

TIME AND COST ANALYSIS OF PILE FOUNDATION WORK USING HYDRAULIC STATIC PILE DRIVER (Case Study: Construction Project of the Official Residence of the Governor of South Kalimantan)

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ABSTRACT

This study analyzes the productivity, time, and cost of foundation piling work using the Hydraulic Static Pile Driver (HSPD) on the Construction Project of the Official Residence of the Governor of South Kalimantan. Piling was carried out at 132 points with a total pile length of 1,584 meters. The results of the study show that the actual productivity reached 60.54 m/hour. The actual implementation time required only 4 working days or 28 hours, which is faster than the initial plan of 7 working days or 49 hours. This study did not include an analysis of the move-to-point time between pile locations. In terms of cost, the actual total cost amounted to IDR 187,246,000.00, which is lower than the estimated budget of IDR 201,608,500.00. These findings indicate that the actual implementation was more efficient in terms of both time and cost, and demonstrate the optimal performance of the HSPD in the field.

Keywords: Equipment Productivity, Construction Cost, Project Duration

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1. INTRODUCTION

The success of a construction project is largely determined by the efficiency of time, cost, and quality management. One of the most crucial aspects of a construction project is foundation work, particularly pile foundations, which are used to transfer structural loads to deeper, more stable soil layers.

The Hydraulic Static Pile Driver (HSPD) method was selected due to its advantages, such as producing no vibration, being environmentally friendly, and being suitable for use in confined areas. However, in practice, the efficiency of this equipment is significantly influenced by field conditions, equipment mobilization, as well as time and labor management. In the Construction Project of the Official Residence of the Governor of South Kalimantan, discrepancies were found between the actual time and cost of implementation compared to the initial planning.

This study was conducted to evaluate the productivity of the HSPD and to analyze the differences in time and cost between planned and actual field data. The results of this analysis are expected to provide valuable input for construction practitioners in improving the efficiency of foundation work using heavy equipment.

2. THEORETICAL BASIS

PRODUCTIVITY

Productivity is a measure of how effectively resources are utilized to complete a task. In the context of construction, particularly pile driving work, productivity is directly related to the volume of work that must be completed and the capability of the heavy equipment used. The proper selection of heavy equipment greatly influences the speed and quality of the work. When the equipment used aligns with technical requirements and site conditions, optimal results can be achieved within the planned timeframe (Rostiyanti, 2002).

PROJECT COST

Construction project costs, specifically in the form of the Owner's Estimate (RAP), are generally divided into two main categories: direct costs and indirect costs. Direct costs include all expenses directly associated with fieldwork, such as material and labor costs, which can account for 40% to 60% of the total project cost (Sedyanto, 2019).

PILE FOUNDATION

A pile foundation is a structural element that functions to receive and transfer loads from the superstructure to deeper soil layers. Pile foundations are used when the surface soil lacks sufficient bearing capacity to support the loads transferred from the structure. Typically, hard soil layers with adequate bearing strength are located at deeper levels.

EFFICIENCY

Efficiency is the effort to achieve maximum output with minimal use of resources such as labor, materials, and equipment (Stoner, 2010). In general, efficiency is defined as the ratio between the output produced and the input used, or how well an input is able to generate a certain output (Permono & Darmawan, 2000, as cited in Priyonggo Suseno, 2008).

HYDRAULIC STATIC PILE DRIVER

The Hydraulic Static Pile Driver (HSPD) is a pile driving machine that installs piles into the ground using a hydraulic pressing method, aided by additional counterweights. The HSPD method does not generate vibration, making it more environmentally friendly. In addition, the hydraulic jack pressure can be monitored directly via a manometer, allowing accurate measurement of the pressing force at specific depths. HSPDs are available in various capacities, such as 120 tons, 240 tons, 320 tons, and 450 tons, and are selected based on the planned load or design capacity of the pile.

SAMPLING TECHNIQUE

Sampling is crucial for researchers. It is often impractical to study every member of a population due to time, cost, and resource constraints. Proper sample collection is a vital step in research since the findings and conclusions are based on the samples gathered. If the sample does not adequately represent the population, the conclusions drawn may be inaccurate (Hikmawati, F., 2017).

3. METHOD

RESEARCH LOCATION

This research was conducted on the Construction Project of the Official Residence of the Governor of South Kalimantan, which is a government housing development project located in. Jl. Bundaran Kantor Gubernur, Kec. Cempaka, Kota Banjar Baru, Kalimantan Selatan.



Figure 3.1 Research Location

RESEARCH PROCEDURE

This study began with a site survey of the project location to identify field conditions and the pile driving method using the Hydraulic Static Pile Driver (HSPD). Primary data were collected through direct observation of pile driving activities, including the number of pile points, working hours, and the volume of piles embedded. Each work stage—such as lifting, clamping, welding, and cutting—was recorded to calculate the cycle time and equipment productivity.

The observed data were then compared to the project planning data to identify differences in productivity, execution time, and costs. Analysis was conducted by calculating the actual productivity (m/hour) and total operational costs based on work duration and operator wages. The comparison results were used to evaluate the efficiency of field implementation and to provide recommendations for improvements in similar future projects.

4. RESULTS AND DISCUSSION

GENERAL OVERVIEW

Project Area	: 6.087 m ²
Project Name	: Construction Project of the Official Residence of the Governor of South Kalimantan
Location	: Jl. Bundaran Kantor Gubernur, Kec, Cempaka Banjar Baru, Kalimantan Selatan
Contract Number	: 003.3/825/PRDJG/SP.KONST/CK/PUPR/2024
Contractor	: PT. PUTRA HARI MANDIRI
Supervising Consultant	: CV. PRAKTIRA KOLSULTAN
Proejct Duration	: 170 Calender Days
Project Cost	: Rp. 29.500.000.000,-
Source of Funds	: APBD

PILE LIFTING WORK

Table 4.1 Pile Lifting Work Data

Duration	Length
147 sec/pile	6 m

Based on the observations, the lifting time (LT) for a 6 m pile was recorded at 2.27 minutes

PILE WELDING WORK**Tabel 4. 1** Pile Welding Work Data

Number of Workers	Time Required	Pile Dimensions
2 Workers	69 seconds	40 x 40 cm

To calculate the welding length, the following formula is used

Pile perimeter x Number of welding layers

Therefore:

$$= ((0,40 \text{ m} \times 4) \times 2 \text{ layers}) \times 20\% \text{ (assumed safety factor)}$$

$$= (1,6 \times 2) \times 20\%$$

$$= 3,2 + 0,64$$

$$= 3,84 \text{ m}$$

Based on the calculation, the total welding length is 3.84 meters or 384 centimeters. Therefore, the welding productivity is calculated as follows:

Therefore:

Welding Duration : 1,09 minutes = 69 seconds

Number of Workers : 2 persons

Panjang Pengelasan : 384 cm

$$\text{Work Duration} = \frac{\text{Volume of Activity (vol.unit)}}{\text{Work Productivity (unit} \cdot \frac{\text{vol}}{\text{time}})}$$

$$\text{Productivity} = \frac{384}{138} = 2,78 \text{ cm /sec}$$

CUTTING PILE WORK**Tabel 4. 2** Cutting Pile Work Data

Dimensi Tiang Pancang	Jumlah Pekerja	Durasi Pembobokan
40 x 40 cm	2 orang	30 menit

Melalui data tersebut, perhitungan produktivitasnya adalah sebagai berikut.

Dimension length : 40 cm x 4 = 160 cm

Number of workers : 2 Orang

Duration : 60 menit

$$\text{Work Productivity} : \frac{\text{Volume (unit.vol)}}{\text{Work Productivity (unit} \cdot \frac{\text{vol}}{\text{time}})}$$

Maka :

$$\text{Work Productivity} = \frac{160}{60} = 2,6 \text{ cm /minute}$$

PILLING PILE WORK

Table 4.3 Pilling Pile Work Data

Pile Length (m)	Driving Speed (m/min)	Equipment Efficiency	Equipment Category
6	9,40	0,75	Good

To calculate the piling duration (PT), substitute into equation 2.11:

$$PT = \frac{2s}{Vo.E} = \frac{2 \times 6}{9,40 \times 0,75} = 1,70 \text{ minutes}$$

Thus, the piling duration for a 6 m pile is 1.70 minutes.

COMPARISON OF TIME AND COST

Table 4.5 Comparison of Time and Cost between Actual and Theoretical Pile Driving Based on Planning Data

Comparison of Piling Time and Cost between Actual Execution and Planned Execution					
	Working Hours (hours/day)	Work Volume (m)	Time Required for Pile Driving		Total Cost
			(Days)	(Time)	(IDR)
Actual	4	1584	4	28	IDR. 187.246.000,00
Planned	7	1584	7	49	IDR. 201.608.500,00

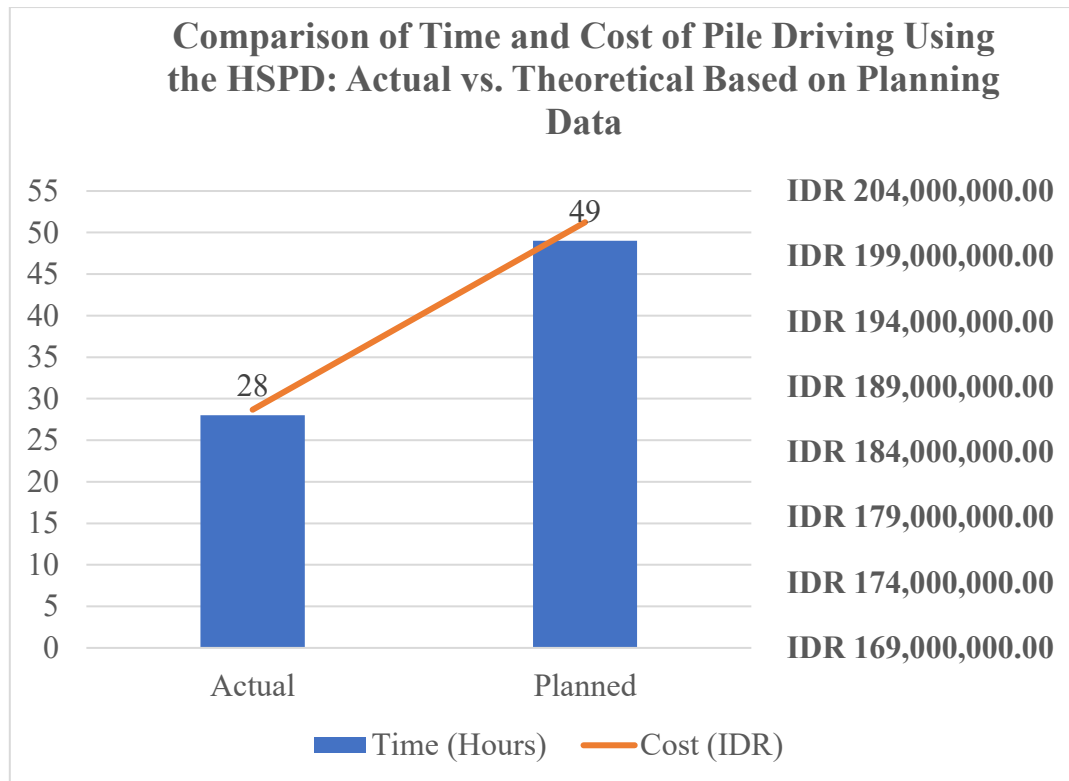


Figure 4.1 Cost Comparison Graph Between Actual and Theoretical Piling Based on Planning Data

From the graph, it can be observed that both time and cost according to the planning data are lower than the actual values. This is due to a difference in the number of working days allocated for the piling operation. According to the plan, seven working days were required, whereas in the field only four working days were used. This discrepancy is attributed to on-site efficiency factors, such as the addition of an extra HSPD unit which accelerated the work, favorable weather conditions with no heavy rainfall, and the absence of technical obstacles like mini-pile provision. Material availability also played a key role, as supplies were well-coordinated materials were staged close to the piling rig and experienced no delays.

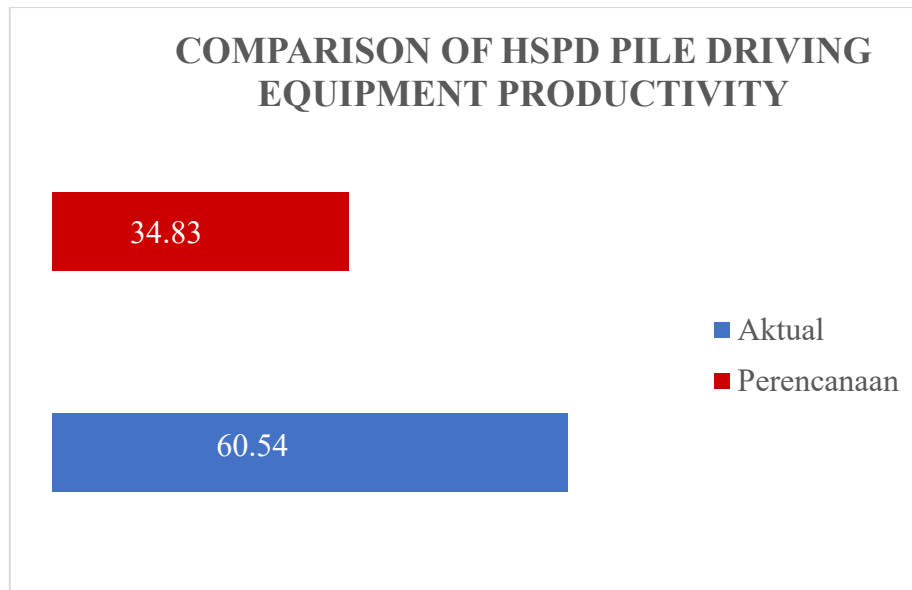


Figure 4.2 Comparison of HSPD Pile-Driving Productivity: Actual vs. Theoretical Based on Planning Data

Based on the study of pile-driving work in the Construction Project of the Official Residence of the Governor of South Kalimantan, an analysis was conducted on 132 sample points out of a total of 512 pile locations. The actual equipment productivity was recorded at 60.54 m/hour, which is higher than the theoretical productivity of 34.83 m/hour. This difference indicates an improvement in on-site efficiency. The impact is evident in both time and cost. Actual completion required only 4 days (28 hours), compared to the planned estimate of 7 days (49 hours). In terms of cost, the total actual expenditure of IDR 187,246,000.00 was also lower than the planned estimate of IDR 201,508,500.00. These results demonstrate that the actual execution was more efficient in both time and cost.

5. CONCLUSION

Based on the results of this study, it can be concluded that the performance of the Hydraulic Static Pile Driver (HSPD) in the pile-driving process for the Construction Project of the Official Residence of the Governor of South Kalimantan demonstrated an optimal level of productivity. From a total of 132 pile points, with a combined embedded length of 1,584 meters, the actual productivity achieved was 60.54 meters per hour. The pile-driving was completed in 4 working days (approximately 28 hours, assuming a 7-hour workday), which is faster than the planned estimate of 7 working days (approximately 49 hours). This time efficiency yielded a positive cost saving: the actual expenditure for piling amounted to IDR 187,246,000.00, which is lower than the initial budget estimate of IDR 201,608,500.00. Therefore, the field execution was judged to be more efficient in terms of time, cost, and equipment productivity.

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