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COMPARATIVE ANALYSIS OF CAST IN SITU SLAB METHOD WITH HALF SLAB PRECAST IN TERMS OF TIME AND COST ON THE KASIH IBU SURAKARTA HOSPITAL CONSTRUCTION PROJECT

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Abstract

The development of methods / systems in the field of construction every year is increasing, so that in planning a construction building can choose the most economical, effective, and efficient method to be applied. One of them is the casting implementation method which can be done by conventional method (cast in situ) and precast method (precast). In this study, the object reviewed is the Kasih Ibu Surakarta Hospital Construction Project, where the method of carrying out floor slab casting work uses the cast in situ method which will later be carried out a comparative analysis between the cast in situ method and the half slab precast method in terms of time and cost. This study uses data in the form of shop drawing, RAB, AHSP, and data on the number of workers to be the basis for analysis between the two methods. The results of the comparative analysis of the cast in situ method and the half slab precast method in terms of time and cost obtained results for the cast in situ method plate takes 129.26 days at a cost of IDR 11.200.040.000 while for the half slab precast method plate takes 108.89 days for IDR 8.898.330.000. The comparative results of the time and cost analysis that have been carried out, can be concluded that using the half slab precast method can shorten the implementation duration by 20.89 days and can reduce costs by IDR 2.301.710.000 compared to the cast in situ method.

Kata Kunci :
Cast In Situ, Half Slab Precast, Waktu dan Biaya

Abstrak

Perkembangan metode/sistem dalam bidang konstruksi setiap tahunnya semakin meningkat, sehingga dalam suatu perencanaan sebuah bangunan konstruksi dapat memilih metode yang paling ekonomis, efektif, serta efisien untuk diterapkan. Salah satunya adalah metode pelaksanaan pengecoran yang dapat dilakukan dengan metode konvesional (cast in situ) dan metode pracetak (precast). Pada penelitian ini objek yang ditinjau adalah Proyek Pembangunan Rumah Sakit Kasih Ibu Surakarta, dimana metode pelaksanaan pekerjaan pengecoran pelat lantai menggunakan metode cast in situ yang nantinya akan dilakukan analisis perbandingan antara metode cast in situ dan metode half slab precast dari segi waktu dan biaya. Penelitian ini menggunakan data berupa shop drawing, RAB, AHSP, serta data jumlah tenaga kerja untuk menjadi dasar analisis antara kedua metode tersebut. Adapun hasil analisis perbandingan metode cast in situ dan metode half slab

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precast dari segi waktu dan biaya didapatkan hasil untuk pelat metode cast in situ membutuhkan waktu 129,26 hari dengan biaya sebesar Rp 11.200.040.000 sedangkan untuk pelat metode half slab precast membutuhkan waktu 108,89 hari dengan biaya sebesar Rp 8.898.330.000. Hasil perbandingan dari analisis waktu dan biaya yang telah dilakukan, dapat disimpulkan bahwa dengan menggunakan metode half slab precast dapat mempersingkat durasi pelaksanaan sebanyak 20,89 hari dan dapat mengurangi biaya sebanyak Rp 2.301.710.000 dibandingkan dengan metode cast in situ.

INTRODUCTION

The development of methods/systems in the construction sector is increasing every year, so you can choose the most economical, effective and efficient method to apply in planning a construction building. One is the casting method, which can be carried out using conventional and precast methods (cast in situ) [1].

There are several precast methods for plate casting, including: *solid flat slab/full slab precast*, *hollow core slab*, and *half slab precast*. In this research, the half slab precast method is chosen, namely a precast plate that still requires further casting (*overtopping*) [2].

In this research, the object under review is the Kasih Ibu Hospital Construction Project in Surakarta, where the method of implementing the floor plate casting work uses the cast in situ method. Based on the explanation in the previous paragraph, this research is planned to use the half slab precast method, which will later carry out a comparative analysis between the cast in situ method and the half slab precast method in terms of time and cost so that this research can be used as consideration for selecting the method more efficient floor plate casting work to be applied to subsequent projects.

The conventional slab method (cast in situ) is a method of casting concrete carried out directly at the location of the planned structural elements [2]. The cast-in-situ method usually uses plywood as formwork or plate moulding tools and scaffolding as supports. Using temporary scaffolding and formwork can increase construction costs and time [3].

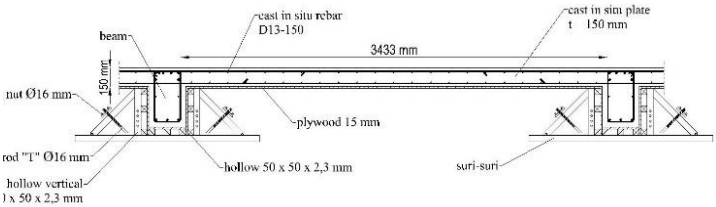

Figure 1. Cast In Situ Plate

The half slab precast method is a combined casting method between two planning systems, namely the precast system and the cast in situ system for overtopping casting [1]. Precast parts can be made at the fabrication site provided at the project location or ordered from a precast factory and installed in the field after the concrete has reached sufficient age [4]. If the concrete components have reached the required age, they can be sent to the project location for installation [5].

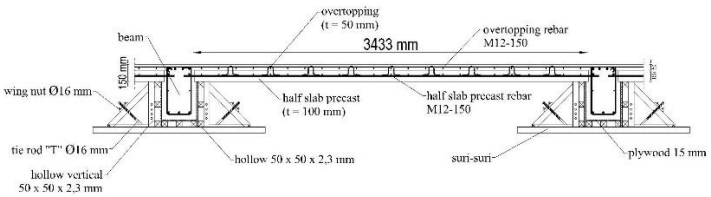

Figure 2. Half Slab Precast

Time and cost analysis begins with calculating the volume of work; the volume of work is calculated to determine time requirements and construction costs; volume calculations can also get productivity measures. Productivity is a comparison between results

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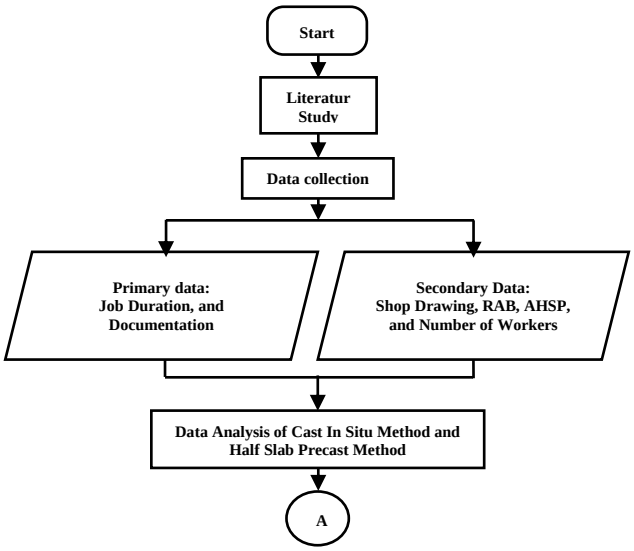
(output) to production components (input) (such as labour, materials, equipment and time) where, if the input time is small, the output is greater. Hence, productivity is higher [6]. Several factors that influence productivity are worker skills, tools used, quality of materials used and selection of methods applied [7]. Time plan calculations and work productivity data on cast in situ method plates in this final project were obtained from daily project reports. The formula for calculating the time plan for slab work using the half slab precast method is calculated using the formula [8]:

$$\text{time} = \frac{\text{work volume}}{\text{work productivity}}$$

RESEARCH METHODS

Research methodology is a way to obtain the necessary data, which will then be used for analysis to obtain cold conclusions reached in the research. The research concept in this final assignment is to compare two methods for implementing plate casting, the cast in situ method and the half slab precast method, which will be reviewed in terms of time and cost. The research method used in this research is an analytical research method with a quantitative data approach. The flow chart for comparative analysis of cast in situ slab method with precast half slabs in terms of time and cost can be shown in the following figure:



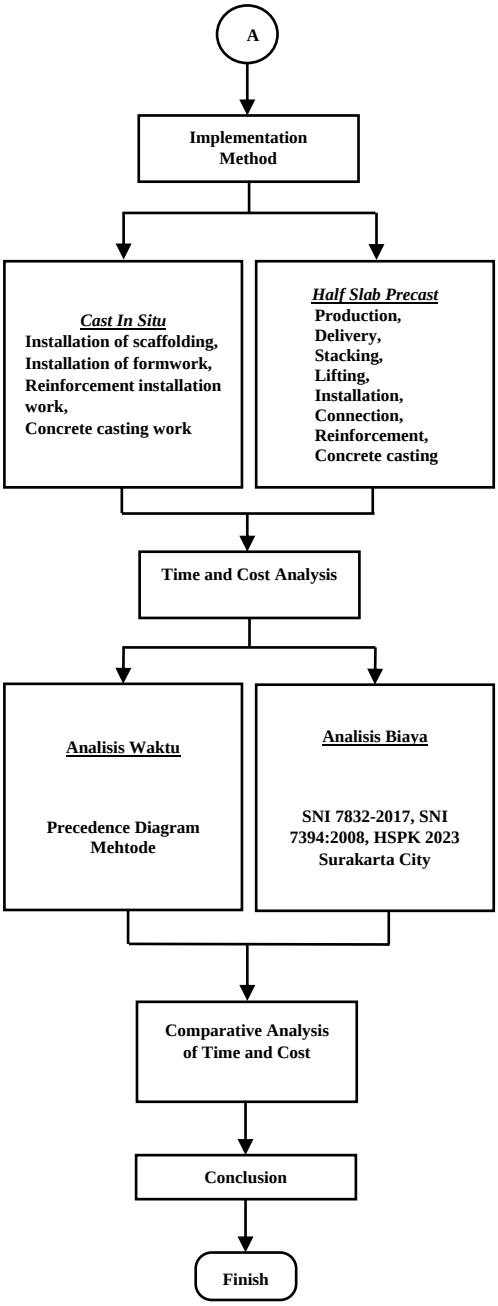


Figure 3. Flow Chart

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RESULTS AND DISCUSSION

Desain half slab precast

Planning data:

Floor plate thickness :15 cm
Precast plate thickness : 10 cm
Thick overtopping : 5 cm
Thick concrete blanket : 20 cm
Bone diameter (Planning) : M12 mm
Lx : 2,05 m
Ly : 3,433 m
Concrete quality (f'c) : K-350 = 29,05 Mpa
Quality of reinforcing steel (fy): 420 Mpa

Lifting and stacking conditions

DL = 360 kg/m^2
qU DL = 432 kg/m^2

In the lifting and stacking conditions, the plate is modeled to be located above the clamp which is in the same position as the lifting point.

Mu = 1413800 Nmm

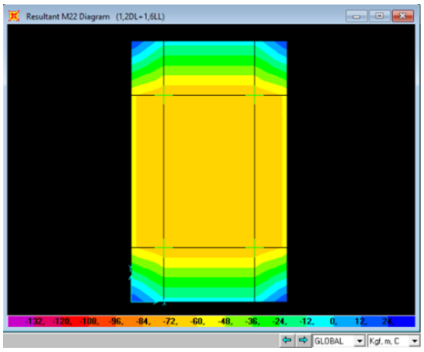

Figure 4. Maximum Moment Under Lifting Conditions

Precast plates planned using M12-150 mm wire mesh bars [9]

$\phi Mn = \phi \times As \times fy\ (dx - 0{,}5a)$
$= 0{,}9 \times 753{,}6 \times 420\ (62 - 0{,}5(12{,}82))$
$= 15835676{,}34$ Nmm

Control

$\phi Mn > Mu$
15835676,34 Nmm > 2210600 Nmm (Fulfil)

So, M12-150 wire mesh reinforcing iron can be used.

Lift control

Based on Precast Concrete Institute Design Handbook 4th Edition [10], lifting points must be located to keep component stresses within allowable limits and to ensure proper alignment of the piece as it is being lifted in caculating the lifting points is planned use 4 lifting reinforcement points.

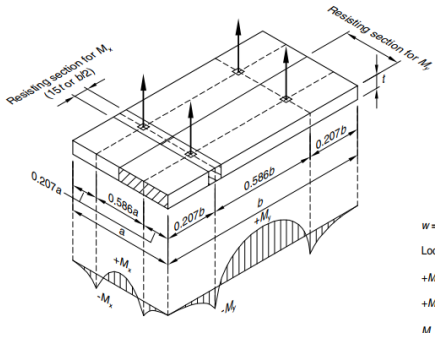

Figure 5. Four Point Pick Up Maximum Moments

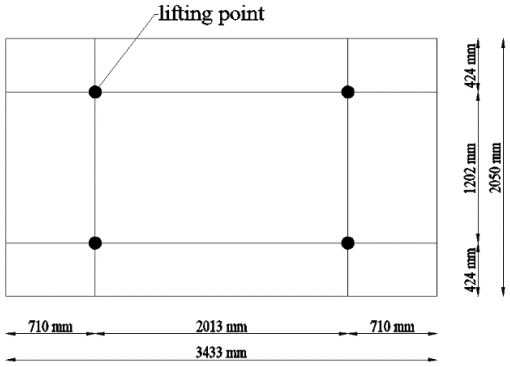

Figure 6. Slab Lifting Point

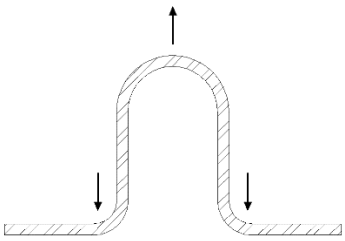

Figure 7. Lifting Reinforcement Plan

It is planned to use reinforcement with a diameter of 10 mm and quality reinforcement U42 (fy = 420 Mpa) for lifting reinforcement; the calculations are as follows: [11]

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W = 2400 × 1,2 × 1,5 = 4320 kg/ m^3
P = W × a × b × plat thickness
= 4320 × 2,05 × 3,433 × 0,1
= 3040,03 kg
T = $\frac{0,125P}{\sin 60°} = \frac{0,125 \times 3040,03}{\sin 60°}$ = 438,82 kg
= 4388,24 N
σ = $\frac{T}{A}$, Where (σ = the tension that occurs,
A = area of reinforcement used)
= $\frac{T}{0,25 \times \pi \times d^2} = \frac{4388,24}{0,25 \times 3,14 \times 10^2}$ = 55,90 N/mm^2 < 420 N/mm^2

So, 10 mm diameter reinforcement with reinforcement quality U42 can be used and is safe as a lift loop.

Condition before composite

DL = 360 kg/m^2
LL = 100 kg/m^2
qU = 592 kg/m^2
Mu = 2210600 Nmm

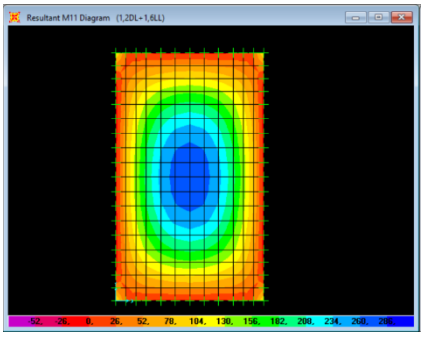

Figure 8. Maximum Moment Before Composite Conditions

Precast plates planned using M12-150 mm wire mesh bars [9]

ϕMn = ϕ × As × fy (dx – 0,5a)
= 0,9 × 753,6 × 420 (74 – 0,5(12,82))
= 19254005,94 Nmm

Control

ϕMn	>	Mu
19254005,94 Nmm	>	2210600 Nmm (Fulfil)

So, M12-150 wire mesh reinforcing iron can be used.

Composite condition

DL = 508 kg/m^2
LL = 383 kg/m^2
qU = 1222,4 kg/m^2

In the composite condition, the plate is modeled as elastically clamped on all four sides.

Mu = 4584300 Nmm

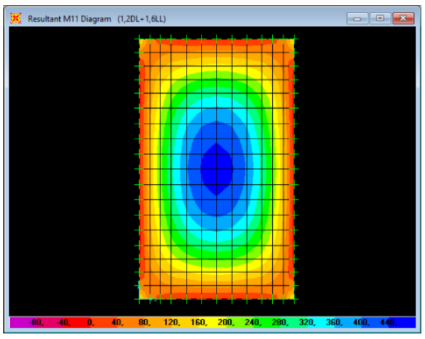

Figure 9. Maximum Moment Composite Conditions

Precast plates planned using M12-150 mm wire mesh bars [9]

ϕMn = ϕ × As × fy (dx – 0,5a)
= 0,9 × 753,6 × 420 (124 – 0,5(12,82))
= 33497045,94 Nmm

Control

ϕMn	>	Mu
33497045,94 Nmm	>	4584300 Nmm (Fulfil)

So, M12-150 wire mesh reinforcing iron can be used.

Execution time analysis of cast in situ methods

Time analysis of cast in situ method based on HSPK 2023 Surakarta City. The time analysis requires the coefficient of each employee and the amount of labor on each job so that the duration of each job will be obtained.

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Table. 1 Working duration of Cast In Situ Method Plate

Floor	Zone		Formwork Work			Casting Works			Foundry Works		
			Volume m²	Time day		Volume kg	Time day		Volume m³	Time day	
1	Z1	a	196,89	1,44	**10,09**	4023,69	0,94	**6,84**	24,61	0,41	**2,63**
		b	247,60	1,82		4833,72	1,13		30,95	0,47	
	Z2	a	387,46	2,84		7537,46	1,76		48,43	0,66	
		b	160,31	1,18		3282,67	0,77		20,04	0,34	
	Z3	a	177,33	1,30		2147,29	0,50		22,17	0,34	
		b	205,96	1,51		7503,88	1,75		25,75	0,41	
2	Z1	a	196,89	1,44	**9,67**	6800,03	1,59	**9,51**	29,53	0,41	**2,63**
		b	264,72	1,94		8664,62	2,02		39,71	0,54	
	Z2	a	330,31	2,42		10217,72	2,38		49,55	0,66	
		b	198,19	1,45		7196,03	1,68		29,73	0,41	
	Z3	a	141,91	1,04		1573,71	0,37		17,74	0,28	
		b	186,35	1,37		6284,28	1,47		23,29	0,34	
3	Z1	a	196,89	1,44	**10,09**	6800,03	1,59	**10,09**	29,53	0,41	**2,70**
		b	264,72	1,94		8664,62	2,02		39,71	0,54	
	Z2	a	387,46	2,84		12738,30	2,97		58,12	0,73	
		b	198,19	1,45		7196,03	1,68		29,73	0,41	
	Z3	a	141,91	1,04		1573,71	0,37		17,74	0,28	
		b	186,35	1,37		6284,28	1,47		23,29	0,34	
4	Z1	a	196,89	1,44	**10,18**	6800,03	1,59	**10,70**	29,53	0,41	**2,76**
		b	264,72	1,94		8664,62	2,02		39,71	0,54	
	Z2	a	400,26	2,94		15354,05	3,58		60,04	0,79	
		b	198,19	1,45		7196,03	1,68		29,73	0,41	
	Z3	a	141,91	1,04		1573,71	0,37		17,74	0,28	
		b	186,35	1,37		6284,28	1,47		23,29	0,34	
5	Z1	a	196,89	1,44	**9,64**	6800,03	1,59	**8,78**	29,53	0,41	**2,63**
		b	264,72	1,94		8664,62	2,02		39,71	0,54	
	Z2	a	326,21	2,39		7098,37	1,66		48,93	0,66	
		b	198,19	1,45		7196,03	1,68		29,73	0,41	
	Z3	a	141,91	1,04		1573,71	0,37		17,74	0,28	
		b	186,35	1,37		6284,28	1,47		23,29	0,34	
6	Z1	a	196,89	1,44	**9,57**	6800,03	1,59	**8,18**	29,53	0,41	**2,57**
		b	264,72	1,94		8664,62	2,02		39,71	0,54	
	Z2	a	317,33	2,33		4545,39	1,06		47,60	0,60	
		b	198,19	1,45		7196,03	1,68		29,73	0,41	
	Z3	a	141,91	1,04		1573,71	0,37		17,74	0,28	
		b	186,35	1,37		6284,28	1,47		23,29	0,34	

Execution time analysis of the half slab precast method

Time analysis of half slab precast method based on HSPK 2023 Surakarta City and SNI 7832: 2017. Time analysis requires the coefficient of each employee and the amount of labour at each job, so that the duration of each job will be obtained.

Table. 2 Duration of Half Slab Precast Method Slab Work

Floor	Zone		Support Pipe Installation Work		Precast Erection Work			Casting Works			Foundry Works		
			Volume unit	Time Day	Volume unit	Time Day		Volume kg	Time Day		Volume m³	Time Day	
1	Z1	a	147	**0,43**	34	0,60	**5,06**	2313,77	1,45	**10,19**	0,74	0,14	**0,83**
		b	196		44	0,78		3096,27	1,94		0,65	0,14	
	Z2	a	289		78	1,38		4556,32	2,85		1,10	0,14	
		b	119		38	0,67		1875,33	1,17		1,10	0,14	
	Z3	a	118		38	0,68		1857,33	1,16		0,97	0,14	

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Floor	Zone		Support Pipe Installation Work		Precast Erection Work			Casting Works			Foundry Works		
			Volume unit	Time Day	Volume unit	Time Day		Volume kg	Time Day		Volume m³	Time Day	
		b	165		52	0,93		2604,17	1,63		1,13	0,14	
2	Z1	a	128	0,41	30	0,55	4,75	2905,23	1,82	13,10	0,74	0,14	0,82
		b	206		44	0,80		4689,37	2,93		0,35	0,14	
	Z2	a	289		78	1,42		6560,53	4,10		1,10	0,14	
		b	145		38	0,69		3284,29	2,05		0,82	0,14	
	Z3	a	97		30	0,56		1535,60	0,96		0,88	0,14	
		b	126		40	0,74		1981,59	1,24		1,14	0,14	
3	Z1	a	147	0,41	34	0,64	4,79	3331,54	2,08	13,07	0,74	0,14	0,82
		b	206		44	0,83		4689,37	2,93		0,35	0,14	
	Z2	a	269		68	1,28		6106,02	3,82		0,57	0,14	
		b	145		38	0,71		3284,29	2,05		0,82	0,14	
	Z3	a	97		30	0,57		1535,60	0,96		0,88	0,14	
		b	125		40	0,76		1969,91	1,23		1,13	0,14	
4	Z1	a	147	0,42	34	0,66	4,98	3331,54	2,08	13,21	0,74	0,14	0,82
		b	206		44	0,85		4689,37	2,93		0,35	0,14	
	Z2	a	278		70	1,36		6319,17	3,95		0,57	0,14	
		b	145		38	0,74		3284,29	2,05		0,82	0,14	
	Z3	a	97		30	0,59		1535,60	0,96		0,88	0,14	
		b	125		40	0,79		1969,91	1,23		1,13	0,14	
5	Z1	a	147	0,41	34	0,68	5,13	3331,54	2,08	12,92	0,74	0,14	0,82
		b	206		44	0,88		4689,37	2,93		0,35	0,14	
	Z2	a	258		70	1,40		5854,81	3,66		1,10	0,14	
		b	145		38	0,76		3284,29	2,05		0,82	0,14	
	Z3	a	97		30	0,61		1535,60	0,96		0,88	0,14	
		b	125		40	0,81		1969,91	1,23		1,13	0,14	
6	Z1	a	147	0,41	34	0,70	5,20	3331,54	2,08	12,86	0,74	0,14	0,82
		b	206		44	0,90		4689,37	2,93		0,35	0,14	
	Z2	a	254		66	1,36		5761,60	3,60		1,02	0,14	
		b	145		38	0,78		3284,29	2,05		0,82	0,14	
	Z3	a	97		30	0,62		1535,60	0,96		0,88	0,14	
		b	125		40	0,83		1969,91	1,23		1,13	0,14	

Cost analysis of cast in situ methods

Time analysis of cast in situ method based on HSPK 2023 Surakarta City

Table 3. Cost of Cast In Situ Slab Work

No.	Description	Volume	Units	Unit price		Total price	
1	Formwork Work	8077,40	m²	IDR	668.080	IDR	5.396.342.631
2	Casting Works	231875,90	kg	IDR	15.843	IDR	3.673.656.246
3	Foundry Works	1136,19	m³	IDR	1.252.909	IDR	1.423.540.390
4	Tower Crane Rental	1	ls	IDR	706.500.000	IDR	706.500.000
Total Cost of Cast In Situ Plates						**IDR**	**11.200.039.268**
approach						**IDR**	**11.200.040.000**

Cost analysis for implementing the half slab precast method

Cost analysis of the half slab precast method using SNI 7832-2017 concerning "Unit Price Analysis of Insitu Precast Concrete Work for Building Construction"[12].

Table 4. Cost of Half Slab Precast Method Slab Work

No.	Description	Volume	Units	Unit price		Total price	
1	Ordering Half Slab Precast					IDR	5.475.806.224
2	Half Slab Precast Drop Curtain	1562	Unit	IDR	106.685	IDR	166.641.189
3	Half Slab Installation	1252,56	m³	IDR	54.953	IDR	68.831.873
4	Overtopping Work	120544,24	kg	IDR	19.646	IDR	2.368.212.190
5	Foundry Works (Overtopping)	29,68	m³	IDR	1.252.909	IDR	37.186.439

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No.	Description	Volume	Units	Unit price		Total price	
6	Bonding Agent Application Work	8942,99	m²	IDR	8.403	IDR	75.147.905
7	Tower Crane Rental	1	ls	IDR	706.500.000	IDR	706.500.000
Jumlah Biaya Pelat *Cast In Situ*						**IDR**	**8.898.325.819**
Dibulatkan						**IDR**	**8.898.330.000**

Comparative Analysis of the Cast In Situ Method and the Half Slab Precast Method

The results of the comparison of time and cost analysis between the cast in situ slab method and the half slab precast method obtained the following results:

Table 5. Recapitulation of Time and Costs for Cast In Situ Slab and Half Slab Precast Methods

Method	Total Time	Total cost	
	(Day)	(IDR)	
Cast In Situ Method	129,26	IDR	11.200.040.000
Half Slab Precast Method	108,36	IDR	8.898.330.000
Comparison Difference	20,89	IDR	2.301.710.000
%	83,83		79,45

CONCLUSION

From the results of the analysis of the cast in situ method with half slab precast method, the results were obtained that the work of the plates of the cast in situ method took 129.26 days, whereas for the half slab precast method took 108.36 days with a time difference of 20.89 days with a presentation of 83,83%. The cast in situ method requires a costs IDR 11.200.040,000, while the half slab precast method involves a cost of IDR 8.898.330.000 with a cost difference of IDR 2.301.710.000 with a presentation of 21.21%. Comparison results from the time and cost analysis that has been carried out, it can be concluded that using the method of half slabs precast can shorten the duration of execution by 20.89 Days and can reduce the cost by as much as IDR 2.301.710.000 compared to the cast on-site method.

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