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Comparative Analysis Method of Work, Time, and Cost of Concrete Spun Pile Work with Bored Pile on Construction of the Light Rail Transit (LRT)

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Abstract

Building construction consists of two parts, namely the upper building and lower building. The upper building transmits forces to the lower building, which then from the lower building is channeled to the supporting soil. Pile foundation is a part of the lower structure that is used to receive and distribute the load from the upper structure to the supporting soil which is located at a certain depth determined by the results of the soil investigation. Piles are used as building foundations if the soil under the building base does not have enough bearing capacity to carry the weight of the building working on it. The stake used in this comparison is the Concrete Spun Pile and Bored Pile foundation. The results of the study show that the Bored pile method is slightly more complicated than the Concrete spun pile method. In terms of time required for the Concrete spun work is 6 hours, while for Bored piles per point is 9 hours assuming the work is 3 months In terms of the cost of foundation work of 1000mm diameter and 30m depth using the Concrete spun pile method is Rp. 13,704,241,634.10 for 156 points. whereas for the Bored pile method with a diameter of 1200mm and a depth of 30m is Rp. 14,242,797,932.85 for 78 points. So the foundation work with the Concrete spun pile method is more effective and efficient than the Bored pile method based on the method of implementation, time and cost.

Keywords: Jakarta, Infrastructure, Bicycle Path, Dominant Variables.

1. Introduction

Indonesia is included in the ranks of developing countries. The thing that becomes a benchmark for a developing country is that it can be seen from the side of the ongoing development. The development of the infrastructure of a large city will also be followed by an increase in population and number of vehicles both public and private vehicles. Jakarta as the nation's capital is one of the cities with the highest density of vehicles in Indonesia. This severe congestion in Jakarta has become the government's background to build safe, convenient and affordable public transportation modes so that drivers of private vehicles can switch to public transportation modes. The aim is to reduce density and unravel congestion on a number of sections such as the Jakarta Cikampek Toll Road & Jagorawi

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Toll Road. Because of these very urgent needs, the government through Presidential Regulation No. 98 of 2015 to improve transportation services, it is necessary to accelerate the implementation of light rail transits or abbreviated as integrated LRT in the Jakarta-Bogor-Depok-Depok region and Presidential Regulation No. 99 of 2015 concerning the acceleration of the Implementation of Public Railways in the Province of the Capital Region of Jakarta. There are 3 things regulated in the Perpres, namely: Appointment of Adhi Karya to build infrastructure (lines including the construction of elevated lines, stations and operating facilities), establish a Jabodebek transport organizing body, related to the appointment of DKI BUMD coordinated by the governor so that LRTs from outside Jakarta then into the Jakarta area, it can be coordinated with the DKI Jakarta Regional Government.

Jabodebek Light Rail Transit (LRT) itself is divided into 3 stages. For the first phase, which is in the process of being divided into 3 service lines, namely the service route 1Cawang-Cibubur (14.89 km) connecting Cawang-TamanMini - Kampung Rambutan - Ciracas - Harja Mukti Cibubur. 2 Cawang-dukuh Atas service line (11.05km) connecting Cawang-Ciliwung-Cikoko-Kuningan-Rasuna Said-Karet Kuningan-Setiabudi-Dukuh Atas, and 3 Cawang-Bekasi Timur (18.49km) service connecting Cawang- Halim-Jati Bening Baru-Cikunir-Cikunir 2-Bekasi Barat-Jatimulya. Whereas for the second phase, the Cibubur-Bogor and Dukuh Atas-Palmerah-Senayan tracts will be built, while the third phase will be built in the Palmerah-Grogol tract.

In the Jabodebek LRT project, there is a number of U-Shaped Girder supporting components including the Pier head. The pier head is the basis for supporting the U-shaped Girder for structures that use a single pier. For certain locations that are not possible with a single pier due to location and other things, the portal is used. Furthermore, there are columns in the form of tall poles that we often encounter at Jabodebek LRT Construction sites. The column is connected to Pilecap which is embedded underground which is supported by the Spun pile Foundation or the Bored pile foundation.

Figure 1. Pieces of pier Normal Structure

Source: Team designer Adhi Karya, 2019

LRT Jabodebek project is arguably unique because many work areas are in direct contact with Toll Roads, Primary Roads, Residential Roads, SUTET areas, PDAM lines, PGN and other utilities. Therefore the process of processing requires special handling, including the most important process of implementation of the work foundation. Because of the above, the foundation work process for this project is divided into two types, each of which has a different impact from various aspects, namely foundation work with Concrete Spun Pile and Bored pile work.

1.1. Problem Formulation

Based on the identification of the problem above, the problem formulation can be taken, including:
1. How do the Concrete foundation implementation methods be compared between spun pile and Bored pile?
2. What is the time ratio of the two types of foundation work?
3. How do the costs of the Concrete spun pile and Bored pile foundation compare?

1.2. Research Objectives

The aims and objectives of this study are:
1. Comparing the implementation method between the work of Concrete spun pile and Bored pile.
2. Comparing the cost of the work of Concrete spun pile with Bored pile
3. Comparing the time needed for the work of Concrete spun pile with Bored Pile

2. Literature Review

2.1 Soil

Soil in the view of civil engineering is a collection of minerals, organic matter and relatively loose deposits located on bedrock (Hardrock), Hardiyatmo, H.C., 2006). Soil is a material consisting of solid aggregates (granules) cemented to one another and from decayed organic matter accompanied by liquid and gas which fill the empty spaces between these solid particles (Braja M Das, 1988).

The role of this soil is very important in the planning or implementation of buildings because the soil serves to support the burden on it, therefore the soil that will be used to support construction must be examined / tested first to determine its characteristics before the construction process is carried out.

2.2 Soil Classification

The soil classification system is a regulation system for different types of soil but has similar characteristics into groups based on their use. The classification system provides an easy language to briefly explain the general properties of soils which vary greatly without detailed explanation (Das, 1995).

The soil classification system is intended to provide information about the characteristics and physical properties of the soil and classify it according to the general behavior of the soil. The soil are grouped in sequence based on a certain physical condition. The purpose of soil classification is to determine suitability for certain uses, and to inform about the state of the soil from one area to other regions in the form of basic data. Soil classification is also useful for a more detailed study of the state of the land and the need for testing to determine the technical properties of the soil such as compaction characteristics, soil strength, weight, etc. (Bowles, 1989).

2.2.1. Sand and Gravel

Sand and gravel are non-cohesive aggregates composed of sub angular or angular regimes. Particles up to 1/8 inch are called sand, while particles that are 1/8 inch up to 6/8 inch are called gravel. Midline fragments larger than 8 inches are disposed of (boulders).

2.2.2. Hardpan

Hardpan is a soil that is resistant to the penetration of a very large drilling tool. Its characteristics are mostly found in a well graded state, unusually dense and an aggregate of cohesive mineral particles.

2.2.3. Inorganic Silt

Inorganic silt is a fine-grained soil with little or no plasticity. The smallest type of plasticity usually contains sedimentary quartz grains, which are sometimes called rock (rock flour), while the very plastic contains flaky particles and is known as plastic silt.

2.2.4. Organic Silt

Organic silt is a rather plastic, fine-grained soil with a mixture of finely separated organic material particles. The color of the soil varies from light gray to very dark gray, besides that it may contain H2S, CO2, and various other gases resulting from plant decay which will give a characteristic odor to the soil. Permeability of organic silt is very low while compressibility is very high.

2.2.5. Clay

Clay soils are aggregates of microscopic and submicroscopic sizes originating from chemical decomposition of rock constituents, and are plastic in moderate to wide water content intervals. In a dry state is very hard, and not easy to peel just with your fingers. The permeability is very low.

2.2.6. Organic Clay

Organic clay is a clay whose partially important physical properties are affected BY the presence of separate organic matter, in an organic saturated state it tends to be very copressible but in dry conditions the strength is very high. The color is dark gray or black, and smelly.

2.2.7. Peat

Peat soil is a rather fibrous aggregate derived from macroscopic and microscopic flakes of plants. The color is light brown and black is compressible, so it is not possible to support the foundation.

2.3 Foundation

The foundation is the lowest part of the construction of civil buildings that are directly related to the land and function to withstand the load force above it. The foundation is made into a solid basic building unit that is under construction. The foundation can be defined as the lowest part of a strong and stable construction. The foundation is an intermediate structure, which has the function of continuing the burden of the building on it (including its own weight), to the ground where the foundation is grounded, without causing soil damage or without causing a reduction in buildings outside the tolerance limit (Asiyanto, 2009).

In planning the foundation for a structure, several types of foundation can be used. The choice of foundation is based on the function of the upper structure (upper structure) to be shouldered by the foundation, the amount of weight and weight of the upper building, the state of the land on which the building was erected and based on an economic view.

To choose an adequate type of foundation, it is important to consider whether the foundation is suitable for various conditions in the field and whether the foundation allows it to be economically completed in accordance with the work schedule.

2.3.1. Concrete Piles

Concrete pillar foundations are used for high rise buildings. To pile piles into the ground is done in several ways such as: hit and jacked which will later be connected to the Pile Cap. Commonly done by hitting strokes using a diesel hammer, the workings of this machine hit the base of the pile to get into the ground, thereby causing a noisy noise around the staking area. That is why staking in this way has its own problems because of the loud noise it creates. There are two types of concrete pile foundations, namely:

1) Precast Concrete Reinforced Pile

This type of concrete is reinforced concrete which is printed in formwork. If the concrete is strong enough and mature, then just lifted and mounted according to its function. The appearance can be in the form of a circle (spun pile), rectangular, octagonal.

Figure 2. Work dokumentation precast concrete pile work
Source : Author’s documentation, 2018

2) Bored Pile

Bored pile foundation is a foundation whose implementation is perforated with a diameter according to the design using a drill tool, the bottom of the hole at the end of the drilling is cleaned (vacuumed with a pump) then the hole is filled with pembesian / reinforcement and then casted concrete using tremi pipes (Asiyanto, 2009).

Figure 3. Dokumentation of bored pile work
Source : Author’s documentation, 2019

2.4. Project Time Management

Project time management is the process of planning, arranging and controlling the schedule of project activities. Mawardi (2014) states that the understanding of project time management is the systematic application of management functions (planning, organizing, implementing and controlling) to a project by using existing resources effectively and efficiently. This is in order to achieve project objectives optimally.

2.5. Project Duration Planning

Scheduling or scheduling is the allocation of time available to carry out each work in order to complete a project so that optimal results are achieved by considering the limitations that exist, project scheduling is one important element because scheduling provides information about project progress in terms of resource performance in the form of costs, labor, equipment and materials as well as the project duration plan and progress time to complete the project.

2.6. Estimated Duration

According to Utomo (2017), determining the duration or duration of work implementation is based on estimated resources. In determining the duration of an activity, it is necessary to determine the production capacity of the resources directly involved in the activity. Production capacity data can be seen from similar work experience data in other projects or expert opinions or assumptions.

2.7. Cost

According to Afik Wijayanto (2018), cost control is the final step of the project cost management process, which is to make sure that the use of expenditure funds is in accordance with planning, in the form of a predetermined budget. Thus, aspects and objects of cost control will be identical with cost planning so that various types of activities in the field must always be monitored and controlled so that the results of their implementation are in accordance with a predetermined budget. Costs are defined as the benefits sacrificed in order to obtain goods and services. These benefits are measured in rupiah through reducing activities or charging debts when the benefits are received.

3. Research Methodology

The method used in this research is quantitative research methods. Quantitative research is a systematic scientific study of parts and phenomena and their relationships. The purpose of quantitative research is to develop and use mathematical models, theories and hypotheses relating to natural phenomena.

The measurement process is a central part of quantitative research because it provides a fundamental relationship between empirical observation and mathematical expression of quantitative relations. The results of quantitative research indicate a number or amount. This study aims to determine each method of implementation, time and cost of the two foundation constructions studied.

a. Expert in Infrastructure, and / or representation in Government.
b. Minimum education of S1 or S2.
c. Minimum 25 years experience for S1 and minimum 10 years for S2.

4. Analysis and Result

Data collection consists of observations in the field and the results of the analysis of the author.

4.1 Comparison of implementation methods

For comparison, the implementation method can be seen from the materials and tools used in both types of work.

Table 1 Comparison of implementation methods

Methods	Tools	Materials
Concrete Spun Pile	1. Bored pile Machine 2. Crane hammer 3. Crawler Crane 4. Dump truck	1. 3 bar of Precast concrete spun pile 2. Cat Zincromate 3. Concrete spun pile stuffing iron depth of ± 2 meters

Methods	Tools	Materials
Bored Pile	1. Bored pile Machine 2. Crawler Crane 3. Temporary casing 4. pipes and mouthpieces	1. 42m3 ready mix concrete 2. Clearance of 30 meters bored pile depth

Source: Researcher's Processed Data, 2019

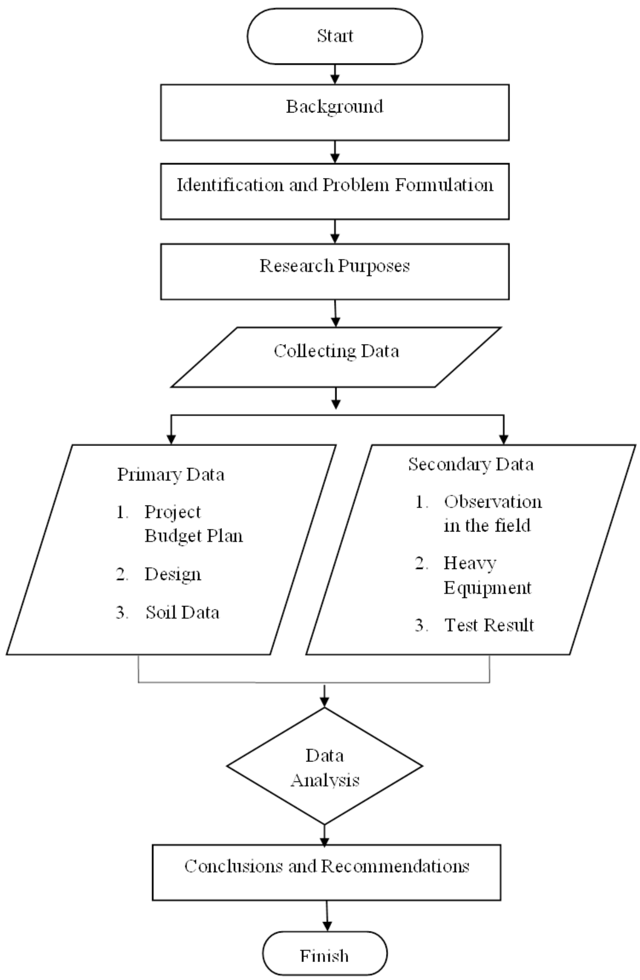

Figure 4. Flowchart of Processed Data
Source : Researcher's Processed Data, 2019

4.2 Comparison of work time

For comparison of the implementation time can be observed directly in the field in both types of work.

Table 2 Timing of the concrete spun pile method

Calculation time method of concrete spun pile	
Capasity calculation	
• vehicle hours	= Jam 08.00-17.00
• Drilling time preboring D= 800mm, H= 25m	= 1-2 hours
• Piling work (3 piles)	= 2-4 hours
• a total 1 point per day	= 6 hours
Assumption of work 3 months (1 week 6 working days)	
1 day	= 2 points
3 months = 78 working days	= 156 points

Source: Researcher's Processed Data, 2019

Table 3. Timing of Bored pile method

Calculation time method of Bored Pile	
Capasity Calcculation	
• Vehicle hours	= Jam 21.00-04.00
• Drilling time preboring D=1200mm, H = 30m	= 1-2 Hours
• Installation of reinforcing iron	= 2-3 Hours
• Installation of tremie pipes and funnels	= 1.5-2 Hours
• Casting	= 1.5-2 Hours
• A total of 1 point per day	= 9 Hours
Assumption of work 3 months (1 week 6 working days)	
1 day	= 1 Hours
3 months = 78 working days	= 78 Hours

Source: Researcher's Processed Data, 2019

4.3 Cost Comparison

Comparative analysis of the cost of foundation work using the Concrete spun pile and Bored pile methods can be seen in the Project Budget Plan, which is the calculation of the construction project budget made by the contractor to estimate how much the actual costs required to complete a construction work contract. Here are the results of the analysis of the prices of the two jobs.

Table 4. Recapitulation of the cost of concrete spun pile work

Concrete Spun Pile Method					
	Descrition	Volume	Unit	Unit Price	Total Cost
Direct Cost					
1	Work Preparation	1	Ls	85,420.62	85,420.62
2	Preboring Work	25	m3	275,253.56	6,881,339.00
3	Finishing Work	340.66	kg	10,938.56	3,726,329.85
4	Casting Work	1.0048	M3	1,369,673.78	1,376,248.21
5	Standing Work	30	m'	2,102,066.02	63,061,980.60
6	PIT test work	1	Ls	15,746.94	15,746.94
7	Landfill work	15.9	m3	22,073.96	350,975.96
8	Welding work	2	Ls	192,420.05	384,840.10
9	Handling work	30	m'	35,346.94	1,060,408.20
10	Pieces removal work	1	titik	22,028.87	22,028.87
	Total Direct Costs				76,965,318.36
	Assumption of work 3 months = 156 points				12,006,589,663.81

Indirect Cost					
1	Staff Salaries	3	Month	18,300,000.00	54,900,000.00
2	General Cost	3	Month	19,952,600.00	59,857,800.00
3	Utility Cost	3	Month	2,100,000.00	6,300,000.00
				Direct Costs + Indirect Costs	12,127,647,463.81
				PPh 3%	363,829,423.91
				Margin 10%	1,212,764,746.38
				Total Cost of Concrete Spun Pile Work	13,704,241,634.10

Source: Researcher's Processed Data, 2019

Table 4. Recapitulation of the cost of concrete spun pile work

Bored Pile Method					
	Descrition	Volume	Unit	Unit Price	Total Cost
Direct Cost					
1	Preboring's work	30	m'	620,746.10	18,622,383.00
2	Rebar work	7669.4	Kg	10,938.56	83,892,192.06
3	Bored pile casting	42	m3	1,369,673.78	57,526,298.76
	Total Direct Costs				160,040,873.82
	Assumption of work 3 months = 78 points				12,483,188,158.27
Indirect Cost					
1	Staff Salaries	3	Month	18,300,000.00	54,900,000.00
2	General Cost	3	Month	19,952,600.00	59,857,800.00
3	Utility Cost	3	Month	2,100,000.00	6,300,000.00
				Direct Costs + Indirect Costs	12,604,245,958.27
				PPh 3%	378,127,378.75
				Margin 10%	1,260,424,595.83
				Total Cost of Bored Pile work	14,242,797,932.85

Source: Researcher's Processed Data, 2019

Based on the results of the analysis above, the total cost for the work of Concrete spun pile with a diameter of 1000 mm and a length of 30 meters is Rp.13,704,241,634.10 while ,the total cost for Bored pile work with a diameter of 1200 mm and a depth of 30 meters is Rp.14,242,797,932.85. Based on the result analysis above, it can be concluded that a more efficient method in terms of cost is the **Concrete Spun Pile method.**

5. Conclusions and Suggestions

5.1. Conclusions

Based on observations and analyzes for the work of Concrete spun pile and Bored pile in terms of implementation method, time and cost, it can be concluded as follows:

1. The implementation method for Concrete spun pile is easier compared to the Bored pile method because for Concrete spun pile the pile is ready and pegged, different from the Bored pile which assembles the reinforcement first, is inserted into the borehole and casted in place.
2. Judging from the time required, the execution of the Concrete spun pile method for 3 pieces is 156 points, faster than the Bored pile that uses 9 hours.
3. In terms of costs required, for Concrete spun pile work of **Rp.13,704,241,634.10,** while for the cost of Bored pile work of **Rp.14,242,797,932.85**, there is a difference in the cost of **Rp.538,556,298.74** where the cost of implementing Concrete spun pile is more efficient than the cost Bored pile implementation.

5.2. Suggestions

1. Based on the analysis and discussion on the work of Concrete spun pile and Bored pile, suggestions that can be made are as follows:
2. Specific planning needs to be done for ordering concrete spun pile pile material that is adjusted to the piling schedule so that when the material is on site, work can be carried out immediately
3. Use the Bored pile method only in special locations, such as in the middle of a busy city or a narrow location that is not possible for the concrete spun pile method.

References

[1] Asiyanto, 2009, Metode Konstruksi Untuk Pekerjaan Pondasi, Penerbit Universitas Indonesia (UI-Press)

[2] Asmarendra, David, 2014, Analisa perbandingan Pondasi tiang pancang pada pembangunan kantor pelayanan perbendaharaan negara (KPPN) Samarinda. Jurnal Teknik Sipil, Universitas 17 Agustus 1945, Samarinda,

[3] Bowles, J,E, 1986, Analisa dan Desain Pondasi Jilid I, Penerbit Erlangga, Jakarta,

[4] Bowles, J,E, 1986, Sifat-sifat Fisis dan Geoteknis Tanah, Penerbit Erlangga, Jakarta,

[5] Braja M., Das. 2014 Principles of Foundation Engineering 8th Edition. Stanford: Global Engineering,

[6] Ginsa Rustira, et.al, 2015, Analisis perbandingan biaya pada pondasi telapak, bor pile dan tiang pancang dengan daya dukung yang sama. Jurnal Konstruksi, Sekolah Tinggi Teknologi Garut, Garut,

[7] Hardiyatmo, H, C, 1996, Teknik Pondasi 1, PT,Gramedia Pustaka Utama, Jakarta,