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Cost and Time Comparison Analysis of Conventional Slab with Half Slab Method for PT. AMP Surabaya Office Building Construction

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A B S T R A C T

This study aims to analyze the application of Precast half-slab formwork with conventional formwork in terms of cost and time. The use of precast concrete is based on advantages in terms of economy, efficiency, speed in implementation, and energy consumption which has an impact on the environment. This office construction project was carried out in the Graha Family area in Surabaya. This project uses the half slab precast method, where half of the plate (precast) is precast with a thickness of 7 cm, and the other half is cast on site (topping). In this final project research, an analysis and comparison of several methods of floor slab work is carried out so that it can be seen which method is considered more profitable. Analysis of conventional half slab and precast methods focuses on calculating direct costs in terms of materials, tools, and workers' wages as well as calculating the time needed to complete the work.

1. Introduction

As time goes on, more and more various methods are applied for time and cost efficiency in a project, one of which is the half-slab concrete method, which is a combination of two methods between precast often known as precast and cast in place which is replaces cast in situ or conventional concrete which is very commonly applied. In the field [1][2]. Half slab is a system of reinforced concrete slabs that are half cast off-site (precast) and half cast in place (cast in situ).[3]. The use of methods that are fast, precise, practical, and safe is very

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helpful in completing work so that the project objectives implemented can be achieved according to plan [4]. One of the industry-based construction systems to support sustainable and cost-effective infrastructure development is the precast structure system. [5].

The use of the half slab method is expected to shorten the duration of construction work, prevent project delays, and support environmental preservation by minimizing the use of wood. [6], because the precast concrete half slab also functions as a working platform for floor slab work [7]. Formwork dismantling, lifting, and stacking of semi-precast slabs can be done in 1 day, compared to 3 days for full precast slabs [8]. For the implementation of development efforts to go well, it is necessary to make careful preparations before work begins [9].

The purpose of this research is to analyze the application of Half Slab Precast as formwork in floor slab work using conventional methods in terms of cost, time, and stages of implementation. The limitations of this research problem include: (1) The use of the precast method is only used for floor slab structures that use the half slab method. (2) The price of basic commodities for each job and the price of workers' wages use the standard price of the City of Surabaya. (3) Structural analysis calculations were not carried out due to changes in the casting method using precast concrete[10], [11].

2. Literatur Review

2.1. Slab

The slab is a floor that is not directly above the ground and is a floor level dividing one level with another level [10][11]. A floor slab is a thin structure made of reinforced concrete with a horizontal direction so that in buildings this plate functions as a horizontal stiffening element which is very useful to support the rigidity of the portal beam. In planning, the floor slab must be made flat, stiff, and straight so that building users can firmly put their feet on it [12].

2.2 Conventional Method

The conventional method is a casting system that is carried out at the project location/field. Conventional slab work is done on-site, generally cast in place along with sectional beams. This method takes a long time because it is waiting for the concrete to be cast until it is old enough [13]. The conventional method is the most widely used but can be costly [14]. The advantages of the conventional method are [15]:

a. Easy and common in work in the field
b. Easily formed in various cross-sections
c. Calculations are relatively easy and common
d. Connections of beams, columns, and slabs are monolithic.

2.3 Precast Method

Precast concrete is defined as the process of transporting concrete produced elsewhere to a construction site and properly assembling it. The precast method is also considered as the future of construction due to the shortening construction period, quality improvement, reduced accidents, and eco-friendly concrete option provided to the construction industry [16]. Several types of precast plates [17]:

a. Solid flat slab or precast full slab, namely precast plates with full thickness according to the specified thickness of the plate.
b. The hollow core slab is the same as the full slab precast plate. The difference is that there are cavities on the sides which function to lighten the load of the structure.
c. Half slab is a precast plate which requires casting again on it (overtopping).
   The half slab is a plate that uses precast concrete as its base and conventional concrete as a topping/cover. There are two types of half slabs, namely flat precast concrete surfaces, and jagged precast concrete surfaces. The use of these serrations aims to

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make the bond between conventional concrete and precast concrete stronger [18]. In general, the half-slab method has the advantage of being fast and requiring fewer fertility workers [19].

2.4 Cost analysis

Cost analysis or budget plan The cost of a building or project is the calculation of the amount of costs required for materials and wages, as well as other costs related to the implementation of the building or project [20]. Calculation of the cost of the conventional method and half slab precast can be calculated using the analysis of the unit price of the work [21]. In this study, cost analysis uses SNI no.28-2016.

2.5 Time Analysis

Time analysis of the two methods can be calculated by dividing the volume of each work by the value of the productivity level of the tool or worker. To determine the overall implementation period for each method, the PDM (Precedence Diagram Method) method is used with Microsoft Project tools [22].

3. Research Method

3.1. Research Location

The location in this research is the office building construction project of PT. Agri Makmur Pertiwi which consists of 9 floors is located on Jl. Taman Perkantoran Graha Family, Surabaya.

3.2. Description and Technical

a. Literature Study
   A literature study is a theoretical basis that is used by researchers as a reference in preparing research. The reference sources used are books, journals, scientific papers, and so on.
b. Problem Formulation
   Finding and identifying a problem during the process to examine it to solve the problem in it.
c. Data Collection
   Data collection is attempted to obtain the information needed to achieve the research objectives. the data in question can be in the form of pictures, unit prices which include the price of wages and materials as well as all the information needed to support the completion of the research. In research, data can be obtained from related projects or surveys at locations or related parties.
d. Data Analysis
   Analyzing to get a result which will be a comparison of several methods that have been calculated.
e. Comparison and Discussion
   Comparison is intended to find out and or test the differences of several methods which are the core of the research discussion.
f. Conclusion
   From the results of the comparison, it can be concluded that the use of a more efficient method for building floor slabs.

4. Results and Discussions

4.1. Calculation of Work Volume

In the initial stage of calculating the cost and time for floor slab analysis, a total volume calculation is carried out which includes calculating the volume of concrete, reinforcement, and formwork based on the reference shop drawing. This office building project consists of 9 floors. There are several types of plates for each floor with types A, A1, B, B1, B2, C, C1, C2, and D for the main plate, and types 1-4 for the canopy plate. The

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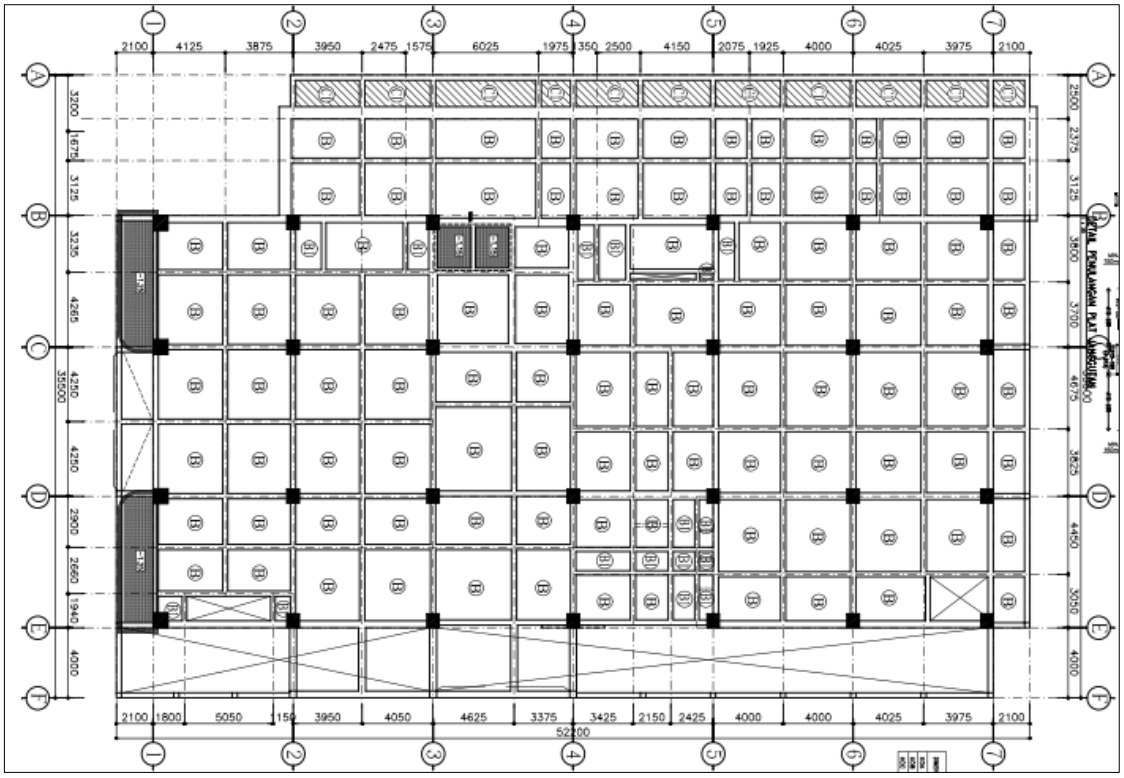
following is a recap of the volume of work for each type of floor slab starting from floors 1-9, which can be seen in Table 1.

Table 1. Recapitulation of floor slab volume

Type	1	2	3	4	5	6	7	8	9
A		752,81	853,62		178,69	834,84	836,84	835,55	
A1		68,75	61,1		65,73	50,98	57,074	57,074	
B	1286,46	128	163,2	986,4	106,25	163,2	176,45	176,5	564,44
B1	66,52			44,78	12,75				340,88
B2									30,62
C									
C1	105,25								88,8
C2									31,2
D				39,4					
1				43,91		71,15		123	123
2		48	77,1				43,5		
3									
4			64,8	86		54,9			

Source: Documentation of research result, 2023.

For the calculation of the total volume of reinforcement and concrete, data on steel specifications and the thickness of the slab to be worked are required. The following detailed specifications for each type of floor slab work can be seen in Table 2.



Source: Documentation of research result, 2023.

Figure 1. Detailed Working Drawings Of Slabs Types

There are several types of plates from floors 1-9. One of them is type A with a slab thickness of 150 mm with reinforcement in the X direction using a diameter of 10 with a

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distance of 150 mm and in the Y direction also using a diameter of 10 with a distance of 150 mm. The following recapitulation of plate types can be seen in Table 2.

Table 2. Reinforcement and Concrete Specifications for Each Type

Type	Plate thickness (mm)	X direction	Y direction
A	150	Ø10- 150	Ø10- 150
A1	150	Ø10- 150	Ø8- 200
B	150	Ø12- 150	Ø12- 150
B1	150	Ø12- 150	Ø8- 150
B2	150	Ø12- 120	Ø12- 120
C	150	Ø13- 200	Ø13- 200
C1	150	Ø13- 200	Ø10- 150
C2	150	Ø13- 170	Ø13- 170
D	180	Ø15- 150	Ø13- 150
1	120	Ø10- 200	Ø8- 200
2	150	Ø10- 150	Ø8- 200
3	150	Ø13- 150	Ø10- 200
4	180	Ø12- 150	Ø8- 150

Source: Documentation of research result, 2023.

After it is known from the data on the total area of the slab in Table 1 and the type of slab in Table 2, it is then possible to calculate the need for formwork, reinforcement, and concrete. The following recapitulation of the volume requirements for formwork, reinforcement, and concrete for each floor can be seen in Table 3.

Table 3. Recapitulation of the volume of each floor

Lv	Repetition Totals (Kg)	Plate Volume (M3)	Extent of Formwork (M2)
1	33.539,24	218,73	1.458,23
2	16.819,25	149,63	997,56
3	20.677,03	184,92	1.219,82
4	27.114,19	182,52	1.200,49
5	6.467,74	54,51	363,42
6	19.857,67	175,77	1.175,07
7	19.149,85	167,08	1.113,86
8	19.843,92	175,13	1.192,12
9	23.749,66	173,15	1.178,94
Total	187.218,55	1.481,45	9.899,52

Source: Documentation of research result, 2023.

4.2. Job Cost Analysis

Cost analysis on work is carried out by finding the basic unit price from related sources, then analyzing the work unit price then multiplying it by the volume of work to get a budget plan. The following is an analysis of the unit price of work based on ministerial regulation number 28 of 2016 as a reference for calculations.

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Table 4. Analysis of the unit price of reinforcement work

No.		Unit	Coefficient	Unit price (IDR)	Total price (IDR)
A	**Workforce**				
	Worker	OH	0,070	IDR 100.000,00	IDR 7.000,00
	Handyman	OH	0,070	IDR 125.000,00	IDR 8.750,00
	Foreman I	OH	0,007	IDR 150.000,00	IDR 1.050,00
	Foreman II	OH	0,004	IDR 175.000,00	IDR 700,00
				Total Workforce (A)	**IDR 17.500,00**
B	**Material**				
	Deformed steel bar	Kg	10,500	IDR 9.500,00	IDR 99.750,00
	Steel wire	Kg	0,150	IDR 20.000,00	IDR 3.000,00
				Total Material Prices (B)	**IDR 102.750,00**
	Amount				IDR 120.250,00
	Overhead & Profit		10%		IDR 12.025,00
	Work Unit Price				**IDR 132.275,00**
	Steel Work Unit Price For 1 Kg				**IDR 13.227,50**

Source: Documentation of research result, 2023.

After calculating all the units of work as in the example in Table 4 of the reinforcement work, multiply them by the total volume that has been calculated in Table 3. Then summarize all the work items to obtain the total required budget plan. The following recapitulation of the total budget plan for the conventional method of floor slab work can be seen in Table 5.

Table 5. recapitulates the cost of the conventional method

No	Occupation	Unit	Volume	Unit price	Total price
1	Formwork	m2	9.899,52	IDR 233.915,00	IDR 2.315.645.752,97
2	Reinforcement Steel Bar	kg	187.218,55	IDR 13.227,50	IDR 2.476.433.411,13
3	Concrete Slab	m3	1.481,45	IDR1.467.510,00	IDR 2.174.041.075,24
4	Lifting Material	ton	639,92	IDR 74.032,22	IDR 47.374.425,09
5	Scaffolding	m2	9.899,52	IDR 157.588,51	IDR 1.560.050.571,12
		Total			IDR 8.573.545.235,56

Source: Documentation of research result, 2023.

One example that has been calculated is reinforcement work, the resulting price is IDR 2,476,433,411.13. then next input all work items and then the total of all estimated costs. Based on Table 5, the results of the conventional budget plan are IDR 8,573,545,235.56.

Table 6. recapitulates the cost of the half-slab method

No	Occupation	Unit	Volume	Unit price	Total price
1	Production land	m3	24,00	IDR 82.930,49	IDR 1.990.331,64
2	Precast formwork	m2	9.899,52	IDR 31.880,02	IDR 315.596.871,43
3	Precast steel bars	kg	102.283,76	IDR 13.227,50	IDR 1.352.958.389,51
4	Precast concrete	m3	641,49	IDR1.467.510,00	IDR 941.394.545,46
5	Opening the formwork	buah	1.192,00	IDR 9.267,50	IDR 11.046.860,00

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Continue **Table 6.** recapitulates the cost of the half-slab method

No	Occupation	Unit	Volume	Unit price	Total price
6	Precast erection	buah	1.192,00	IDR 347.463,38	IDR 414.176.348,96
7	Top-coated steel bar	kg	93.609,28	IDR 13.227,50	IDR 1.238.216.705,31
8	Concrete toppings	m3	839,96	IDR1.467.510,00	IDR 1.232.646.529,78
9	Langsir	buah	2.247,00	IDR 88.531,85	IDR 198.931.066,95
10	Lifting materials	ton	108,93	IDR 74.032,22	IDR 8.064.492,46
11	Scaffolding	m2	9.899,52	Rp 157.588,51	IDR 1.560.050.571,12
		Total			IDR 7.275.072.712,63

Source: Documentation of research result, 2023.

Based on the table above, the results for the budget plan for the half slab method are IDR. 7.275.072.712,63.

4.3. Job Time Analysis

The calculation of work productivity is obtained by calculating the number of workers multiplied by the number of teams and divided by the coefficient. Furthermore, the total volume of work is divided by the productivity calculated earlier, then the total duration of days needed to complete a job will be obtained.

an example of formwork work with an estimate of 2 teams with 40 workers per team, a productivity of 121.2 is obtained. because it is known that the volume of the formwork is 9,899.52 then divided by the productivity, the result is a duration of 81.7 or rounded up to 82 days. The following example of calculating the productivity of formwork work can be seen in Table 7.

Table 7. Work Productivity of Plate Formwork

Number of Teams	2	team		
Job volume	9.899,52	m2		
Labor	Coefficient (OH)	number of workers	productivity	duration (days)
Worker	0,66	40	121,21	81,7
Carpenter	0,33	20	121,21	81,7
Foreman I	0,033	2	121,21	81,7
Foreman II	0,033	2	121,21	81,7
Total				82,0

Source: Documentation of research result, 2023.

After calculating productivity as in Table 7, then also calculate all work items. Next, input work productivity using the help of the Microsoft Project application to set the time for each work item and carry out scheduling. The following scheduling results can be seen in Figure 2.

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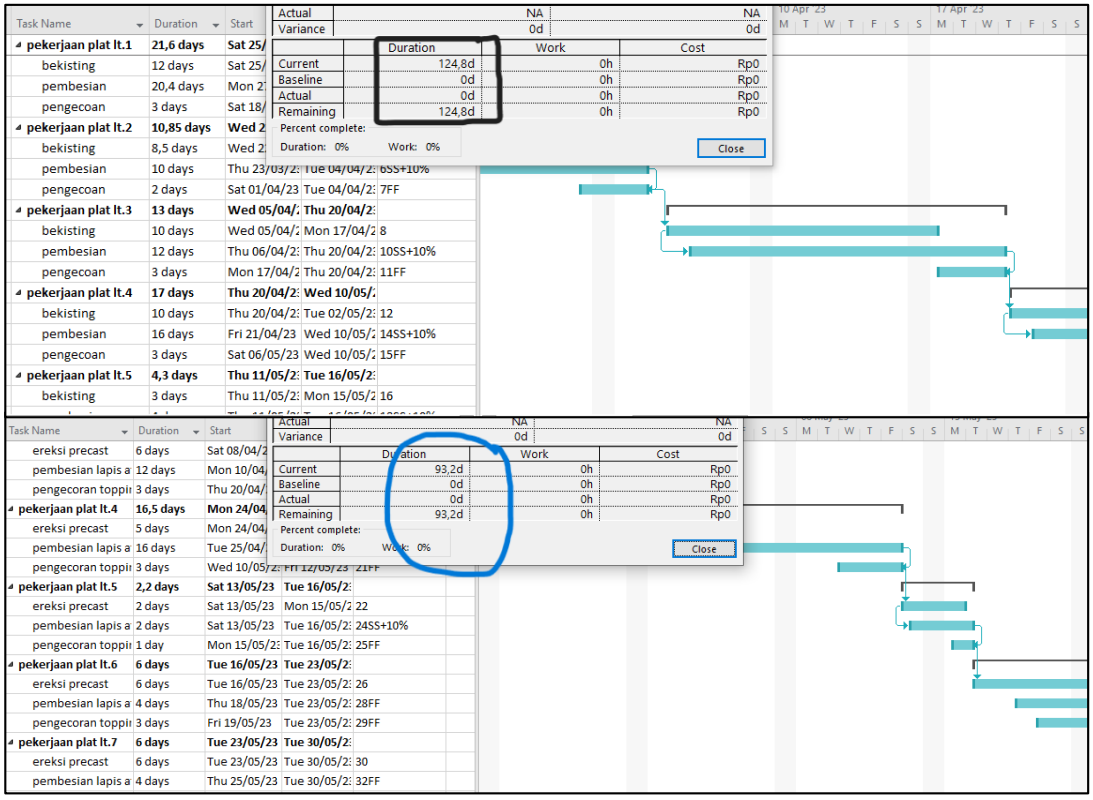


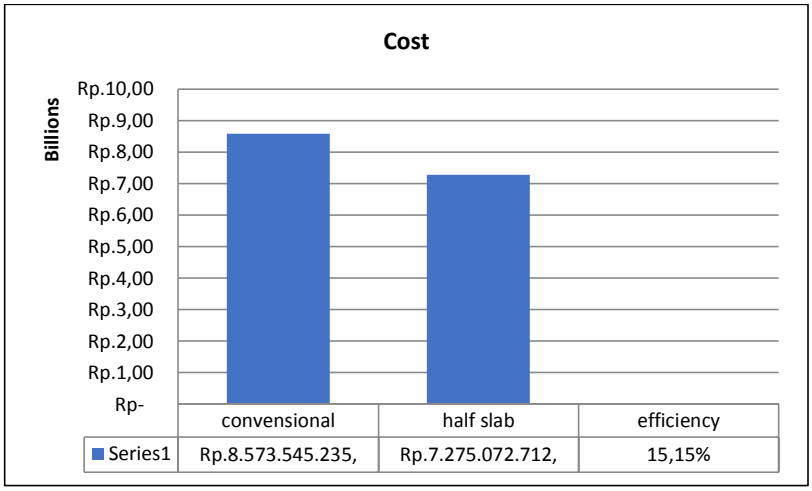
Source: Documentation of research result, 2023.

Figure 2. Scheduling slab work using the conventional method and half slab method using MS.Project

Scheduling results were obtained with the help of the ms. project application for conventional method slab work with a total time required of 124.8 days or if rounded up to 125 days and for the half slab method it was 93.2 or 94 days. Differences can occur due to differences in items and work productivity.

4.4. Comparison analysis

After calculating the budget plan and the duration of the plate work for the two methods, a comparison is then made to determine which method is more efficient.



Source: Documentation of research result, 2023.

Figure 3. Cost Comparison Diagram For Plate Work Using Ms.Excel Tool

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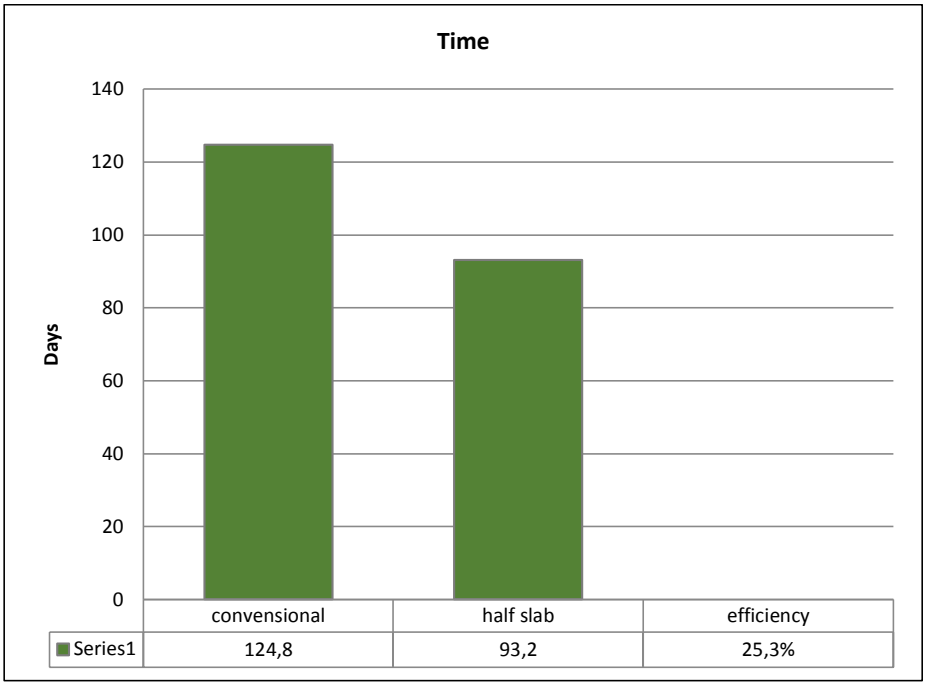
From the results in Table 5 and Table 6, it is known that for conventional slab work, a cost of 8.6 billion is required and for the half slab method it is 7.3 billion. From the comparison of the two methods, a difference of 1.3 billion or an efficiency of 15.15% is obtained.



Source: Documentation of research result, 2023.

Figure 5. Time Comparison Diagram For Plate Work Using Ms.Excel Tool

From Figure 2, it is known that conventional slab work takes 125 days and 94 days for the half slab method. From the comparison of the two methods, a difference of 31 days or an efficiency of 25.3% was obtained.

5. Conclusion and Suggestion

5.1 Conclusion

Based on the results of a comparative analysis of costs and time on conventional plate work with the half slab method, it can be concluded that: Obtained the cost value for plate work on the conventional method of IDR 8,573,545,235.56 and for a working time of 124.8 days. Whereas in the half-slab method, the cost is IDR 7,275,072,712.63 and for a work time of 93.2 days. From the two methods, it can be concluded that the half slab method is cheaper and faster than the conventional method with a cost difference of 15.15% and a difference of 25.32% time.

5.2. Suggestion

In this study several suggestions may be needed when conducting further research, namely: It is necessary to add more references and guidelines, especially for the half slab method. In this study, the cost and time calculations used the analytical approach from AHSP. It would be better if a search was carried out on related companies.

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