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ANALISIS DAYA DUKUNG PONDASI TIANG PANCANG DENGAN METODE *MAYERHOF* (STUDI KASUS : PEMBANGUNAN GEDUNG KANTOR PT. PELINDO SAMARINDA)

ANALYSIS OF PILE FOUNDATION USING MAYERHOF METHOD (CASE STUDY: CONSTRUCTION OF PT. PELINDO SAMARINDA OFFICE BUILDING)

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ABSTRACT

The analysis of bearing capacity is conducted to determine the required bearing capacity to support the structure's load [1]. Soil bearing capacity is crucial for the stability of buildings constructed on it. One parameter used in bearing capacity analysis is the calculation based on soil boring test data. This research aims to analyze the bearing capacity of pile foundations using the Mayerhof method in the planning of the construction project for the PT. PELINDO SAMARINDA Office Building at Jalan Niaga Timur No. 130, Samarinda Port. The study identifies problem formulations related to the foundation's bearing capacity and the number of piles needed using the Mayerhof method. To achieve the research objectives, soil testing is conducted using the Standard Penetration Test (SPT) method. The obtained soil test data are utilized for soil bearing capacity analysis based on the Mayerhof method. The research results reveal the foundation's bearing capacity using the Mayerhof method and determine the number of piles needed to ensure the building's safety and stability. For a diameter of 0.3, pile types P1, P2, and P3 each show Qp values of 92.21 tons, 81.62 tons, and Qu (Ultimate Bearing Capacity) of 173.84 tons. The number of piles (N) for P1 is 5, P2 is 4, and P3 is 3. Furthermore, for P1, P2, and P3 with a diameter of 0.3, they each have SF values of 3, Qall of 57.95, Eg of 0.795, and Qg for P1 of 212.35, P2 of 169.88, and P3 of 127.41. Meanwhile, for a diameter of 0.4, pile types P1, P2, and P3 each show Qp values of 164.06 tons, 108.83 tons, and Qu of 272.87 tons. The number of piles (N) for P1 is 4, P2 is 3, and P3 is 2. For a diameter of 0.4, Qg for P1 is 263.65, P2 is 197.74, and P3 is 131.83. The conclusion of this research is that the use of a combination of pile types indicates a safe condition, and the optimal choice is the P3 pile type with a diameter of 0.4 m, ensuring the stability of the foundation structure.

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1. INTRODUCTION

Bearing capacity analysis is conducted to determine the required load-bearing capacity to support the structure above it [1]. Soil bearing capacity is crucial for the stability of buildings constructed on it. One parameter used in bearing capacity analysis is the calculation based on soil boring test data [2]. The foundation is one of the primary elements in the building structure, located at the bottom, situated in the soil layer, and plays a crucial role in transferring the loads received by the building, including live loads, dead loads, wind loads, earthquake loads, and other loads [3]. There are several types of foundations, including deep foundations and shallow foundations. In the category of deep foundations, there are various variations such as pile foundations, bore pile foundations, and mat foundations [4]. One of the most commonly used foundation types is pile foundations. This foundation type has the advantage of being precast designed and has a higher level of quality control compared to other foundation types [5]. In the context of the PT. PELINDO SAMARINDA office building construction project, several crucial aspects need to be understood to depict the comprehensiveness of the work undertaken. Firstly, the project is situated on a land area of 3600 square meters, with plans to construct a building measuring 2312 square meters. However, what makes this project intriguing is the transformation that will take place in the existing structure. Initially a two-story building, it will be converted into a taller three-story structure in this project. Such a transformation demands careful planning and construction to ensure the stability and safety of the building to be constructed. The office building of PT. PELINDO SAMARINDA located at Jalan Niaga Timur No. 130, Samarinda Port City, serves as a facility designed to enhance its capacity in handling cargo and port services as a whole. This is instrumental in accommodating the growth of business and the increasing demands from customers, particularly from the residents of Samarinda City. Besides functioning as a hub for transportation and logistics services, the author conducted boring tests at a specific location in the construction area of the PT. PELINDO SAMARINDA office building at Jalan Niaga Timur No. 130, Samarinda Port City, to calculate the bearing capacity. The foundation approach employed in this research involves the use of deep foundations, specifically pile foundations. The construction process of the PT. PELINDO SAMARINDA office building at Jalan Niaga Timur No. 130, Samarinda Port City, spans over a period of 26 months. Initiated in 2022, the current construction phase is in the finishing stage, with ongoing progress to complete the project. The building itself encompasses a floor area of 2,313 m². In the planning of the PT. PELINDO SAMARINDA Office Building at Jalan Niaga Timur No. 130, Samarinda Port City, one of the key aspects is the structural strength and type of foundation. The calculation of the structural strength of the foundation heavily relies on the soil's bearing capacity. By comprehending the soil's bearing capacity thoroughly, it is possible to design a construction that is robust, safe, and economically efficient [6]. These factors play a crucial role in determining the foundation's bearing capacity. These factors include the distribution of loads from the building above, influenced by various soil characteristics such as particle size, soil shear angle, dry unit weight, and saturated unit weight for each soil layer. To gain a better understanding of the soil at the project site, various geotechnical tests such as Standard Penetration Test (SPT) and Boring Test are conducted to gather the necessary soil data for the planning and implementation of the underground foundation [7]. The existing soil conditions significantly determine the most suitable type of foundation for the building [8]. Therefore, the planning and calculation of the foundation must meet the established requirements to ensure that the foundation can withstand substantial loads and transmit them safely to the soil. In the context of planning the pile foundation for the Construction Project of the PT. PELINDO SAMARINDA Office Building at Jalan Niaga Timur No. 130, Samarinda Port City, it is crucial to understand the soil characteristics at the location. The advantage of using pile foundations in this project lies in the ability to effectively control material quality due to its manual working process [9]. This thesis will examine whether the use of deep foundations with different methods yields almost identical or significantly different bearing capacity values. Additionally, an analysis of the bearing capacity of pile foundations or deep foundations in the same case will be conducted based on the Mayerhof method. Following the analysis performed, I have chosen the research title "Analysis of Pile Foundation Bearing Capacity Using the Mayerhof Method."

2. METHODS

The research is conducted at PT. PELINDO SAMARINDA, located at Jalan Niaga Timur No. 130, Samarinda City Port, with a building area of 2,313 m². The company operates in the field of port management and logistics in Samarinda.

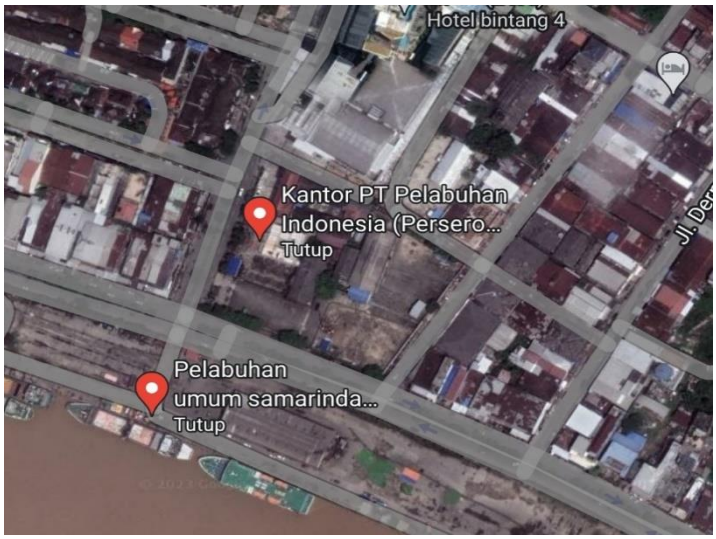

Figure 1. Research Location

2.1 Research Duration

The research commenced in September 2023 and is scheduled to conclude in January 2024. This five-month timeframe is intended to facilitate all stages of the research, including planning, data collection, analysis, interpretation, and the comprehensive report compilation on the research findings.

2.2 Data Collection

The initial stage of this research involves collecting data from borehole tests. Borehole tests entail drilling holes at the research site to obtain soil samples from various depths. These soil samples will be utilized to analyze the characteristics of the soil beneath the surface.

2.3 Secondary Data Collection

The secondary data collection in the research "Analysis of foundation bearing capacity using borehole data based on the Mayerhof method" refers to information or data obtained from previously existing sources, such as scientific literature, previous research reports, or technical records related to the research location. The following are the detailed steps of secondary data collection in the context of this research:

1. The initial stage of the data collection process involves planning the borehole tests to acquire the necessary geotechnical information.
2. Locations within the research site are selected based on geological and geotechnical considerations, as well as the data requirements for foundation analysis.

This secondary data collection is a crucial component in enriching geotechnical research and can contribute to strengthening the generated analyses and recommendations. Secondary data can provide additional insights and a more comprehensive understanding of the soil conditions at the research site, thereby supporting more accurate and effective foundation planning [10].

2.2 Analysis and Discussion

The Mayerhof method is an empirical formula utilized in geotechnical engineering to estimate the bearing capacity of foundations based on specific geotechnical data [11]. In this phase, the Mayerhof method will be employed to calculate the bearing capacity of foundations using data obtained from borehole tests and laboratory analyses. This formula encompasses factors such as soil strength, foundation diameter, and other correction factors relevant to the soil conditions at the research site [12].

3. DISCUSSION

Foundation planning is a crucial stage in the design of a building structure. Foundations serve as the lower part of the structure responsible for transferring loads from the upper structure to the underlying soil layers. The adequacy of the soil to support the building load without experiencing damage or settlement beyond permissible limits is of utmost importance. Foundations are designed to withstand the maximum planned load. In the construction of the PT. PELINDO Samarinda office building, a soil investigation was conducted to understand the physical characteristics of the soil at each layer. The results of this investigation form the basis for foundation planning and maintenance, as well as for obtaining accurate bearing capacity values. Soil investigation was performed using the Standard Penetration Test (SPT) method, involving machine drilling at a single point with depth intervals reaching 24 meters. Foundation planning also includes the calculation of the foundation's strength to be used. This is essential because the foundation must be able to withstand the maximum planned load or any potential load. The strength or bearing capacity of the foundation can be calculated by considering soil investigation data, building loads, pile dimensions, pile spacing, pile depth, and other supporting data such as the quality of the concrete to be used. In this study, the analysis of the bearing capacity of pile foundations was conducted using static methods, while pile settlement analysis adopted empirical methods.

Table 1. Summary of Ultimate Bearing Capacity Analysis of Foundation Piles
Pile Foundation Mayerhof

D		0,3			0,4	
Pile Types	P1	P2	P3	P1	P2	P3
Qp (Ton)	92,21	92,21	92,21	164,06	164,06	164,06
Qs (Ton)	81,62	81,62	81,62	108,83	108,83	108,83
Qu (Ton)	173,84	173,84	173,84	272,87	272,87	272,87
N (Pile)	5	4	3	4	3	2

Based on the recapitulation of ultimate bearing capacity analysis results of the foundation pile, the table above indicates that at a diameter of 0.3 with pile types P1, P2, and P3, each has a Qp of 92.21 tons, Qs of 81.62 tons, and Qu (Ultimate Bearing Capacity) of 173.84 tons. The number of piles (N) for P1 is 5 piles, P2 is 4 piles, and P3 is 3 piles. Meanwhile, at a diameter of 0.4 with pile types P1, P2, and P3, each shows a value of Qp of 164.06 tons, Qs of 108.83 tons, Qu of 272.87 tons, and N for P1 is 4 piles, P2 is 3 piles, and P3 is 2 piles.

Table 2. Recapitulation of Foundation Pile Group Bearing Capacity Analysis

Pile Foundation Mayerhof

D	0,3			0,4		
Pile Types	P1 (202,11 Ton)	P2 (133,8 Ton)	P3 (93,5 Ton)	P1 (202,11 Ton)	P2 (133,8 Ton)	P3 (93,5 Ton)
Qu (Ton)	173,88	173,88	173,88	272,87	272,87	272,87
SF	3	3	3	3	3	3
Qall (Ton)	57,95	57,95	57,95	90,96	90,96	90,96
N (Pile)	5	4	3	4	3	2
Eg	0,795	0,795	0,795	0,795	0,795	0,795
Qg (Ton)	212,35	169,88	127,41	263,65	197,74	131,83
Check	OK	OK	OK	OK	OK	OK

Based on the recapitulation of the ultimate bearing capacity analysis results for the pile foundation group from the table above, for a 0.3 diameter pile type, where the SF value for P1, P2, P3 is 3, with Qu values for P1, P2, P3 respectively being 318.77 tons, 510.03 tons, and 318.77 tons. And the Qijin value for P1 is 102.7 tons, for P2 is 166.4 tons, and for P3 is 102.7 tons. There is also an EG value where the values for P1, P2, P3 are 0.462. And the Qg value for P1 is 237.532 tons, for P2 is 153.997 tons, and for P3 is 95.012 tons. The number of piles or N for each is P1 5 pieces, P2 2 pieces, and P3 2 pieces. Then for a 0.4 diameter pile type, where the SF value for P1, P2, P3 is 3, with Qu values for P1, P2, P3 respectively being 482.43 tons, 722.94 tons, and 584.51 tons. And the Qijin value for P1 is 154.5 tons, for P2 is 234.7 tons, and for P3 is 188.5 tons. There is also an EG value where the values for P1, P2, P3 are 0.616. And the Qg value for P1 is 285.847 tons, for P2 is 144.731 tons, and for P3 is 116.268 tons. The number of piles or N for each is P1 3 pieces, P2 1 piece, and P3 1 piece. The calculation analysis using the Mayerhof Method indicates a positive outcome, signifying that the pile foundation has been designed and constructed in accordance with the required technical standards to ensure structural safety. The reliability of the pile foundation's bearing capacity will play a crucial role in ensuring the overall success of the project and instilling confidence among stakeholders that the foundation is capable of facing challenges and loads that may occur during the lifespan of the structure.

4. CONCLUSION

1. Based on the calculation results, it can be concluded that the use of all combinations of pile types indicates a safe condition and can be a more suitable choice to support the stability of the foundation structure.
2. Among the various analyzed options, the first alternative is selected, which is the P3 type of pile with a diameter of 0.4 m, and the calculation is conducted using NSPT data. Two piles are used in one pile group. The analysis result of the pile group's bearing capacity (Qg) in this option reaches 131.83 tons, a value exceeding the axial load (P) and X-direction moment on the building structure, which are 93.5 tons. Therefore, it can be concluded that the use of pile foundations in this option can be considered safe.

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