Design Load	:	250 ton
e.	Safety Factor	:	2.5
f.	Pile Depth	:	41.5 m 37.5 m
g.	Pile Diameter	:	800 mm

Investigation Data of Embankment Soil

It can be seen from the results of the soil investigation in the previous sub-chapter that the existing soil conditions in this project tend to be soft in the upper layer, as seen from the low SPT value around Depth 0-6 meters. Therefore, the planners added embankment soil to improve the performance of the existing soil after the station building was built. The description of the embankment soil layer can be seen as follows:

Soil Type	:	Sandy silt (MH)
Plasticity Index	:	16.473%
CBR	:	100% = 8.90%
Cu	:	80 kPa ≈ 80 kN/m^2

In this study, the CBR value was obtained from the results of laboratory tests that the author obtained from the contractor. Still, for the Cu value, the author used the assumption of the relationship between the CBR value and the DCP value, as seen in the following table.

Table 1. Typical relationship between DCP and CBR

Blows/100 mm	In situ CBR (%)	mm/blow
<1	<2	>100 mm
1-2	2-4	100-50 mm
2-3	4-6	50-30 mm
3-5	6-10	30-20 mm
5-7	10-15	20-15 mm
7-10	15-25	15-10 mm
10-15	25-35	10-7 mm
15-20	35-50	7-5 mm
20-25	50-60	5-4 mm
>25	>60	<4 mm

Table 2. Soil parameters are based on DCP values

Material	Description	DCP - n (Blows/100 mm)	Strength
Clays	V. Soft	0-1	C_u = 0-12kPa
	Soft	1-2	C_u = 12-25 kPa
	Firm	2-3	C_u = 25-50kPa
	Stiff	3-7	C_u = 50-100kPa
	V. Stiff	7-12	C_u = 100-200kPa
	Hard	>12	C_u > 200 kPa
Sands	V. Loose	0-1	φ < 30°
	Loose	1-3	φ = 30-35°
	Med dense	3-8	φ = 35-40°
	Dense	8-15	φ = 40-45°
	V. Dense	>15	φ > 45°
Gravels, Cobbles, Boulders*		>10	φ = 35°
		>20	φ > 40°
Rock		>10	C' = 25 kPa, φ > 30°
		>20	C' = 50 kPa, φ > 30°

Based on the table above, the author assumes that the Cu value in the embankment soil is 80 kPa ≈ 80 kN/m^2.

Calculation of Bearing Capacity Based on Boring Log Data (SPT)

Reese & Wright Method

The following is the calculation of bearing capacity using the Reese & Wright method.

A. Calculation at point BH-1

Ultimate End Resistance (Qp)

Qp = Nc x Cu x Ap

Look for Ap:

Ap = π x r^2 = 3.14 x 0.4 x 0.4 = 0.5024

Look for Cu:

Cu = 6 x Nspt = 6 x 60 = 360 kN/m^2

So Qp:

Qp = 9 x 360 x 0.5024 = 1627.78 kN/m^2

Qp = 1627.78 kN/m^2 ≈ 165.99 ton/m^2

Frictional Resistance of Cover (Qs)
Qs = 5251.99 kN/m^2 ≈ 535.55 ton/m^2

Ultimate Carrying Capacity (Qu)
Qu = Qp + Qs
= 165.99 ton + 535.55 ton = 701.54 ton

Permit Support Capacity (Qall)
Qall= Qu / SF = 701.54 / 2.5 = 280.62 ton

B. Calculation at point BH-2
Ultimate Edge Resistance (Qp)
Qp = Nc x Cu x Ap
Look for Ap:
Ap = π x r^2 = 3.14 x 0.4 x 0.4 = 0.5024
Look for Cu:
Cu = 6 x Nspt = 6 x 60 = 360 kN/m^2
So Qp:
Qp = 9 x 360 x 0,5024 = 1627,78 kN/m^2
Qp = 1627.78 kN/m^2 ≈ 165.99 ton/m^2

Frictional Resistance of Cover (Qs)
Qs = 5468.36 kN/m^2 ≈ 557.62 ton/m^2

Ultimate Carrying Capacity (Qu)
Qu = Qp + Qs
= 165.99 ton + 557.62 ton = 723.60 ton

Permit Support Capacity (Qall)
Qall= Qu / SF = 723.60 / 2,5 = 289.44 ton

C. Calculation at point BH-4
Ultimate Edge Resistance (Qp)
Qp = Nc x Cu x Ab
Look for Ab:
Ap = π x r^2 = 3.14 x 0.4 x 0.4 = 0.5024
Look for Cu:
Cu = 6 x Nspt = 6 x 60 = 360 kN/m^2
So Qp:
Qp = 9 x 360 x 0.5024 = 1627.78 kN/m^2
Qp = 1627.78 kN/m^2 ≈ 165.99 ton/m^2

Frictional Resistance of Cover (Qs)
Qs = 5393.30 kN/m^2 ≈ 549.96 ton/m^2

Ultimate Carrying Capacity (Qu)
Qu = Qp + Qs
= 165.99 ton + 549.96 ton = 715.95 ton

Permit Support Capacity (Qall)
Qall= Qu / SF = 715.95 / 2.5 = 286.38 ton

Meyerhof method

The following is a calculation of bearing capacity using the Meyerhof method.

A. Calculation at point BH-1

Ultimate Edge Resistance (Qp)

Qp = Ap x qp

Look for Ap:

Ap = π x r^2 = 3.14 x 0.4 x 0.4 = 0.5024

Look for qp:

qp = 1/3 x 4 x Pa x N_{60}

Look for N_{60}:

10D= 10 x 0.8 = 8 m

4D = 4 x 0.8 = 3.2 m

The average value of NSPT corrected for pile tip can be seen in the following table.

Table 3. N_{60} BH-1 Value

Depth (m)	Nb'
30.00	28.00
32.00	37.50
34.00	25.00
36.00	37.50
38.00	37.50
40.00	37.50
Average	33.83

The corrected average NSPT value obtained was 33.83, So:

qp = 1/3 x 4 x 100 x 33.83 = 4511.11 kN

So Qp:

Qp = Ap x qp

= 0.5024 x 4511.11 kN

= 2266.38 kN ≈ 231.11 ton

Frictional Resistance of Cover (Qs)

Qs = 4315.62 kN/m^2 ≈ 440.07 ton

Ultimate Carrying Capacity (Qu)

Qu = Qp + Qs

= 231.11 ton + 440.07 ton = 671.18 ton

Permit Support Capacity (Qall)

Qall= Qu / SF = 671.18 / 2.5 = 268.47 ton

B. Calculation at point BH-2

Ultimate Edge Resistance (Qp)

Qp = Ap x qp

Look for Ap:

Ap = π x r^2 = 3.14 x 0.4 x 0.4 = 0.5024

Look for qp:

qp = 1/3 x 4 x Pa x N_{60}

Look for N_{60}:
10D= 10 x 0.8 = 8 m
4D = 4 x 0.8 = 3.2 m
The average value of NSPT corrected for pile tip can be seen in the following table.

Table 4. N_{60} BH-2 Value

Depth (m)	**Nb'**
30.00	25.5
32.00	24.5
34.00	37.5
36.00	36.0
38.00	37.5
40.00	37.5
Average	33.08

The average value of the corrected N SPT was 33.08, So:
qp = 1/3 x 4 x 100 x 33.08 = 4411.11 kN
So Qp:
Qp = Ap x qp
= 0.5024 x 4411.11 kN
= 2216.14 kN ≈ 225.98 ton

Frictional Resistance of Cover (Qs)
Qs = Qs1 + Qs2 = 290.23 + 4014.18
= 4304.40 kN/m^2 ≈ 438.93 ton

Ultimate Carrying Capacity (Qu)
Qu = Qp + Qs
= 225.98 ton + 438.93 ton = 664.91 ton

Permit Support Capacity (Qall)
Qall= Qu / SF = 664.91 / 2,5 = 265.96 ton

C. Calculation at point BH-4

Ultimate Edge Resistance (Qp)
Qp = Ap x qp
Look for Ap:
Ap = π x r^2 = 3.14 x 0.4 x 0.4 = 0.5024
Look for qp:
qp = 1/3 x 4 x Pa x N_{60}
Look for N_{60}:
10D= 10 x 0.8 = 8 m
4D = 4 x 0.8 = 3.2 m
The average value of NSPT corrected for pile tip can be seen in the following table.

Table 5. N_{60} BH-4 Value

Depth (m)	Nb'
30.00	26
32.00	33
34.00	32.5
36.00	39.5
38.00	37.5
40.00	37.5
Average	34.33

The average corrected NSPT value was 34.33, So:
qp = 1/3 x 4 x 100 x 34.33 = 4577.78 kN
So Qp:
Qp = Ap x qp
= 0.5024 x 4577.78 kN
= 2299.88 kN ≈ 234.52 ton

Frictional Resistance of Cover (Qs)
Qs = Qs1 + Qs2 = 220.29 + 4215.14
= 4435.43 kN/m^2 ≈ 452.29 ton

Ultimate Carrying Capacity (Qu)
Qu = Qp + Qs
= 234.52 ton + 452.29 ton = 686.81 ton

Permit Support Capacity (Qall)
Qall= Qu / SF = 686.81 / 2.5 = 274.72 ton

Comparison of Bearing Capacity Values based on Boring Log data (SPT)

A comparison of ultimate bearing capacity values based on boring log (SPT) data using the Reese & Wright and Meyerhof methods can be seen in Figure 2.

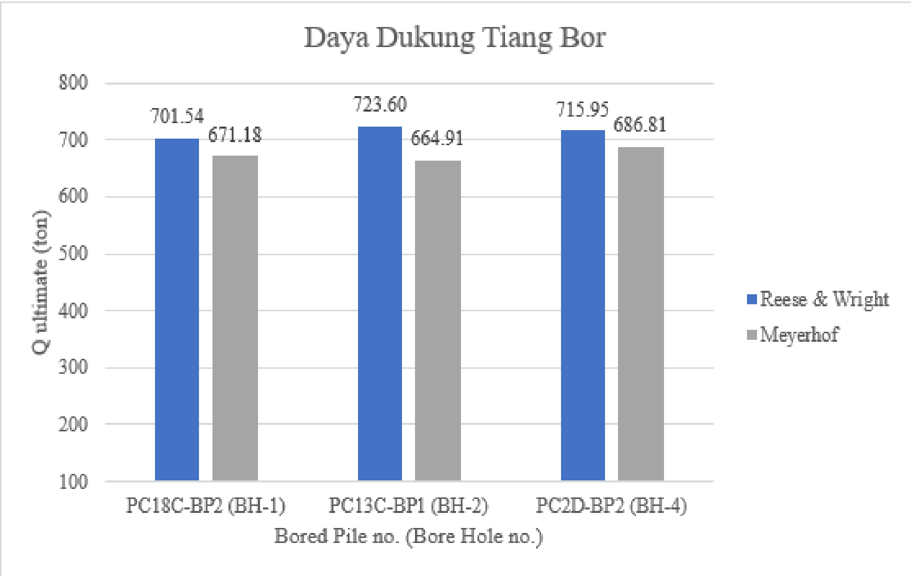

Figure 2. Comparison of Bearing Capacity Values based on Boring Log Data (SPT)

This study calculates the efficiency value using the Los Angeles, Converse-Labarre, and Seiler-Keeney methods. The bearing capacity data to be used refers to the single pile bearing capacity analysis of the Reese & Wright method and the Meyerhof method that has been conducted previously. The number of piles to be used is the same as the existing one in the case study of the Karawang HSR Station on PC18C (BH-1) and PC13C (BH-2) have 2 piles, then PC2D (BH-4) has 4 piles. For more details, see Figure 3. In Figure (a), there is Pile Cap PC18C and Pile Cap PC13C; in Figure (b), there is Pile Cap PC2D.

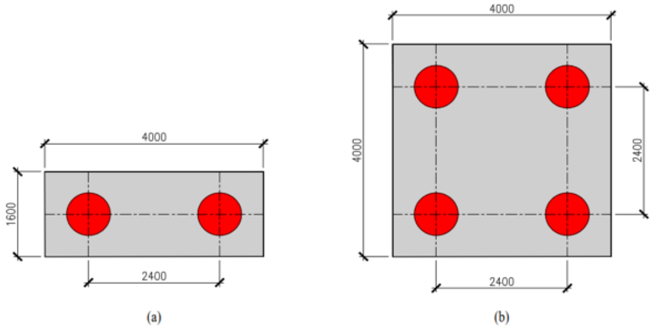

Figure 3. Top View of Existing Pile Cap

From the Figure, so for the analysis of the pile group bearing capacity, a pile configuration is made as in Figure 4.

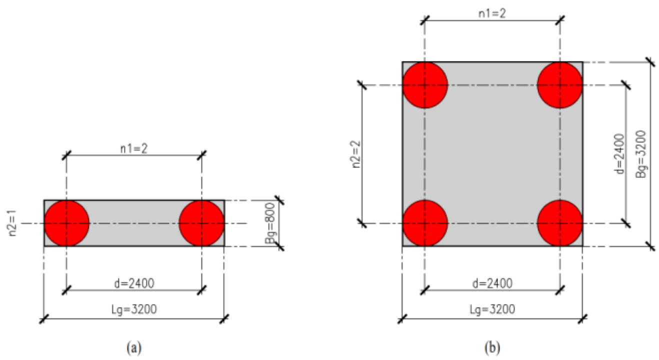

Figure 4. Pole Group Configuration

Los Angeles Method Efficiency

The following is a calculation of pile group efficiency using the Los Angeles method.

Pile Cap PC18C & PC13C

$$n = 1 - \frac{0,8}{3,14\,x\,2,4\,x\,2\,x\,1}\left[2(1-1) + 1(2-1) + \sqrt{2(1-1)(2-1)}\right]$$

$$= 1 - 0.05308\,[2,4142]$$

$$= 0,8718$$

Pile Cap PC2D

$$n = 1 - \frac{0,8}{3,14\,x\,2,4\,x\,2\,x\,2}\left[2(2-1) + 2(2-1) + \sqrt{2(2-1)(2-1)}\right]$$

$$= 1 - 0.02654\,[5,4142]$$

$$= 0,8563$$

The results of the calculation of the bearing capacity of the pile group using the Los Angeles method efficiency can be seen in the following table:

Table 6. Carrying Capacity of Los Angeles Pile Group

Pile No.	Number of Pilets (n)	Efficiency (η)	Qg(u) = η.Σqu 9ton)	
			Reese & Wright	Meyerhof
PC18C (BH-1)	2	0.8718	1223.29	1271.10
PC13C (BH-2)	2		1261.76	1259.24
PC2D (BH-4)	4	0.8563	2452.31	2352.49

Efficiency of the Converse-Labarre Method

The following is the calculation of pile group efficiency using the Converse-Labarre method.

Pile Cap PC18C & PC13C

$$n = 1 - \left[\frac{(2-1)1 + (1-1)2}{90\ x\ 2\ x\ 1}\right] tan^{-1}(0,8/2,4)$$

$$= 1 - 0,00179$$

$$= 0,9982$$

Pile Cap PC2D

$$n = 1 - \left[\frac{(2-1)2 + (2-1)2}{90\ x\ 2\ x\ 2}\right] tan^{-1}\left(\frac{0,8}{2,4}\right)$$

$$= 1 - 0,00358$$

$$= 0,9964$$

The calculation results of the bearing capacity of the pile group using the Converse-Labarre method efficiency can be seen in the following table:

Table 7. Converse-Labarre Pile Group Carrying Capacity

Pile No.	Number of Piles (n)	Efficiency (η)	Qg(u) = η.Σqu 9ton)	
			Reese & Wright	Meyerhof
PC18C (BH-1)	2	0.9982	1400.57	1339.95
PC13C (BH-2)	2		1444.62	1327.44
PC2D (BH-4)	4	0.9964	2853.57	2737.42

Efficiency of the Seiler-Keeney Method

The following is the calculation of pile group efficiency using the Seiler-Keeney method.

Pile Cap PC18C & PC13C

$$n = \left\{1 - \left[\frac{11\ x\ 2,4}{7(2,4^2 - 1)}\right]\left[\frac{2+1-2}{2+1-1}\right]\right\} + \frac{0,3}{2+1}$$

$$= 1 - 0,1014 + 0,1$$

$$= 0,9986$$

Pile Cap PC2D

$$n = \left\{1 - \left[\frac{11\ x\ 2,4}{7(2,4^2 - 1)}\right]\left[\frac{2+2-2}{2+2-1}\right]\right\} + \frac{0,3}{2+2}$$

$$= 1 - 0,1352 + 0,1$$

$$= 0,9398$$

The results of the calculation of the bearing capacity of the pile group using the Seiler-Keeney method efficiency can be seen in the following table.

Table 8. Seiler-Keeney Pile Group Bearing Capacity

Pile No.	Number of Piles	Efficiency	Qg(u) = η.Σqu 9ton)	
	(n)	(η)	Reese & Wright	Meyerhof
PC18C (BH-1)	2	0.9986	1401.09	1340.45
PC13C (BH-2)	2		1445.15	1327.93
PC2D (BH-4)	4	0.9398	2691.32	2581.78

Calculation of Bearing Capacity based on Static Load Test Data

Based on the results of field testing, it can be seen that the maximum lower pole movement on the PC2D-BP2 pole is 3,390 mm, and on the PC14D-BP3 pole is 3,025 mm. Then the maximum movement of the upper pole of the PC2D-BP2 pole is 1,705 mm, and the PC14D-BP3 pole is 1,600 mm at a load of 2500 kN or equivalent to an effective load of 5000 kN (working load 100%). Based on field testing, it is plotted into a load vs displacement graph, which can be seen in Figure 5 and Figure 6.

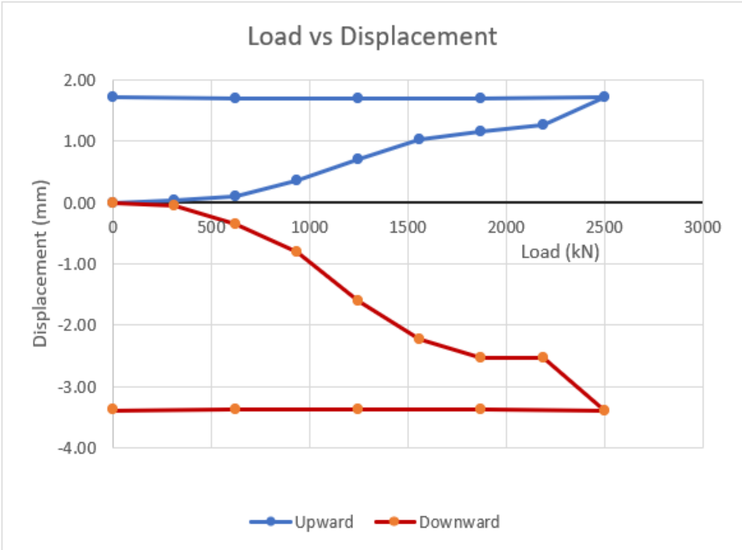

Figure 5. PC2D-BP2 Load vs Displacement Chart

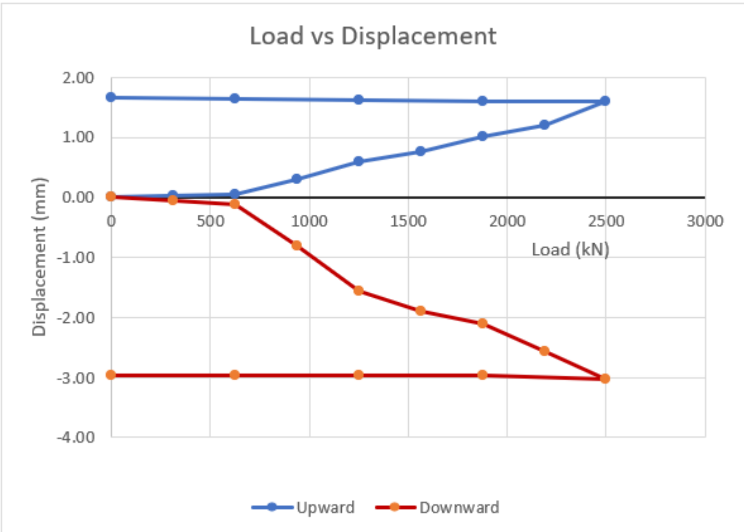

Figure 6. Load vs Displacement Chart PC14D-BP3

Davisson's Method

The following is the determination of the bearing capacity value based on the interpretation of static l adding test data using the Davisson method.

Determining the elastic decline (Δ)

E = 370,45 ton/cm²

$$\Delta = \frac{P.L}{E.A} = \frac{250\ ton\ .3800\ cm}{370{,}45\ ton/cm2\ .5026\ cm2} = 0.51\ cm = 5.1\ mm$$

Draw a line based on the calculation of Δ, then make a line parallel to the line Δ with a distance of X, which X is:

$$X = 0{,}15 + \frac{D\ (inch)}{120} = 0{,}15 + \frac{31{,}496}{120} = 0{,}412\ inch = 10{,}477\ mm$$

Plot the equivalent top load curve, then the intersection between the load curve and the Δ line is the ultimate bearing capacity value. The following are the results of the interpretation of the Davisson method.

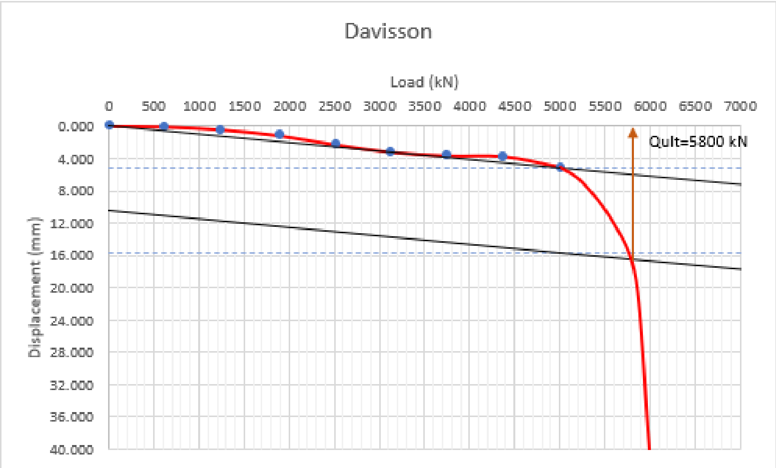

Figure 7. Interpretation of Davisson PC14D-BP3 Method

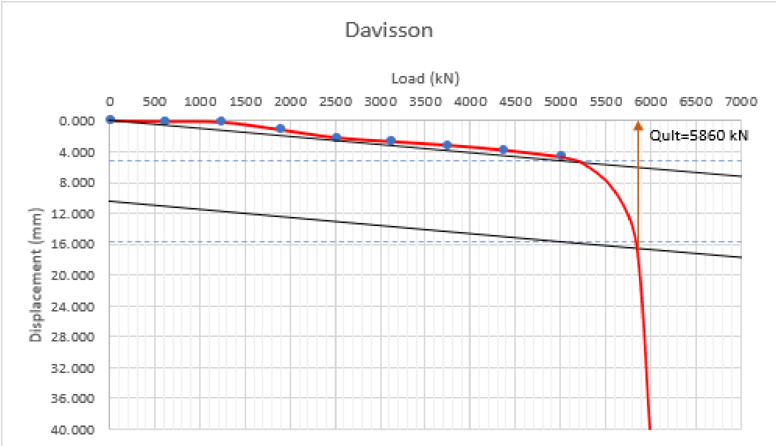

Figure 8. Interpretation of Davisson PC14D-BP3 Method

From the interpretation of the Davisson method, the bearing capacity value obtained for PC2D-BP2 was 5800 kN or 591.4 tons, and then for PC14D-BP3, it was 5860 kN or 597.55 tons.

Mazurkiewicz Method

The following is the determination of the bearing capacity value based on the static loading test data interpretation using the Mazurkiewicz method.

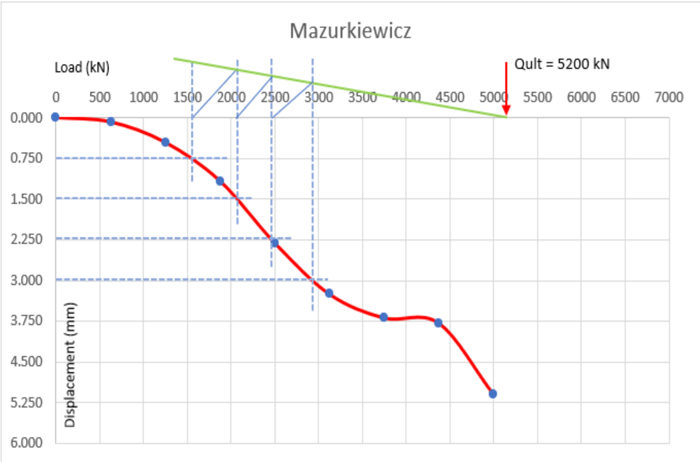

Figure 9. Interpretation of the Mazurkiewicz Method PC2D-BP2

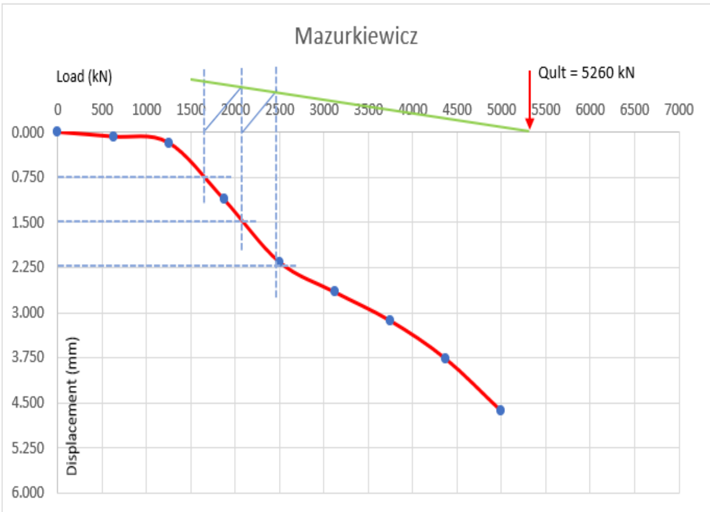

Figure 10. Interpretation of the Mazurkiewicz Method PC14D-BP3

From the results of the interpretation of the Mazurkiewicz method, the bearing capacity value obtained for PC2D-BP2 was 5200 kN or 530 tons, and then for PC14D-BP3 it was 5260 kN or 536.37 tons.

CONCLUSION

From the results of the calculation analysis that has been conducted, the value of the bearing capacity of the bored pile foundation in the Jakarta-Bandung High-Speed Train Station construction project, Karawang section, can be concluded as follows:

a. The results of manual calculation of single pile bearing capacity based on boring log (SPT) data using the Reese & Wright method, on BH-1 the ultimate bearing capacity was 701.54 tons, on BH-2 the ultimate bearing capacity was 723.60 tons and on BH-4 the ultimate bearing capacity was 715.95 tons.
b. The results of manual calculation of single pile bearing capacity based on boring log (SPT) data using the Meyerhof method, on BH-1 the ultimate bearing capacity was

671.18 tons, on BH-2 the ultimate bearing capacity was 664.91 tons and on BH-4 the ultimate bearing capacity was 686.81 tons.

c. The results of the calculation of pile group bearing capacity using the Los Angeles, Converse-Labarre, and Seiler-Keeney efficiency methods can be seen in the presented tables.
d. Interpretation results based on static loading test (SLT) data using the Davisson method, on bored pile PC2D-BP2 obtained an ultimate bearing capacity value of 591.40 tons and on bored pile PC14D-BP3 obtained an ultimate bearing capacity value of 597.55 tons.
e. Interpretation results based on static loading test (SLT) data using the Mazurkiewicz method, on bored pile PC2D-BP2 obtained an ultimate bearing capacity value of 530.00 tons and on bored pile PC14D-BP3 obtained an ultimate bearing capacity value of 536.37 tons.
f. The bearing capacity value was based on PDA Test data, which was continued using CAPWAP software by the contractor, on the PC18C-BP2 bored pile, the bearing capacity value was 822.69 tons, on the PC13C-BP1 bored pile, the bearing capacity value was 602.16 tons, on the PC2D-BP2 bored pile, the bearing capacity value was 596.10 tons.

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