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Analysis Of The Bearing Capacity Of The Boredpile Foundation In The Advanced Construction Project Of Class Iia Prison Pematang Siantar Using Analytical Method And Finite Element Method With Plaxis 2D

M.Husni Malik Hasibuan[1], Jupriah Sarifah[2], Nazla Elyza[3]
[1]Teaching Staff, Civil Engineering Study Program, Islamic University of North Sumatra
[2] Teaching Staff, Civil Engineering Study Program, Islamic University of North Sumatra
[3] Undergraduate student, Civil Engineering Study Program, Islamic University of North Sumatra
[1]husnihasibuan@ft.uisu.ac.id; [2]jupriah@ft.uisu.ac.id; [3]nazlaeliza221102@gmail.com

Abstract - Foundations are used in civil engineering to define a building construction that functions as a building support and transmits the load of the building above it to a layer of soil that has sufficient bearing capacity. Meanwhile, the foundation itself consists of two types, namely shallow foundation and deep foundation. Boredpile foundation is an example of a deep foundation. Bored pile foundation is a type of tube-shaped deep foundation (deep well), which functions to forward the load of the building structure above it from the ground surface to the hard soil layer below. The purpose of writing this thesis is to determine the settlement value and bearing capacity of bored pile foundation with the comparison of analytical methods (Meyerhoff and Schmertmann & Nottingham) and finite element method with the help of Plaxis 2D Software and PDA. The results and discussion of the calculation analysis obtained the conclusion that the comparison of the bearing capacity of the foundation using the analytical method and the finite element method with Plaxis 2D obtained comparison results with the Mayerhoff method of 33.37%, Schermetmann & Nottingham produced 44.44%, and Plaxis 2D of 38.64%. While in the comparison of foundation settlement results obtained with mayerhoff results of 6.22%, Schermetmann & Nottingham produces 4.56%.

Keywords: Foundation, Bored Pile, Plaxis 2D

1. INTRODUCTION

Infrastructure development in Indonesia continues to increase, along with the need for proper public facilities, including correctional institutions (Lapas). One of the main challenges in the construction of new prisons, such as the class IIA PematangSiantar prison, is the unfavorable soil conditions in terms of foundation bearing capacity. Soils with low bearing capacity characteristics require careful foundation planning to ensure structural stability and safety. Boredpile foundations are often used as a solution for such conditions due to their ability to withstand large loads in soft soils.

However, many infrastructure projects experience technical failures due to inaccuracies in foundation bearing capacity analysis. Therefore, a comprehensive analysis approach is needed by combining analytical methods such as Mayyerhoff and Schmertmann&Nottingham, as well as finite element-based numerical methods using Plaxis 2D software.Although each method has been widely used, previous studies tend to use only one approach so that the analysis results do not fully reflect the field conditions accurately.

This study aims to analyze and compare the results of the calculation of bearing capacity and settlement of boredpile foundations using the analytical method and the finite element method (Plaxis 2D), and relate them to field test data from PDA. With this approach, it is expected to obtain more representative results as a technical reference in foundation planning in similar projects.

2. RESEARCH METHODOLOGY

2.1 Research Location

The analyzed location is the bearing capacity of the bored pile foundation in the project of continued development of class IIA prison in JL. Asahan No.7, Pantoan Maju Kec. Siantar, Simalungun Regency, North Sumatra Province, which can be seen on the following map

Figure.1. Research Location Map

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2.2 Data Collection Methods

In conducting this research, there are several methods that will be used to collect data that supports completing this research. The following data collection methods will be carried out, among others: 1. Data collection The data required in this study were obtained from the data taken, among others:

a. Soil examination in the laboratory
b. Sondir results
c. Foundation plan and foundation detailing
d. Working drawings which include situation drawings, plans, sections, construction details and load results on PDA.

Conduct a literature study
In this research, references are cited regarding information and data on theories related to the subject matter to be reviewed from various sources, both from literature, journals, articles and crossref and google scholar.

2.3 Research Stages

1. Data collection
2. Calculating bored pile bearing capacity (CPT) with meyerhoff, schertmann& Nottingham and plaxis 2D methods
3. Calculating the Single Pole settlement and Allowable Settlement
4. Comparative analysis of bearing capacity and settlement with the two methods
5. Conclusion

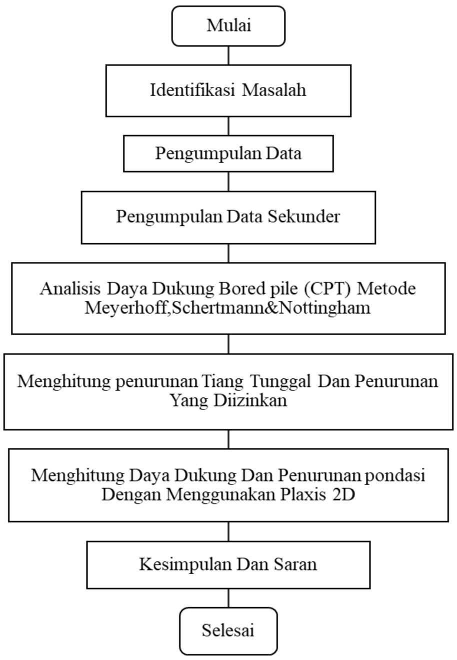

Figure 2. Research Flow

2.4 Analytical Method

The steps of the analytical method planning are asfollows:

1. Conduct a geotechnical investigation with the aim of knowing the characteristics of the soil at the location
2. Calculate the ultimate bearing capacity of the bored pile using several methods namely Meyerhoff, Schertmann & Nottingham
3. Calculate the efficiency and settlement of foundation piles using these methods

2.5 Finite Element Method WithPlaxis 2D

In this research, references are cited that concern information and data regarding the theory that is

1. Analysis of soil parameters
2. Geometry modeling
3. Soil parameter input
4. Determine groundwater table
5. Calculation
6. 2D Plaxis Results

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3. RESULTS AND DISCUSSION

3.1 Foundation Technical Data and CPT

This technical data is obtained from the implementation of the project so that it can be calculated as follows:
1.Foundation Depth: 11.675 m
2.Bored Pile Length: 12 m
3.Foundation Diameter: 0.4 m
4.Concrete Quality: K-300 (26.4Mpa)
5.Steel Quality: 420 Mpa
6.Safety Factor: 3
7.Number of sondir points: 5 points

3.2 Results of Support Calculation Using the Mayyerhoff Method

Table 1. Calculation results of ultimate bearing capacity (Qu) and allowable bearing capacity (Qall)

No	Titik Sondir	Qult		Qall=Qijin	
		KN	TON	KN	TON
1	Titik 1	290,1989818	29,01989818	96,73299	9,673299
2	Titik 2	190,6641699	19,0664169	63,554723	6,3554723
3	Titik 3	353,313680	35,3313680	117,70456	11,7704560
4	Titik 4	233,6842573	23,36842573	77,899475	7,7894752
5	Titik 5	328,6339112	32,86339112	109,54463	10,954463
	Rata-Rata	279,29899	27,929899	93,0873	9,30863

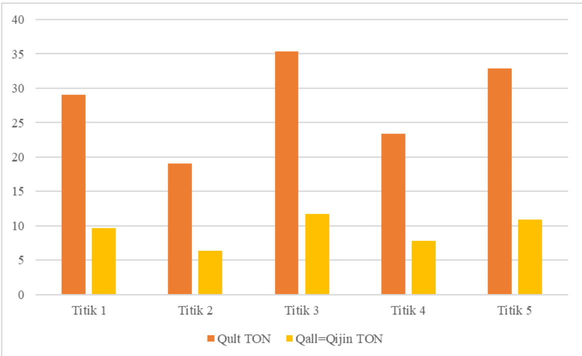

Figure 3. Graph of ultimate bearing capacity (Qu) and allowable bearing capacity (Qall)
Source: Data Analysis

3.3 Results of Support Calculation Using Schertmann& Nottingham Method

Table 2. Calculation results of ultimate bearing capacity (Qu) and allowable bearing capacity (Qall)

No	Titik Sondir	Qult		Qall=Qijin	
		KN	TON	KN	TON
1	Titik 1	412,2780207	41,227802	137,593402	13,7593402
2	Titik 2	307,81071	30,781071	102,6036	10,26036
3	Titik 3	430,6510	43,06510	143,5503	14,35503
4	Titik 4	330,052378	33,0052378	110,0174593	11,00174593
5	Titik 5	436,060522	43,6060522	145,353507	14,5353507
	Rata-Rata	383,370526	38,3370526	127,824	12,7824

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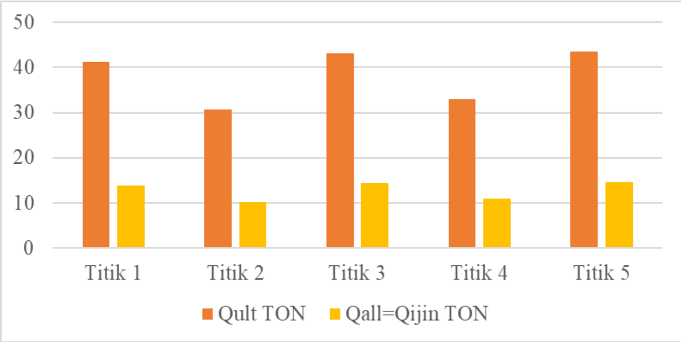

Figure 4. Graph of ultimate bearing capacity (Qu) and allowable bearing capacity (Qall)

3.4 Decline Calculation Results Using the Mayyerhoff Method

Table 3. Mayerhoff reduction results

No	Titik Sondir	Penurunan	
		m	mm
1	Titik 1	0,024339178	24,339178
2	Titik 2	.0,01452751362538	14,52751362538
3	Titik 3	0,03382782581721	33,82782581721
4	Titik 4	0,01968605072468	19,68605072468
5	Titik 5	0,02704992684791	27,04992684791
	Rata - Rata	0,023886099	23,886099

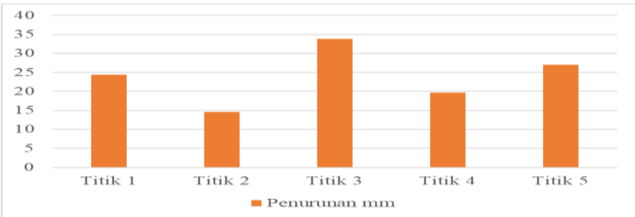

Figure 5. Mayerhoff settlement graph (mm) Source: Data Analysis

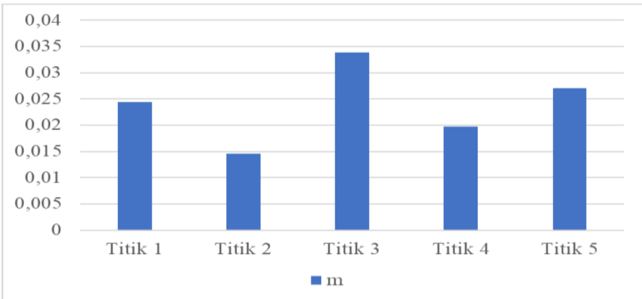

Figure 6. Mayerhoff subsidence graph (m)
Source: Data Analysis

3.5 Decline Calculation Results Using the Schertmann& Nottingham Method

Table 4. Schmertmann& Nottingham Derivation Results

No	Titik Sondir	Penurunan	
		m	mm
1	Titik 1	0,019611634	19,611634
2	Titik 2	0,01041175486	10,41175486
3	Titik 3	0,023074918	23,074918
4	Titik 4	0,013477525	13,477525
5	Titik 5	0,0208600032704	20,8600032704
	Rata - Rata	0,01749	17,48716703

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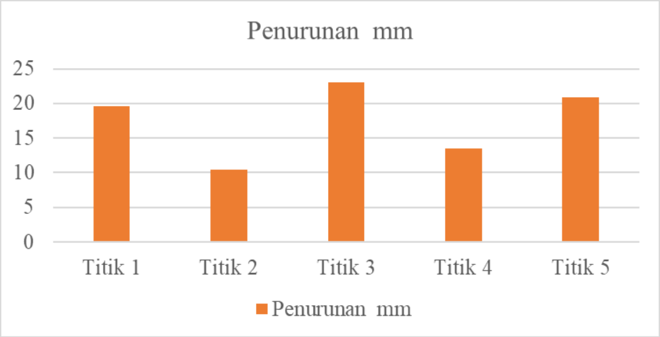

Figure 7. Schmertmann & Nottingham settlement graph (mm)

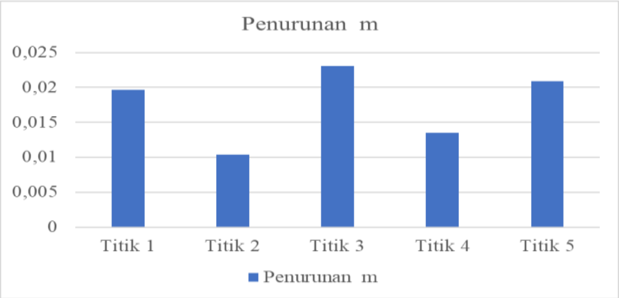

Figure 8. Schmertmann & Nottingham drop graph (m)

3.6 Results of Support Calculation Using Plaxis 2D

Table 5. Plaxis Program Results

No	Titik Sondir	Plaxis	
		Penurunan (m)	Daya dukung (Ton)
1	Titik 1	0,39307	33,527664
2	Titik 2	0,37469	33,118208
	Rata- Rata	0,38388	33,3229

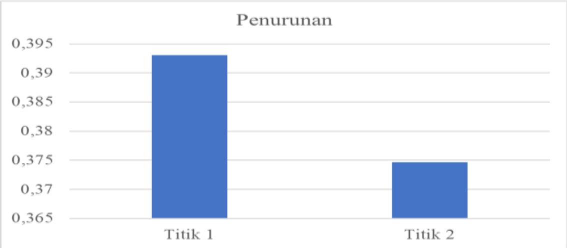

Figure 9. Results of settlement calculation on plaxis (m)

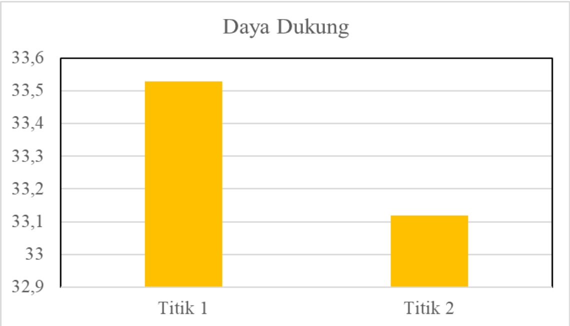

Figure 10. Results of bearing capacity calculation on plaxis (tons)

3.7 Comparison of Analytical Method and Finite Element Method with Plaxis Program

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Table 6. Comparison Results of Decrease

Mayerhoff (m)	Nottingham(m)	Plaxis(m)
0,023886099	0,01749	0,38388

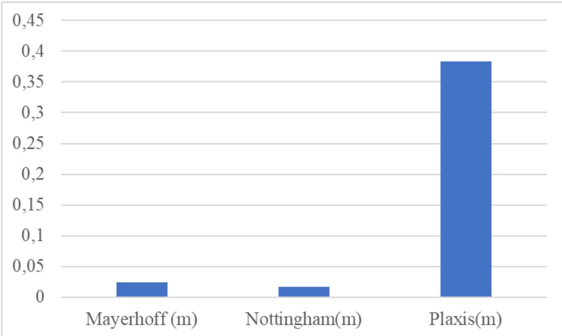

Figure 11. Comparison results of decrease (m) Source: Data Analysis

3.8 Comparison of Supportability Results of Analytical Method and Finite Element Method with Plaxis and PDA Programs

Table 7. Supportability comparison results

Mayerhoff (Ton)	Nottingham(Ton)	Plaxis(Ton)	PDA(Ton)
27,92989999	38,3370526	33,3229	86,25

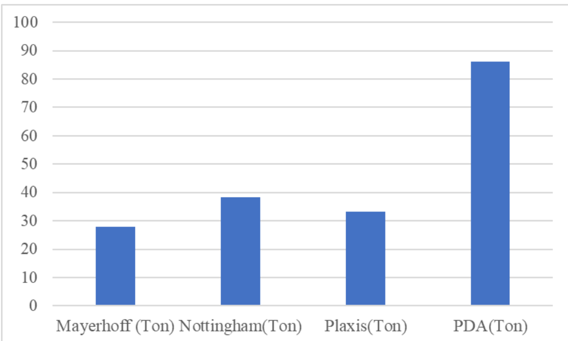

Figure 12. Comparison chart of Support Capacity (Tons)

3.9 Analysis of Bored Pile Foundation Support Comparison Results

The results of the comparison of soil bearing capacity values show:
- Mayerhoff: 27,92989999 tons
- Schermetmann& Nottingham: 38.3370 Tons
- Plaxis 2D: 33.3229 Tons
- PDA: 86.25 Tons

Analysis

- The bearing capacity values obtained from the analytical methods (Mayerhoff and Schermetmann& Nottingham) are much lower than the results from the finite element method (Plaxis 2D) and field data (PDA). - The result from PDA of 86.25 Tons indicates that the soil conditions in the field have a higher bearing capacity than predicted by

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both analytical methods. This could be due to variations in soil conditions that are not fully represented in the analytical model.
- The significant difference between the analytical results and field data shows the importance of verifying the analytical results with field testing. It also emphasizes the need for a better understanding of the soil characteristics at the project site.

3.10 Analysis of the Comparative Results of Single Pole Bored Pile Foundation Decline
The comparison results of foundation settlement show different values between the analytical method and the finite element method:
- Mayerhoff: 0,023886099 m
- Schermetmann& Nottingham: 0,01749 m
- Plaxis 2D: 0.38388 m

Analysis
- The settlement values obtained from the analytical methods (Mayerhoff and Schermetmann& Nottingham) are much smaller than the results from the finite element method (Plaxis 2D). This indicates that the analytical method may not fully consider the complex factors present in the field, such as soil and foundation interaction, as well as more dynamic load conditions.
- The larger results from Plaxis 2D show that this method is able to capture more realistic and complex soil behavior, which may not be accommodated by the analytical method. This could be due to the more detailed model and Plaxis' ability to analyze inhomogeneous soil conditions.

4. CONCLUSIONS

After conducting research related to soil bearing capacity and podation settlement with analytical methods and finite element methods using the 2D plaxis program, the results were obtained

1. Based on the calculation results, the Mayerhoff method produces a bearing capacity of. 32.37% compared to the reference value from field testing. The Schermetmann& Nottingham method yields 44.44%, while the numerical simulation using Plaxis 2D shows a value of 38.64%. These results indicate that the analytical and numerical methods provide lower estimates than the actual data from the field.
2. In the settlement calculation, the Mayerhoff method yields a settlement value of 6.22%, while the Schermetmann& Nottingham method is 4.56% when compared to the results from the finite element method using Plaxis 2D. This shows that the analytical method gives much smaller settlement estimates and tends not to represent the full complexity of the soil conditions as accounted for in the finite element method.
3. The comparison results show that the analytical and numerical methods produce much lower bearing capacity and settlement estimates than the field test results and the finite element method. The bearing capacity of the analytical method only reaches 32-44%, and the settlement is even only about 4-6% of the reference results. This confirms that the finite element method is more capable of accurately representing complex soil conditions.

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