



Analysis of Precast Concrete Construction Cost Comparison with Conventional Concrete in Building (Case Study of A1 & A2 Building) Sartikaasih Bhayangkara Hospital Bandung)

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ABSTRACT

This study discusses the comparison of cost and time efficiency between precast and conventional concrete systems in the structural work of building construction. The research adopts a quantitative comparative approach on two segments of the Sartikaasih Bhayangkara Hospital project in Bandung. The BoQ calculation results show that the precast system incurred lower total costs, amounting to IDR 17.6 billion (A1) and IDR 12.74 billion (A2), compared to the conventional system with IDR 19.86 billion (A1) and IDR 14.29 billion (A2). In terms of time, the precast system demonstrated significant efficiency, with savings of 65.02% on A1 and 21.43% on (A2). This efficiency contributes to the reduction of indirect costs and the risk of project delays. These findings indicate that the precast system can serve as a more economical and efficient alternative for building construction projects.

INTRODUCTION

The growth of the construction sector in Indonesia is spurred by the need for public facilities and high-rise buildings, where time, cost, and quality efficiency become crucial aspects in the success of a project. Building structures, especially columns, beams, and floor plates play an important role in determining these three aspects, as explained by (Rani & Fuadi, 2016) .

Two commonly used methods are conventional concrete (cast-in-situ) and precast concrete. Conventional concrete is cast directly at the project site from formwork installation, reinforcement, casting to curing, which generally consumes a lot of time and labor, and is vulnerable to weather disturbances (Najoan et al., 2017) . In contrast, precast concrete is produced in controlled facilities such as precast yards, then transported and installed in the field offering better quality control and speed of execution.

The use of precast methods is considered more efficient in terms of speed and quality because the structural elements are produced under more controlled conditions. Precast concrete has advantages in terms of quality, productivity, and quality control because the production process is carried out in a place that is not directly affected by weather and project environmental conditions (Špak et al., 2016) . In addition, precast systems can reduce the volume of site work, including casting and concreting.

However, the precast method is often associated with higher initial costs, particularly for production, transportation, and installation. For example, a comparative study of structural systems for low-cost apartment buildings (Pakiding, 2022) found that the use of the precast method was 26% more expensive than the conventional method, but resulted in a time acceleration of approximately 21 days. In contrast, a study by (Alvandi et al., 2021) explained that the use of precast concrete for beam structures had a lower cost than conventional concrete, with a cost difference of IDR 121 million.

With the increasing need for efficiency in the construction of high-rise buildings, the selection of the right construction method is key to the success of the project. Therefore, this research is important to provide data-based input in determining the concrete structural system that best suits the characteristics of the project, not only from a technical aspect, but also in terms of cost and implementation efficiency.

LITERATURE REVIEW

Precast Concrete

Precast concrete is a structural concrete element that is produced off-site, usually in a factory, with strict quality control, then delivered and installed at the construction site. This process enables mass production of concrete elements with consistent quality and faster installation times than conventional methods. Based on the study results (Rahmadia et al., 2024) , the use of precast concrete systems, not only speeds up the construction process but also reduces material waste, which contributes to the sustainability of construction projects.

Precast concrete systems are a construction method in which structural and architectural elements are manufactured at a location separate from their installation site. The fabrication process of these precast elements can be carried

out in a production facility such as a factory or at the project site. Factory production is generally permanent and allows the application of various techniques and the use of more varied production equipment, depending on the number of elements to be fabricated in order to achieve efficiency and economy. In contrast, the production of precast elements in the field is temporary, so the methods used tend to be more limited and adapted to the existing project conditions(Zainul Khakim, M. Ruslin Anwar, 2011)

There are a number of advantages of applying precast concrete systems in the implementation of building construction, which provide added value both in terms of technical and implementation efficiency(Pramana et al., 2023)

1. The production process is carried out using machines
2. Relatively constant conditions in the factory/workshop
3. More careful supervision
4. Conditions of the work environment are better. (not in direct sunlight) The implementation of construction is almost unaffected by the weather.

In addition to having various advantages, precast concrete systems also have a number of limitations that need to be considered in their implementation on construction projects. Some of the disadvantages or challenges commonly encountered in the use of precast concrete will be explained in the following section(Pramana et al., 2023) :

1. Transportation

The distribution of precast concrete elements from the factory to the project site requires additional costs, especially for transportation. The dimensions and severity of the elements are major factors in the choice of transportation mode, which is generally a pickup truck, and affect the efficiency of delivery on site.

2. Erection

The Erection process is the stage of arranging and uniting the precast concrete elements to form a complete building structure. This stage requires the use of tools such as tower cranes, which are used to lift and place the precast elements to the planned position. However, the use of these tools requires a relatively high cost investment.

3. Connection

In an effort to unite precast concrete elements, an additional construction is required that is able to transmit all forces acting in each element. The constraint that arises is how to determine the type of connection that is able to anticipate all forces.

Conventional Concrete

Conventional concrete is a method of concrete construction that is done manually and requires careful implementation planning before the casting process is carried out. This system generally requires a large budget, especially for formwork and labor needs. In the *cast-in-place* method, the process of mixing and casting concrete is carried out directly at the construction site of the structure. Structural elements are formed in place using formwork made of

materials such as wood or plywood, and equipped with scaffolding as temporary support during the hardening process(Pramana et al., 2023)

Conventional concrete has several advantages that make it still widely used in construction practice, including(Cainawa, 2020)

1. Easy and common to work with,
2. Easy to form in various cross-sections,
3. Calculations are relatively easy and common,
4. Beam, column, floor plate connections are monolithic (fully bonded).

Although it has a number of advantages, conventional concrete also has limitations that need to be considered, including(Cainawa, 2020)

1. Quite a lot of labor is required (relatively expensive),
2. The use of formwork is relatively more,
3. The work in construction is longer because the work is sequentially interdependent with other work,
4. Affected by the weather, if it rains then concrete work cannot be done.

The hypothesis in this study consists of two statements, namely

1. Null Hypothesis (H_0) which states that there is no significant difference in total construction cost between the use of precast concrete and conventional concrete.
2. Alternative Hypothesis (H_1) which states that there is a significant difference in the total construction cost between the two systems.

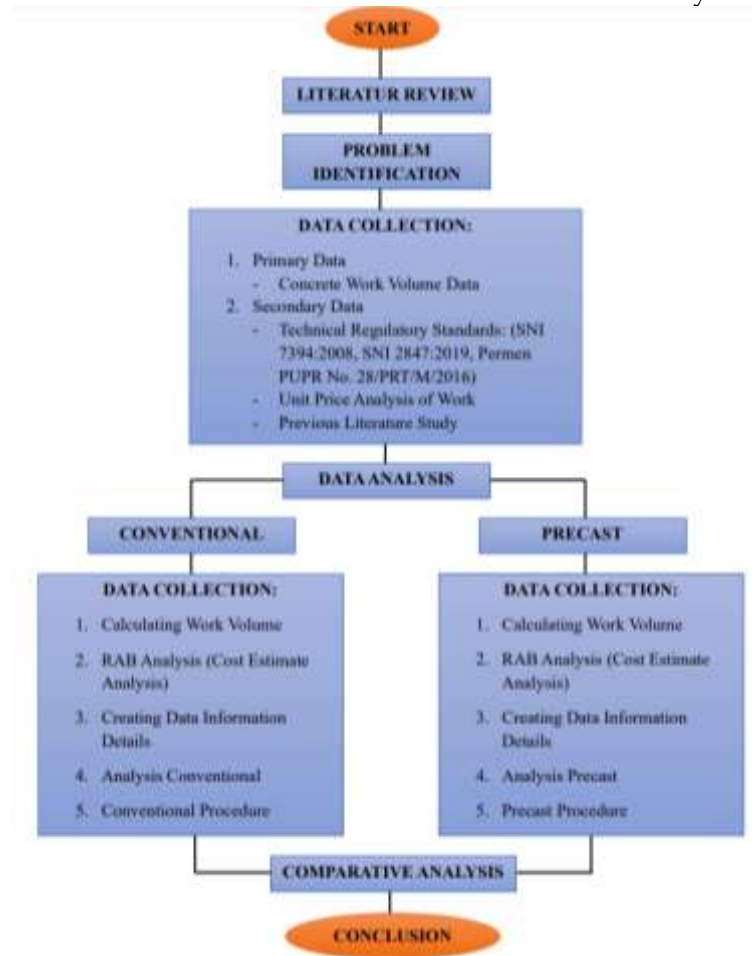


Figure 1. Conceptual Framework

METHODOLOGY

This research uses a comparative quantitative approach, which is an approach that aims to compare two or more variables statistically based on numerical data obtained from the field and project documentation. This type of research focuses on hypothesis testing to determine whether there is a significant difference between two construction methods, namely precast concrete systems and conventional concrete systems, in terms of the total cost of implementing multi-storey building projects.

RESEARCH RESULTS

This research was conducted at the Sartikaasih Bhayangkara Hospital building project, Jl. BKR, Pelindung Hewan Village, Astanaanyar District, Bandung City, West Java Province.

The type of building in this project is a hospital building consisting of two main buildings: Building A1, is a multi-storey building with a total of 9 floors while Building A2, is a multi-storey building with a total of 5 floors. Both buildings are designed to support hospital operations in an integrated manner, with the division of space functions according to the needs of medical and administrative services.

Each building has a different number of floors and building area, as follows:

Table 1. Building Area of Each Floor

A1 Building			A2 Building		
Floor	Area (m ²)	Height (m)	Floor	Area (m ²)	Height (m)
1st floor	1.316	6,2	1st floor	2.100	6,2
2nd floor	1.112	4	2nd floor	2.053	4
3rd floor	1.420	4,8	3rd floor	2.161	4,8
4th floor	1.468	4	4th floor	2.157	4
5th floor	1.399	4	5th floor	168	
6th floor	1.219	4	Total	8.638	19
7th floor	1.220	4			
8th floor	1.238	4			
9th floor	534				
Total	10.926	35			

Building A1 is a building with a total of 9 floors, has a total area of 10,926 m² and a total building height of 35 meters. The most spacious floor is on the fourth floor which is 1,468 m² and the floor with the largest height is the first floor as high as 6.2 meters, which is designed for the lobby or main access function of the hospital.

Meanwhile, Building A2 consists of 5 floors with a total area of 8,638 m² and a total building height of 19 meters. The 6.2 meter-high first floor is designed for activities with high circulation, although the hospital's central access and public services are located in Building A1. The largest floor area is on the third floor, 2,161 m², which is used for large horizontal space requirements such as hospitalization, medical support facilities, and other operational units.

Table 2. BOQ of Precast Concrete

A1 Precast Building BOQ				A2 Precast Building BOQ			
No	Floor		Amount (Rp)	No	Floor		Amount (Rp)
1.	1st floor	Rp.	776.008.611,27	1.	1st floor	Rp.	1.175.481.385,65
2.	2nd floor	Rp.	2.124.857.322,88	2.	2nd floor	Rp.	3.606.535.812,56
3.	3rd floor	Rp.	2.602.262.850,85	3.	3rd floor	Rp.	3.826.329.382,82
4.	4th floor	Rp.	2.437.640.560,16	4.	4th floor	Rp.	3.726.663.996,39
5.	5th floor	Rp.	2.314.527.379,45	5.	5th floor	Rp.	409.216.289,59
6.	6th floor	Rp.	2.100.724.936,56	Total		Rp.	12.744.226.867,01
7.	7th floor	Rp.	2.209.840.345,98				
8.	8th floor	Rp.	2.229.360.454,68				
9.	9th floor	Rp.	810.402.223,30				
Total			Rp. 17.605.624.685,13				

Based on the RAB results, the total construction cost with the precast concrete system is IDR 17.6 billion for Building A1 and IDR 12.74 billion for Building A2. The largest cost component was identified on the 3rd floor in both buildings. The characteristics of the precast system indicate a larger initial investment requirement, along with the demands of fabricating and installing the elements off-site. Nonetheless, this system provides advantages in terms of accelerated implementation time as well as improved quality control of the building structure.

Table 3. RAB of Conventional Concrete

BOQ Building A1 Conventional				BOQ Building A2 Conventional			
No	Floor		Amount (Rp)	No	Floor		Amount (Rp)
1.	1st floor	Rp.	793.826.527,12	1.	1st floor	Rp.	1.196.080.017,79
2.	2nd floor	Rp.	2.412.407.797,08	2.	2nd floor	Rp.	4.093.573.186,71
3.	3rd floor	Rp.	2.961.318.717,20	3.	3rd floor	Rp.	4.351.722.195,59
4.	4th floor	Rp.	2.681.136.925,16	4.	4th floor	Rp.	4.199.501.561,31
5.	5th floor	Rp.	2.638.284.525,89	5.	5th floor	Rp.	454.010.473,49
6.	6th floor	Rp.	2.392.162.910,32	Total		Rp.	14.294.887.434,88
7.	7th floor	Rp.	2.459.239.233,79				
8.	8th floor	Rp.	2.460.576.210,44				
9.	9th floor	Rp.	1.068.318.912,71				
Total			Rp. 19.867.271.759,68				

As for the conventional concrete system, the total construction cost was recorded at Rp 19.86 billion for Building A1 and Rp 14.29 billion for Building A2. As with the precast method, the highest cost also occurred on the 3rd floor in each building. This method is more economical in terms of direct costs, but requires a longer implementation duration and has a high dependency on field activities and unpredictable weather conditions.

Cost Comparison

The following is the data from the construction cost comparison between conventional and precast methods in the Bhayangkara Sartikaasih Bandung Hospital Building construction project.

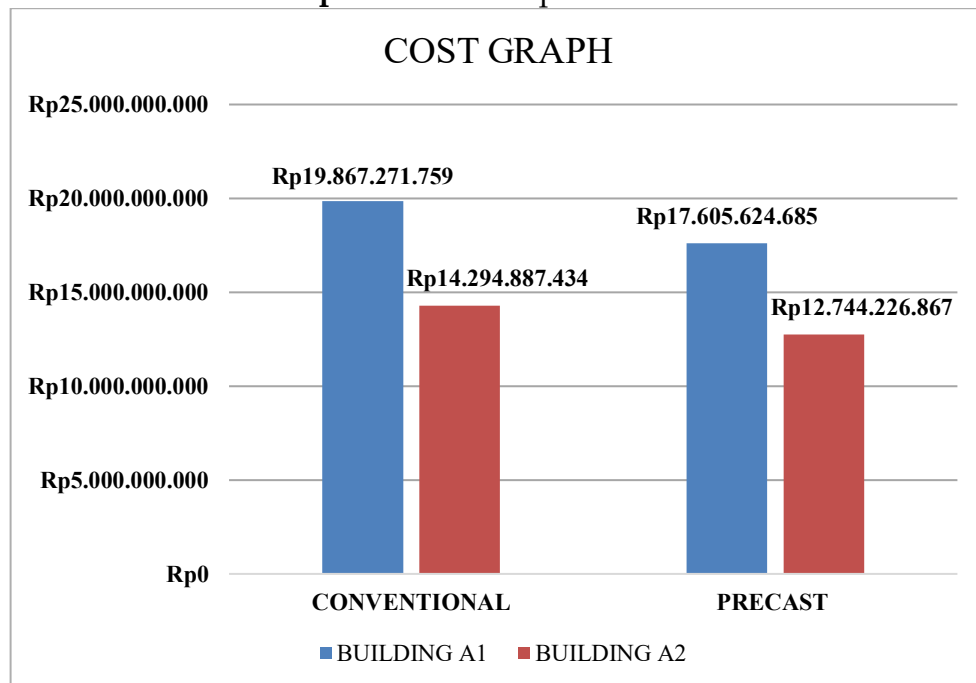
Table 4. Cost Comparison of Concrete Work:

Method	Building A1 (Rp)		Building A2 (Rp)	
Conventional	Rp.	19.867.271.759	Rp.	14.294.887.434
Precast	Rp.	17.605.624.685	Rp.	12.744.226.867

Table 5. Area of Each Building:

Method	Building A1 (m2)	Building A2 (m2)
Conventional	10.926	8.638
Precast		

Graph 1. Cost Comparison Chart



Vertical axis : Total cost (Rp)
Horizontal axis : Building A1 and A2, each with two bars (conventional and precast)

Based on the tables and graphs, it can be concluded that although the precast method has the potential for cost efficiency, overall it shows lower construction costs than the conventional method for both buildings in this project.

Cost Efficiency Analysis

The cost efficiency of the Bhayangkara Sartikaasih Bandung Hospital Building construction project was analyzed based on the cost difference between the conventional and precast methods, both in terms of rupiah value and percentage.

Table 6. Comparison of Cost Efficiency

		Conventional Total Cost		Precast Total Cost		Difference		Percentage (%)	
		(a)		(b)		(c = a - b)		(d = c/b)	
GA1	Rp	19.867.271.759		Rp	17.605.624.685		Rp	2.261.647.074	12,85
GA2	Rp	14.294.887.434		Rp	12.744.226.867		Rp	1.550.660.567	12,17

Based on the RAB calculation, the precast system has a total cost of IDR 17.6 billion (A1) and IDR 12.74 billion (A2), while the conventional system is IDR 19.86 billion (A1) and IDR 14.29 billion (A2). The difference is Rp. 2.26 billion (A1) and Rp. 1.55 billion (A2) respectively, with a percentage difference of 12,85% and 12,17%.

Time Efficiency Analysis

The results of the overall duration analysis of Building A1 and Building A2, in terms of the difference to the percentage obtained as follows:

Table 7. Comparison of Time Efficiency

Overall Duration				
Building	Conventional (days)	Precast (days)	Difference (days)	Percentage (%)
(a)	(b)	(c)	(d = b - c)	(e = d / c)
A1 Building	335	203	132	65,02
Building A2	170	140	30	21,43

In terms of time, precast concrete is shorter at 203 days in Building A1 and 140 days in Building A2, while the duration of implementation in conventional concrete is longer at 335 days in Building A1 and 170 days in Building A2. The time difference obtained from the two systems used, for Building A1 is 132 days faster and Building A2 is 30 days faster, the precast system shows an efficiency of 65.02% (A1) and 21.43% (A2).

From these results, it can be concluded that the precast method is much more efficient in terms of implementation time than the conventional method, especially in Building A1.

Thus, although the precast method is more costly, it provides a great advantage in time efficiency, which can have a positive impact on accelerating building operations and reducing project indirect costs.

DISCUSSION

The results of this study are in line with the findings (Teknik et al., 2024) which concluded that the use of precast concrete systems can accelerate project execution time as well as significantly reduce labor costs. In addition, the study by (Naully et al., 2022) also supports these results, stating that precast systems have major advantages in terms of construction time efficiency.

However, the results of this study are not entirely in line with the study conducted by (Senduk et al., 2022) , which shows that in the flats project, the precast system is indeed more economical in total than the conventional system, except for the floor slab element. This finding indicates that the cost efficiency of using precast systems may vary depending on the type of structural elements used. In particular, beam and column elements tend to be more cost-effective using precast methods.

The analysis results indicate that although the precast concrete system tends to yield lower direct construction costs compared to the conventional concrete method, its primary advantage lies in the efficiency of structural work duration. In the two case study buildings analyzed, the precast system proved to be more economical in nominal cost while also completing the structural works in a significantly shorter time than the conventional method.

Furthermore, the considerable difference in total cost and execution duration between the two construction methods provides a basis to conclude that there is a significant relationship between the construction system used and the total project efficiency. Therefore, based on the results of this analysis, it can be stated that there is a strong basis to receive the alternative hypothesis and reject the null hypothesis. This finding provides important implications in making technical decisions in the selection of construction methods, especially in multi-storey building projects, where cost effectiveness and time efficiency are the main considerations in the successful implementation of the project.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of a cost comparison analysis between precast concrete and conventional concrete systems in two case study buildings, it can be concluded that, in general, the precast system offers advantages in terms of direct construction cost efficiency. The total construction cost using the precast concrete method was recorded at IDR 19.867.271.759,68 for Building A1 and IDR 14.294.887.434,88 for Building A2. Meanwhile, the total construction cost using the conventional method amounted to IDR 17.605.624.685,13 for Building A1 and IDR 12.744.226.867,01 for Building A2.

The cost differences of IDR 2.261.647.074,55 (12,85%) for Building A1 and IDR 1,550,660,567.87 (12.17%) for Building A2 indicate that the precast system is more cost-effective in nominal terms than the conventional system. Although the percentage difference is relatively small for Building A1, the cost savings

achieved in Building A2 are considered quite significant for medium- to large-scale building projects. Therefore, from the perspective of direct construction costs, the precast concrete system can be considered a more economical option.

In terms of the duration of the main structural works, the precast system showed superior performance compared to the conventional system. In Building A1, the implementation of the main structural works using the precast method can be completed in 203 days, while the conventional method takes up to 335 days. For Building A2, the precast system completed the work in 140 days, while the conventional method required 170 days.

Thus, the accelerated execution time obtained from using the precast system was 132 days for Building A1 and 30 days for Building A2. This shows that the precast system has significant advantages in the efficiency of implementation time, which not only has an impact on reducing indirect costs, but is also able to minimize the risk of project delays. This speed of implementation makes the precast system a strategic alternative for projects with tight time constraints or targets to accelerate the construction schedule.

ADVANCED RESEARCH

This research has limitations in the scope of the case study, which is limited to only two buildings, and only focuses on comparing the direct costs of the main structural elements such as columns, beams, and floor plates. In addition, the cost calculation data was obtained through self-estimation due to limited access to real data from the implementing contractor, which may affect the accuracy in representing actual field conditions.

For future research, it is recommended that analysis be conducted with a more diverse project scope, both in terms of building type, geographic location, and project scale. In addition, further research can integrate indirect cost aspects in more detail, including mobilization costs, maintenance costs, and the risk of time delays. A more comprehensive approach such as the use of Building Information Modeling (BIM) or integration with real data from actual project implementation can also improve the accuracy of the analysis results and their implementation in construction practice.

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