OPEN ACCESS

DYNAMICS
Journal of Architecture and Engineering

Vol. 1, No. 1, July 2024, 49 – 54
P-ISSN: XXXX-XXXX and E-ISSN: XXXX-XXXX
https://jurnal.imat.ac.id/index.php/dynamics

EVALUATION OF PILE DRIVING CALCULATION FROM SPT DATA WITH PDA TEST RESULTS ON A 5,000 KILOLITER WATER TANK IN SEI SIAK, PEKAN BARU

Syahrian[a], Tika Ermita Wulandari[a]
[a]Civil Engineering Study Program, Faculty of Engineering, Universitas Medan Area, Indonesia,
email: tikaermita@staff.uma.ac.id

Article Info:
- Received: 15/07/2024
- in revised form: 26/07/2024
- Accepted: 26/07/2024
- Available Online: 26/07/2024

ABSTRACT

The foundation is a part of a substructure system that supports its own weight and all load forces from the superstructure, then transfers them to the soil and rock layers beneath. This research aims to determine the bearing capacity of the foundation using the Mayerhof method, to determine the efficiency of the pile group using the Feld formula, to compare the analytical results with the PDA test data, and to identify which method most closely approximates the PDA test field data. The results of the study show that the pile foundation design is safe after being evaluated with the PDA test, as the bearing capacity obtained from the PDA test is greater than the planned value. The bearing capacity of a single pile based on SPT (Mayerhof) data at a depth of 30 meters is 126.7 tons, and the PDA test result is 194 tons. Piling at a depth of 30 meters is feasible and does not need to extend beyond 30 meters. The required number of piles is 54, which is fewer than the number of piles already used (driven).

***Key Words**: Bearing capacity of foundation, PDA Test, SPT (Standart Penetration Test)*

ABSTRAK

Pondasi adalah bagian dari suatu sistem struktur bawah (sub structure) yang menahan berat sendirinya dan seluruh beban gaya dari struktur atas, kemudian meneruskannya ke lapisan tanah dan batuan yang terletak di bawahnya.. Penelitian ini bertujuan untuk Mengetahui daya dukung pondasi dengan menggunkan metode mayerhoff, Mengetahui efisiensi kelompok tiang pancang menggunkan formula feld. Untuk mengetahui perbandingan hasil analitis yang dilakukan dengan hasil data PDA test serta mengetahui metode mana yang lebih mendekati data lapangan PDA test .. Dari hasil penelitian yang dilakukan penulis menemukan bahwa Hasil perencanaan pondasi tiang pancang setelah dievaluasi dengan PDA test dinyatakan aman karena nilai daya dukung yang dihasilkan dari pengujian PDA test lebih besar dari nilai perencanaan. Dimana daya dukung tiang tunggal berdasarkan data SPT (mayerhoff) pada kedalaman 30-meter sebesar 126,7ton dan dari hasil PDA test sebesar 194 ton, kedalaman pemancangan memungkinkan hanya pada kedalaman 30-meter dantidak perlu sampai pada kedalaman lebih dari 30 meter, Jumlah tiang yang dibutuhkan sebanyak 54 titik lebih sedikit dibandingkan dengan jumlah tiang yang sudah digunakan (dipancang).

***Kata Kunci**: Daya dukung pondasi, PDA Test, SPT (Standart Penetration Test)*

1. INTRODUCTION

The foundation is part of a substructure system that supports its own weight and all force loads from the upper structure, then transmits them to the layers of soil and rock beneath it.

It often happens that the results of planning the bearing capacity of pile foundations do not exactly match the results of Pile Drive Analysis tests in the field. So the number of piles used is sometimes excessive and sometimes the number is insufficient or insufficient to carry the load carried by the foundation. There are several main data that can be selected for planning pile foundations, namely SPT (Standard Penetration Test) data and also CPT (sondir) data. However, this final project uses standard penetration test data as data for calculating the bearing capacity of piles.

This research aims to determine the bearing capacity of the foundation using the Mayerhoff method, determine the efficiency of pile groups using the Feld formula, to find out the comparison of analytical results carried out with the results of the PDA test data and to find out which method is closer to the PDA test field data.

2. DATA AND METHODS

2.1. Soil Investigation Data

The data from the soil investigation tests carried out during the construction of this tank foundation was an SPT (standard penetration test) investigation and evaluated using a PDA test (pile drive analysis).

2.2. Calculation of the load that will act on the foundation

Loading calculations are used to find out how much load the foundation will accept. The calculation of the working load is done manually

2.3. Analysis Method

If the load acting on the foundation is known, then to plan the foundation so that the tank can stand firmly and not tilt due to partial subsidence of the foundation, it is necessary to analyze the bearing capacity of the foundation. In this final project, to analyze the bearing capacity of the foundation, we will use N SPT data and use the Mayerhoff method.

3. RESULTS AND DISCUSSION

In this research, the calculation of the bearing capacity of piles will use SPT (Standard penetration test) data and use the Mayerhoff formula, the results of the bearing capacity calculation will be compared with the results of the PDA Test (Pile drive analysis).

3.1 Calculation of Loads Acting on Tank Foundations

1. Tank plate shell weight: SS 400 plate type, size 6' x 20'

Plate used:	10 mm thick	= 26 sheet
	8mm thick	= 13 sheet
	6 mm thick	= 39 sheet
Plate weight:	10 mm thick	= 875 kg/sheet
	8mm thick	= 700 kg/sheet
	6 mm thick	= 525 kg/sheet
Tank shell weight		= (26 x 875) + (13 x 700) + (39 x 525)
		= 52,442 kg
		= 52,442 tons

2. Weight of tank bottom plate
   SS 400 plate type size 6' x 20'
   Plates used: 8 mm thick = 47 sheets
   Plate weight: 8 mm thick = 700 kg/sheet
   Tank bottom weight = 47 lbr x 700 kg/lbr = 32,900 kg = 32,900 tons

3. Weight of annular tank plate
   SS 400 plate type size 6' x 20'
   Plate used: 10 mm thick = 13 sheet
   Plate weight: 10 mm thick = 875 kg/sheet
   Tank annular weight = 13 lbr x 875 kg/lbr= 11,375 kg = 11,375 tons

4. Weight of the tank roof plate
   SS 400 plate type size 6' x 20'
   Plate used: 6 mm thick = 59 sheet
   Plate weight: 6 mm thick = 525 kg/sheet
   Tank roof weight = 59 lbr x 525 kg/lbr= 30,975 kg = 30,975 tons

5. Weight of tank hand railing
   Types of steel construction hand railings

Material used:	angle steel 50.50.5	= 17 stem
	16 mm concrete iron	= 12 stem
	landing plate # 4.5 mm	= 5 sheet
Material weight:	angle steel 50.50.5	= 22.68 kg/stick
	16 mm concrete iron	= 18.90 kg/stick
	landing plate # 4.5 mm	= 110 kg/sheet

   Hand railing weight = (17 x 22.68) + (12 x 18.9) + (5 x 110)= 1,162 kg = 1.162 tons

6. Weight of the tank roof frame
   Type of steel construction roof frame

Material used:	angle steel 50.50.5	= 85 sticks
	angle steel 70.70.7	= 46 sticks
	UNP 100 steel	= 51 sticks
	gusset plate 10 mm	= 7 sheets
	black pipe Ø 8”	= 1 sticks
Material weight	:angle steel 50.50.5	= 22.68 kg/stick
	angle steel 70.70.7	= 44.28 kg/btg
	UNP 100 steel	= 56.20 kg/stick
	gusset plate 10 mm	= 875 kg/sheet
	black pipe Dia. 8”	= 252.12 kg/stick

   Roof frame weight = (85 x 22.68) + (46 x 44.28) + (51 x 56.20) + (7 x 875) + (1 x 875)
   = 13,208 kg = 13,208 tonnes

7. Tank curb angle weight
   Curb angle type steel construction

Material used:	angle steel 100.100.10	= 13 sticks
	strip plate 5 x 50 mm	= 10 sheets
Material weight:	angle steel 150.150.15	= 202 kg/stick
	strip plate 5 x 50 mm	=22.4 kg/sheet

   Curb angle weight = (13 x 202) + (10 x 22.4) = 2,850 kg = 2,850 tons

8. Weight of tank contents (weight = volume)
   Tank diameter = 25.24 meters
   Tall = 10.92 meters
   Weight of tank contents = ¼ x Π x D^2x T
   = ¼ x 3.14 x (25) 2 x 10.92
   = 5,360,000 kg
   = 5,360 tons

9. Weight of the tank foundation pile cap concrete
   Concrete volume = ¼ x Π x D2 x T
   = ¼ x 3.14 x (26.24) 2 x 0.67
   = 362.14 m3
   Specific gravity of concrete = 2400 kg/m^3
   Concrete weight = 362.14 M3 x 2400 kg/m3
   = 869.13 kg
   = 869,130 tons

10. Weight of pile
   Number of points =69 points
   Pole depth = 30 meters
   Pole length =69 x 30 = 2,070 meters
   Mast weight = 195 kg/m
   Pile weight =2070 m x 195 kg/m
   = 403,650 kg
   = 403,650 tons

The total weight of the working load is:

1. Thick SS 400 plate shell (10, 10, 8, 6, 6, 6) x 6' x 20'	=52,442	tons	
2. Bottom plate SS 400 # 8 mm x 6' x 20'	= 32,900	tons	
3. Annular plate SS 400 # 10 mm x 6' x 20'	= 11.375	tons	
4. Roof plate SS 400 # 6 mm x 6' x 20'	= 30.975	tons	
5. Hand railings	= 1.162	tons	
6. Roof framing	= 13.208	tons	
7. Curb angle	= 2,850	tons	
8. Weight of tank contents	= 5,360,000	tons	
9. Weight of the tank foundation pile cap concrete	= 869.136	tons	
10. The weight of the pile is 69 points @ 30 meters	=403,650	tons	
Total working load	= 6,777,698	tons	+

3.2 Calculations Using Standard Penetration Test (SPT) Data

In calculating carrying capacity, it is calculated using the following data:

1. The diameter of the pile is taken to be 400 mm = 0.4 meters
2. Drill Hole BH-1
3. The SPT (N) value from the boring log table and graph is taken at a depth of 30 meters

Qu= 40 Nb. Ap + 0.2 N . US
Qu= 40 x 31 x 0.126 + 0.2 x 21.36 x 37.68
Qu= 156.24 + 160.97
Qu= 317.21 tons
So the bearing capacity of the pile at a depth of 30 meters:
Qa = *Qu / FK*
Qa = 317.21 / 2.5
= 126.88 Tons/single pole
So: 126.88 tons ≤ 194 tons …….. ok
Where the figure of 194 tons was obtained from the PDA test results attached in Table 1 below.

Table 1. PDA Test Results

Pile No.	CAPWAP						
	Total Bearing Capacity (ton)	Skin Friction (ton)	End Bearing (ton)	Displacement (mm)	Set (mm)	Integrity	Remark
P-16	194	176	18	24.3	3	Good Ple	Actual Bearing Capacity > Engineering Bearing Capacity

3.3 Calculation of the Number of Poles Required

The number of poles required based on the total working load is:
n =6,777,698 tons / 126.88 tons
n = 53.42*pile*~ 54 piles
From the general guidelines for determining the efficiency of pile groups in sandy soil where in piles, both friction resistance piles and end resistance piles with S ≥ 3 D, the bearing capacity of the pile group can be taken to be equal to the sum of the bearing capacities of each pile Eg = 1.
However, actualization in the field is that the number of pile points used is 69 points. So we can predict the range of efficiency of pile groups used by planners in the field so that it can be an indicator that the number of pile points applied is more than the results of this evaluation.

Qg = Eg xnx Qa
6,777.698 = Eg x 69 x 126.88
Eg = 6,777.698 / (69 x 126.88)
Eg = 6777.698 / 8754.72
Eg = 0.78 x 100%
Eg = 78 %

3.4 Relationship and Comparison of Evaluation Analysis with the Actual Number of Piles in the Field with the PDA Test Results

The relationship between the evaluation analysis and the actual number of driving implementations in the field as well as the results of the PDA test is: where from the same standard penetration test data, the number of calculations for pile point requirements is different, but both results are still within safe limits according to the results of the bearing capacity. evaluation and test results of the PDA test. Where the bearing capacity from the evaluation is 126.88 tons and the bearing capacity from the PDA test results is 194 tons. However, if we compare the evaluation with the PDA test results, there is a very significant difference in the bearing capacity that dominates the end bearing pile and skin friction. Where in the evaluation results there is an end bearing pile of 62.5 tons and skin friction of 64.38 tons. So the dominance percentage for end bearing piles is 49.26% and for skin friction it is 50.74% and it can be concluded that the carrying capacity of end bearing piles is almost the same as skin friction. Where in the PDA test results, here the very dominant bearing capacity is skin friction which has a value of 176 tons and for the end

bearing pile it is 18 tons. So the skin friction percentage is 90% and the end bearing pile is 10%. and it can be concluded that the carrying capacity of the end bearing pile is much smaller than that of skin friction. So from the results of the evaluation of the carrying capacity of the end bearing pile and skin friction it can be assumed that neither one dominates because they have a balanced amount of bearing capacity and vice versa, it is very different from the results of the PDA test. there is dominance in the bearing capacity of skin friction compared to end bearing pile.

4. CONCLUSION

The results of the pile foundation planning after being evaluated with the PDA test were declared safe because the bearing capacity value resulting from the PDAtest test was greater than the planning value. Where the carrying capacity of a single pile based on SPT data (Mayerhoff formula) at a depth of 30 meters is 126.7 tons and from the PDA test results it is 194 tons.

5. OFFICIAL STATEMENT

The author would like to thank Mrs. Ir. Tika Ermita Wulandari, S.T., M.T., as supervisor and Head of the Civil Engineering Study Program, Faculty of Engineering, Universitas Medan Area which has provided many suggestions. Apart from that, the author conveys his appreciation to Mr. Imbran Azhari, S.T., Mrs. Atika, Sister Sadarunnisa who have helped the author a lot during the preparation of his thesis.

6. REFERENCE

ASTM D4945. (n.d.). *Standard test method for high strain dynamic testing of deep foundations*. Metode pelaksanaan PDA test.

ASTM D1586. (1958). *Standard test method for standard penetration test (SPT)*.

Hardiatmo, H. C. (1996). *Teknik pondasi I*. Jakarta: PT Gramedia Pustaka Utama.

Hardiatmo, H. C. (2008). *Teknik pondasi II* (Edisi ke-4). Jakarta: PT Gramedia Pustaka Utama.

Sardjono, H. S. (1998). *Pondasi tiang pancang* (Jilid 1). Surabaya: Penerbit Sinar Jaya Wijaya.

Schmertmann, J. H., & Nottingham, L. C. (1975). LCPC method 1991.

Sosrodarsono, S., & Nakazawa, K. (1990). *Mekanika tanah dan teknik pondasi* (Edisi kelima). Jakarta: Penerbit Pradnya Paramita.

Universitas Katolik Parahyangan. (n.d.). *Manual pondasi tiang*.