

Analysis of Productivity and Annual Cost of Casting Plates and Beams Using Concrete Pump and Columns with Concrete Bucket (Case Study of Residence Apartment Project)

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Abstract

Traditional casting in multi-storey buildings necessitates specialized equipment such as concrete buckets and concrete pumps for the application of ready mix concrete. Various types of equipment have an impact on both productivity and the duration of casting. This study collected primary data by conducting field observations at the B Residence Apartment Project, with a specific focus on worker and equipment needs, tool effectiveness, and labor force. The secondary data comprised of structural photos and cost information pertaining to manpower and equipment. The study revealed that the utilization of a concrete pump incurs a cost of IDR 1,231,543 m³, but employing a concrete bucket results in a cost of IDR 1,719,141 m³. The concrete pump achieved a volume of 281.02 m³ in a duration of 1101 minutes, while the bucket achieved a volume of 47.98 m³ in a duration of 538.77 minutes. The productivity of the concrete pump was 0.255 m³/minute, whereas the productivity of the concrete bucket was 0.089 m³/minute. According to these findings, utilizing the concrete pump will greatly enhance time efficiency and decrease the incurred expenses.

Keywords

Productivity, effective time, cost, concrete pump, concrete bucket

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PENDAHULUAN

Infrastructure development in Indonesia had a downturn in recent years as a result of the epidemic. However, it is currently undergoing tremendous growth, particularly in the industrial sector. With the growth of the population, there is a corresponding increase in the demand for housing, resulting in a reduction in the amount of land that is available [1][2][3]. Therefore, the use of heavy machinery has become indispensable in construction operations. Each form of casting equipment has a unique impact on production, which in turn impacts the time of the casting process [4][5]. One of the heavy equipment used in construction operations is the concrete pump. A concrete pump is heavy equipment used in construction to transport and deposit freshly mixed concrete from a truck mixer to the desired location. Its benefits include requiring minimal space for the pipe conduit, the ability to pump concrete continuously, moving both vertically and horizontally, and versatility in various project scales. It can access tall buildings and has a comparatively shorter installation time [6].

The objective of this study is to ascertain the efficiency and expenses involved in utilizing concrete pumps for the construction of plates and beams, as well as concrete buckets for the construction of columns in the B Residence Apartment Project. The goal is to assess the efficiency of these instruments and the real expenses associated with using concrete pumps for casting plates and beams, as well as concrete buckets for columns.

Theoretical Foundation

Construction Management refers to the strategic allocation and utilization of resources by the project manager in order to effectively execute a construction project. The resources used in construction projects can be categorized into five main groups: personnel, material, machines, money, and methods [7]. In order to attain the objective by a systematic approach or technical means, it is essential to optimize the utilization of limited resources to achieve maximum outcomes in terms of precision, efficiency, security, and total cost-effectiveness [8][9][10]. During the project implementation, it is crucial to focus on the aspects of planning, organizing, executing, and monitoring the project [11]. It is good to consider these factors while initiating a construction project in order to reduce the occurrence of errors during the project [12]:

1. Planning

This planning stage is conducted meticulously, comprehensively, and with meticulous attention to detail, ensuring the utmost accuracy. Nevertheless, the outcomes of this planning serve as a guide for the execution and monitoring phases. Planning is regularly revised to accommodate any alterations and advancements that arise.

2. Organizing

At this step, the categorization of task types is conducted based on the authority and duty of each organizational element. In order to effectively manage the organization, the leader must possess the ability to guide and build interpersonal communication among all those involved. The organizational structure is tailored to meet the requirements of the project and the responsible party, and is designed to use the knowledge available.

3. Implementation (Actuating)

At this point, the specified planning is being implemented to ensure that the end product aligns with the agreed objectives. At this stage, while the planning conditions are still provisional, there is a need for improvement in order to make accurate predictions. Consequently, revisions from the original plan frequently occur.

4. Controlling

At this point, it is necessary to verify that the established plans and work standards can be successfully implemented and yield suitable outcomes. This control is designed to ensure that work rules can be accomplished with minimal effort and with results that exceed the norm. And endeavors to evaluate a performance based on pre-established criteria. The subsequent steps outline the process of casting utilizing concrete pumps [13]:

- a. Truck Concrete from ready mix comes to casting site
- b. Then ready mix concrete is poured into the storage tank at the concrete pump
- c. Ready mix concrete is transferred from the concrete pump sump to the desired casting location using a tremie pipe. Previously, the pipe was linked based on the specific location or range of locations where the concrete would be poured, ensuring a uniform distribution of the concrete during the pouring process.
- d. Once the ready mixed concrete has been poured, the workers use a rake to level it and spread it over areas that are not covered by the tremie pipe.
- e. Compaction of concrete is achieved by employing a vibrator to eliminate air bubbles within the concrete, thereby increasing its density and preventing concrete segregation. To

prevent bleeding in the concrete, it is important to keep the compaction process relatively short.

- f. After that, flatten the concrete surface with wood so that the concrete surface becomes smooth.

The following are the stages of casting with a concrete bucket as follows [14]:

- a. Ready Mix truck carrying ready mix concrete comes to the site
- b. Then Ready Mix concrete is poured into the concrete bucket reservoir
- c. After the concrete bucket is full, the concrete bucket is lifted using a hook by a tower crane to the specified elevation
- d. Once the predetermined elevation is reached, the operator positions the tremie pipe or trunk in the concrete bucket at the location where the casting will take place. If all the components are placed correctly, the operator has the ability to manipulate the lever on the concrete bucket.

RESEARCH METHODS

This research employs a methodical approach by utilizing a flowchart to direct the process of gathering data. The flowchart delineates every stage and juncture in the study approach, guaranteeing that the data collection is methodical and uniform. This approach not only facilitates the organization of research activities but also offers a distinct visual depiction of the process. The flowchart used in this study is depicted in [Figure 1](#).

Data collection method

The data collection process refers to the systematic approach that will be employed to gather both primary and secondary data. The required data for this study include casting data obtained from concrete pumps and concrete buckets, as well as working drawings, work plans, and circumstances. The project executor immediately supplies the project data. For a more comprehensive categorization, the divide is as follows [15]:

1. Primary Data

The study collected primary data through Effective time: This circumstance occurs when a concrete pump or concrete bucket is used to distribute fresh concrete to the designated casting location.

2. Secondary Data

Secondary data is acquired by the collection of information pertaining to the structural drawings of a construction project, including working drawings, labor data, and work data.

Data Analysis Method

From the data that has been obtained, data analysis is then carried out. Steps in data analysis are as follows :

- a. Analyze the volume of work and column casting time based on shop drawings
- b. Analyzing the volme of work and time of casting plates and beams based on shop drawings
- c. Calculating the casting work time by direct observation in the field
- d. Analyze the time required to perform column, beam and plate casting work

Calculating the costs required for casting columns, beams and plates

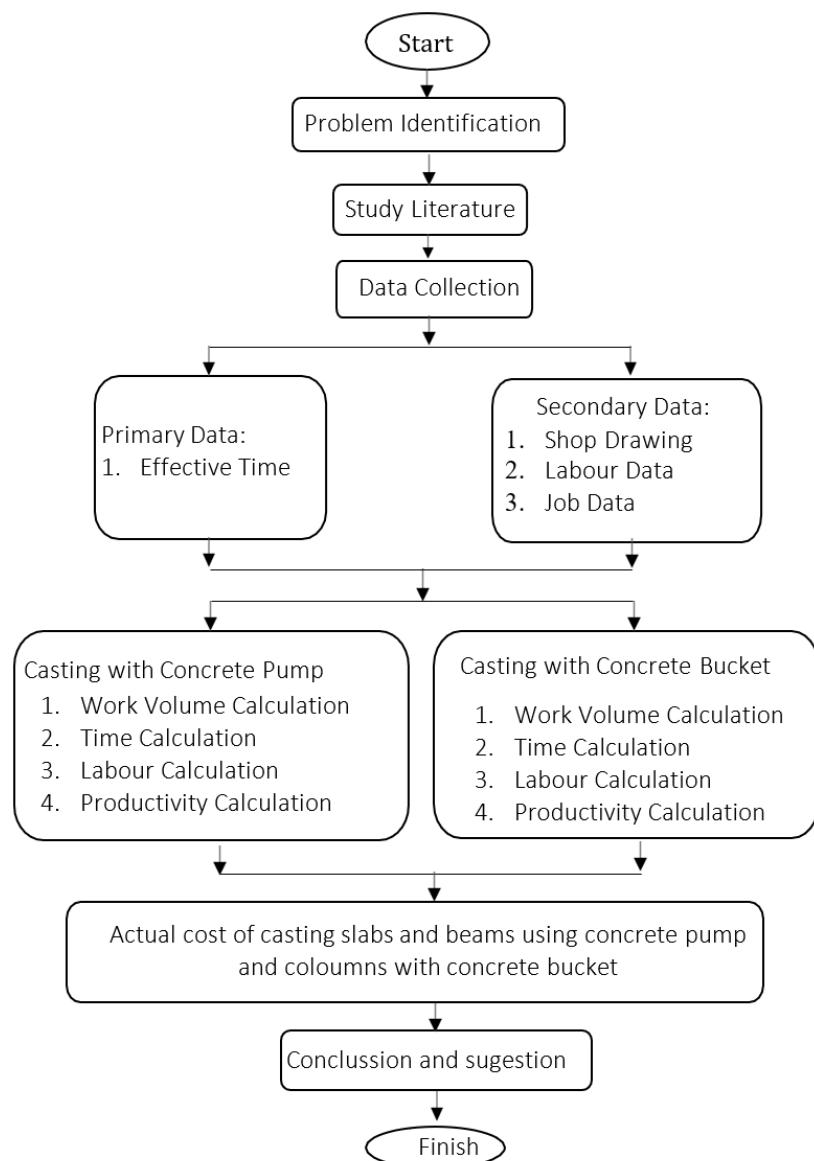


Figure 1. Research Flow Chart

RESULTS AND DISCUSSION

This study was carried out on the construction project of Apartment B Residence in Jakarta. This study examines the cost and productivity of casting utilizing concrete bucket and concrete pump tools. The research methodology employed in this study involves the direct measurement of time. The project data, including shop designs, labor requirements, casting volume, and casting implementation costs, is collected using project documentation. The evaluated castings are divided into four zones: zone 1, zone 2, zone 3, and zone 4. These castings are made utilizing two different methods: concrete bucket and concrete pump. In this study, observations were conducted over a period of 9 days to observe the process of casting a concrete pump and casting concrete into a bucket.

Volume of work Data

Prior to commencing the casting stage of the project, it is necessary to obtain data regarding the volume of fresh concrete that will be required for the casting process. The required data for casting includes architectural blueprints, measurements of columns, floor slabs, beams, and

specifications of reinforcement for each element. [Table 1](#) and [Table 2](#) show the Volume of casting work using concrete pump and bucket.

[Table 1. Volume of casting work using concrete pump](#)

Work Location	Date	Work Volume
Zone 1	27 June 2023	67,3959 m ³
Zone 2	20 June 2023	77,9673 m ³
Zone 3	22-23 June 2023	66,4525 m ³
Zone 4	24 June 2023	69,2012 m ³

[Table 2. Volume of casting work using concrete bucket](#)

Work Location	Date	Work Volume
Zone 1	21 June 2023	11,6865 m ³
Zone 2	22 June 2023	18,4715 m ³
Zone 3	29-30 June 2023	10,0315 m ³
Zone 4	27 June 2023	7,791 m ³

Manpower Data

The implementation of casting work has different methods and the amount of labor used. The amount of labor required can be seen in the [Table 3](#).

[Table 3. Labor Data](#)

Method of Work	Manpower Type				Total Labor (Person)
	Workers	Masons	Head Builder	Foreman	
Concrete Pump	9	1	1	1	12
Concrete Bucket	1	1	1	1	10

Duration of work

Duration work shown in [Table 4](#) and [Table 5](#).

[Table 4. Duration of casting work using concrete pump](#)

No	Volume (m3)	Location	Effective casting time (minutes)	Effective casting time (hour)	Casting realization time (minutes)	Casting realization time (hour)
1	67,3959	Zone 1	247	4,11	282	4,7
2	77,9673	Zone 2	284	4,73	334	5,57
3	66,4525	Zone 3	240	4	257	4,28
4	69,2012	Zone 4	330	5,5	355	5,91
Total Volume	281,0169	Total casting time	1101	18,35	1228	20,46

[Table 5. Duration of casting work using concrete bucket](#)

No	Volume (m3)	Location	Effective casting time	Effective casting time	Casting realization time	Casting realization time

			(minutes)	(hour)	(minutes)	(hour)
1	11,6865	Zone 1	142,92	2,38	220	3,60
2	18,4715	Zone 2	168,28	2,80	365	6,08
3	10,0315	Zone 3	125,77	2,09	242	4,03
4	7,791	Zone 4	101,80	1,69	164	2,73
Total Volume	47,9805	Total casting time	538,77	9,37	991	16,51

Manpower Coefficient

Prior to searching for the labor coefficient, it is essential to determine the productivity of a single laborer within a work group in terms of their ability to produce concrete within one hour. Duration work shown in [Table 6](#) and [Table 7](#).

[Table 6. Labor Coefficient of Slab and Beam](#)

Manpower	Coefficient
Workers	1,2124
Masons	0,1400
Head Builder	0,1115
Foreman	0,0611

[Table 7. Coefficient of column work](#)

Labor	Coefficient
Workers	1,4708
Masons	0,2451
Head Builder	0,2144
Foreman	0,1468
Operator Tower	0,2451
Crane	

Productivity

Casting productivity is calculated by dividing the entire casting volume by the total casting time. The productivity analysis is presented in the [Table 8](#).

[Table 8. Productivity Analysis](#)

Method of work	Volume (m ³)	Effective Productivity	Realization Productivity
Concrete Pump	281,0169	0,255	0,228
Concrete Bucket	47,9805	0,089	0,048

Actual Cost

a. Analysis of the actual cost of casting work on floor slabs and beams using a concrete pump.

The details of the costs ([Table 9](#)) are based on the results of real field calculations where the cost to be incurred with 1 m³ is IDR 1.231.543 and for the total cost of casting with a casting volume of 281,0169 m³ that must be incurred is IDR 346.084.369.

Table 9. Analysis of the actual cost of casting work on floor slabs and beams using a concrete pump

No	Description	Unit	Coefficient	Unit Price (IDR)	Total Unit Price (IDR)
A	Manpower				
1	Masons	OH	0,1400	150.000	21.000
2	Foreman	OH	0,0611	200.000	12.220
3	Head Builder	OH	0,1115	170.000	18.955
4	Workers	OH	1,2124	150.000	181.860
Total Price of manpower					234.035
B	Material				
1	Ready Mix FC 35	M ³	1,05	805.000	845.250
Total Price of Material					845.250
C	Tools				
	Assistive Tools	Ls	1,0	40.300	40.300
D	Net (A+B+C)				
E	Overhead (10% x D)				
F	Unit Price of The Work (D-E)				
					1.231.543

b. Analysis of the actual cost of casting work on floor slabs and beams using a concrete bucket.

The aforementioned costs are derived from actual field estimates, indicating that the cost per cubic meter is IDR 1,719,141 (Table 10). The total cost for a casting volume of 47.9805 m³ amounts to IDR 82,485,244.

Table 10. Analysis of the actual cost of casting work on floor slabs and beams using a concrete bucket

No	Description	Unit	Coefficient	Unit Price (IDR)	Total Unit Price (IDR)
A	Manpower				
1	Masons	OH	0,302	150.000	45.255
2	Foreman	OH	0,193	200.000	38.680
3	Workers	OH	1,811	150.000	271.605
4	Head Builder	OH	0,265	170.00	44.999
5	TC Operators	OH	0,302	245.00	73.917
Total Price of manpower					474.456
B	Material				
1	Ready Mix FC 35	M ³	1,05	990.000	1.039.500
Total Price of Material					1.039.500
C	Tools				
	Assistive Tools	Ls	1,0	48.900	48.900
D	Net (A+B+C)				
E	Overhead (10% x D)				
F	Unit Price of The Work (D-E)				
					1.719.141

CONCLUSIONS

Conclusions

Based on the data analysis and processing, it can be concluded that the total effective time for casting plates and beams using a concrete pump is 1101 minutes or 18 hours. The total effective time for casting columns using a concrete bucket is 538.77 minutes or 9 hours and 37 minutes. On the other hand, the total realized time for casting plates and beams using a concrete pump is 1228 minutes or 20 hours and 46 minutes. The total realized time for casting columns using a concrete bucket is 991 minutes or 16 hours and 51 minutes.

The productivity generated by using a concrete pump is an effective productivity of 0,265 m³/min and a realized productivity of 0,238 m³/min. For the effective productivity of the concrete bucket, it is 0,080 m³/min and the realized productivity is 0,043 m³/min.

The cost required for casting plates and beams using a concrete pump is IDR 1.231.543/m³ and total casting cost in casting incurred IDR 346.084.369 for a casting volume of 281,0169 m³. The cost required in casting the column is IDR 1.719.141/m³ and the total casting cost incurred is IDR 82.485.244 for casting volume of 47,9805 m³.

Future Works

Based on the aforementioned findings, the author proposes the following recommendations: Replace the 0.8 m³ bucket on the tower crane with a 1 m³ bucket in order to reduce the casting time. If the project site is accessible and the road area is adequate for the installation of ready mix trucks and concrete pumps, it will enhance the efficiency and effectiveness of concrete casting tools. It is imperative to take into account the utilization of casting tools to enhance efficiency in terms of both cost and time in the project.

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