ANALYSIS OF CONSTRUCTION COST EFFICIENCY BETWEEN PRECAST METHOD AND CONVENTIONAL METHOD IN BUILDING PROJECT

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ABSTRACT: The objectives of this research are to analyze how much the cost of building efficiency between precast method and conventional method in Samarinda State Islamic Institute Library Building Project and to analyze the pattern of building price efficiency of precast and conventional construction methods in Samarinda State Islamic Institute Library Building Project. This research uses quantitative research method by analyzing two different data, based on method type, where it uses action research method; looking for the difference and efficiency that can be obtained from two calculation results which are done; and aim to find the most effective way. The results of this research are the efficiency of building price between precast method and conventional method in Samarinda State Islamic Institute Library Building Project is IDR. 341,372,815.86 or 7.12% and the biggest efficiency pattern was obtained from structural work of 2nd Floor and 3rd Floor of the building, this is because the first floor only has two major items: works of Tie Beam and Column. The highest efficiency pattern was obtained from the work of the ground beam as much 3.5% and the column beam was 2.08% and the floor plate was 1.58%. The conclusion of this research is that maximum efficiency for structural component was obtained from the dimension of structure component, which has big dimension.

Keywords: Conventional, Cost, Method, Pattern, Precast

1. Introduction

To control a project to be on time, cost-appropriate, and quality-appropriate, it requires a proper method of work or method of execution. The application of technology has played an important role in a construction project (Son, 1999). Generally, the application of this technology is widely applied in the implementation methods of large construction work. The use of appropriate, practical, fast, and secure methods is highly helpful in the completion of work on a construction project (Latour and Woolgar, 2013). The implementation of construction methods, which are suitable with the field conditions, will be very helpful in the completion of construction projects concerned.

Implementation of construction execution methods, besides closely related to the field conditions in which a construction project is done, also depends on the type of project which is being undertaken. (Rao et al., 2007) The method of work execution for buildings is different from the method of irrigation building work, power plant building, dock construction, and road and bridge construction. All stages of building work have an implementation method referred to the design of the planning consultant (Kendall et al., 2008). The aspects that influence the method of building implementation are: Conditions of the project site, Volume of work, surrounding situation of the project site, conditions of access road for materials and equipment, availability of tools, level of quality required, schedule of implementation, availability of construction technology and resources.

The planning of the implementation method will follow the time schedule provided for the work. From the planning of this method, it will obtain the required equipment data, the type and the volume of materials that will be needed, technical and order of work implementation and quality control patterns that should be applied (Pacheco-Torgal et al., 2013). If the available operation time is not sufficient in the execution of the building, then based on the ability of existing resources in the area, a realistic schedule of implementation that has taken into account all possibilities in the implementation of the building is made (Brühwiler, 2012). Buildings are usually constructed by conventional methods where all necessary construction materials are casted at the site of a construction project, for example, concrete for columns and beams casted directly at the project site (Kendall et al., 2011). There are several points of concern in this conventional method which are the long and less clean construction execution time and the cast basic materials which become more expensive and rare leading to the construction price which becomes more expensive (Abbas et al., 2009).

Many skyscraper building construction use precast method meaning that the building structure is not casted in the construction site, such as conventional method, but casted at the factory site/plan or at the site location (below), so that the quality can be maintained well and can be produced massively. In this precast method, after fabrication is done, this precast component will be brought to the construction site/shunted and then arranged into a unit of building construction. The advantages of this precast system are good quality, relatively shorter construction execution time, environmentally friendly, and fewer construction materials to be thrown out of the construction site (Rangan and Joyce, 1992). By using precast method, then much cost can be saved, for example the cost of formwork is cheaper and the overheat cost is more affordable because the time of implementation is faster than conventional, so the precast method becomes more efficient when compared to conventional method. But the efficiency level of each building is different, this depends on the building level (Fava et al., 2003). The higher the level of the building, the more structural components that are used, so that the structure components can be massively produced in which it makes the cost become cheaper and increases cost efficiency (Hancock et al., 2007). In Indonesia, this precast method is well known. The structural components often utilize precast system, such as pile, column, beam, and floor plate. Besides determined by the method, the efficiency of a building is also determined from the price of materials and wages. The price of materials and wages vary by region and it can affect the magnitude of the building efficiency value in the area.

2. Research Methods

This research uses quantitative research method by analyzing two different data, while if it is seen from its method type, it uses action research method; look for the difference and efficiency that can be obtained from two calculation results which are done; and aim to find the method or the most effective way. This method is appropriately used to examine the status of a group of people, the company as the object of research, aiming to create descriptive explication systematically, factually, and accurately about the facts and the relationship between the investigated phenomena (Kwan et al., 2012).

2.1 Calculation of Conventional Concrete Cost Budget Plan

The price-forming component in the calculation of the conventional concrete cost budget plan is divided into two main components: work volume and unit price of work. For calculation of concrete, the unit used is m^3, the calculation of reinforcing steel uses unit of kg, and the calculation of formwork uses unit of m^2. This unit of calculation is adjusted to the unit at the unit price of work taken from the analysis of the work unit price. The Unit Price Calculation of Cost Budget Plan were done by using SNI 7394 analysis year of 2008 and Regulation of Public Works and Housing Minister No.28 of 2016. The unit price of wages and materials which become the basis calculation is got from the unit price of Samarinda City Government in 2015.

After all the calculation of the unit price of the work is calculated in accordance with the applicable analysis, the price is multiplied with the work volume of each appropriate item (Xing et al., 2008).

Table 1 and Table 2 show the example of the calculation of conventional concrete cost budget plan for Tie Beam work.

Table 1 Tie Beam Work Cost Budget Plan

No.	Job description	Volume	Unit	Unit Price (IDR)	Total Price (IDR)
I.	**STRUCTURE WORK 1**				
1	Tie Beam TB1 30x50				
	- K-250 Concrete	47.75	M^3	1,640,746.04	78,349,725.14
	- Threaded reinforcing steel	5292.93	Kg	21,778.38	115,271,606.77
	- Plain reinforcing steel	2624.19	Kg	20,728.38	54,395,275.23
	- Formwork	322.90	kg	182,982.50	58,252,478.88
	Total price				**306,269,086.01**
2	Tie Beam TB2 25x40				
	- K-250 Concrete	13.40	M^3	1,640,746.03	21,985,996.89
	- Threaded reinforcing steel	1285.70	Kg	21,778.37	28,000,400.84
	- Plain reinforcing steel	785.98	Kg	20,728.37	16,292,002.15
	- Formwork	107.20	kg	182,982.50	19,615,724.00
	Total price				**85,894,123.90**

Table 2 Recapitulation of Structure Work Cost Budget Plan Conventional Method

No.	Job description	Total Price (IDR)
I	Structure Work Floor 1	649,984,600.55
II	Structure Work Floor 2	1,501,816,153.11
III	Structure Work Floor 3	1,501,816,153.11
IV	Structure Work Roof Floor 1	738,187,505.91
V	Structure Work Roof Floor 2	379,217,568.86
	Total price	**4,771,021,981.57**

2.2 Calculation of Precast Concrete Cost Budget Plan

To accomplish the calculation of Precast Concrete Structure Work Cost Budget, some things must be considered as follows, the weight of each construction component that will be planned uses a precast system as it is related to the maximum capability of the conveyance or tool for erection, maximum length of construction component that will be planned, calculation of the strength of construction components at the time of elevation, the height of the building that will be done because it is related to the conveyance or the tool used for erection. The structural components are separated into several groups of parts with length and width or modules that are suitable for the need of making the same cast or formwork, so that efficiency can be achieved in formwork making (Okamura and Ouchi, 2003).

2.3 Calculation of Unit Price Analysis

To calculate work unit price of precast concrete structure in library building of Samarinda State Islamic Institute, the Work Unit Price Analysis from SNI no. 7832 year of 2012 is utilized. Table 3 gives the example of how to calculate the unit price by using the analysis of SNI 7832 of 2012 with the price of materials and wages taken from the unit price of Samarinda city government budget year 2015.

Table 3 Production Field Analysis of 10 cm thick for precast concrete K-175

1 M2 of 10 cm thick Production Field for precast concrete K-175: SNI 7832: 2012				
Coefficient	**Unit**	**Description**	**Unit Price (IDR)**	**Total Price (IDR)**
32,600	Kg	PC Cement	1,725.00	56,235.00
0.0543	M^3	Concrete sand	442,750.00	24,035.00
0.0756	M^3	Gravel	511,750.00	38,665.56
0.1650	OH	Workers	100,000.00	16,500.00
0.0280	OH	Craftsman	130,000.00	3,640.00
0.0030	OH	Craftsman head	140,000.00	420.00
0.0080	OH	Foreman	150,000.00	1,2000.00
		Total price		**140,695.56**

2.4 Calculation of Precast Concrete Cost

By using the analysis of work unit price for precast concrete and combined by using the unit price of wages and materials obtained from the price of the Samarinda city government unit of Budget Year 2015 and the precast volume concrete, precast concrete work cost budget plan can be calculated as shown in Table 4.

Table 4 Recapitulation of Structure Work Cost Budget Plan Precast Method

No	**Job description**	**Total Price (IDR)**
I	Structure Work Floor 1	605,075,034.49
II	Structure Work Floor 2	1,383,189,734.85
III	Structure Work Floor 3	1,383,189,734.85
IV	Structure Work Roof Floor 1	706,520,591.76
V	Structure Work Roof Floor 2	351,674,069.77
	Total price	**4,429,649,165.71**

2.5 Comparison of Precast Concrete and Conventional Concrete Cost Budget Plan

Recapitulation of Construction Cost Comparison between Conventional Concrete and Precast Concrete can be seen in Table 5.

Table 5 Recapitulation of Construction Cost Comparison between Conventional Concrete and Precast Concrete

NO	WORK ITEM	TOTAL PRICE (Rp)		RESULTED EFFICIENCY		
		CONVENTIONAL CONCRETE	PRECAST CONCRETE	EFFICIENCYOF COST (Rp)	THD. PEK (%)	THD. KES (%)
I	STRUCTURE WORK OF FLOOR 1	649,984,600.56	605,075,034.49	44,909,566.07	6.91	0.94
II	STRUCTURE WORK OF FLOOR 2	1,501,816,153.12	1,383,189,734.85	118,626,418.27	7.90	2.49
III	STRUCTURE WORK OF FLOOR 3	1,501,816,153.12	1,383,189,734.85	118,626,418.27	7.90	2.49
IV	STRUCTURE WORK OF ROOF FLOOR 1	738,187,505.92	706,520,591.76	31,666,914.16	4.29	0.66
V	STRUCTURE WORK OF ROOF FLOOR 2	379,217,568.86	351,674,069.77	27,543,499.09	7.26	0.58
	TOTAL	4,771,021,981.58	4,429,649,165.71	341,372,815.86		7.16

Table 5 shows that the structure work with precast concrete can save the cost of IDR 341,372,815.86 or as much 7.16 % of the cost of conventional concrete structure.

2.6 Efficiency Pattern of Precast Construction in Library Building of Samarinda State Islamic Institute

The cost efficiency of the precast concrete structure in the library building of Samarinda State Islamic Institute is contributed by three components of the structure with different efficiency patterns. From Table 6, it can be seen that the pattern of efficiency for each component of different structures depends on the dimensions of structure components. For components of beams and Tie Beam, the obtained efficiency will be higher if the beam dimension is bigger and the number of beams becomes more abundant (Institute, 2006). The efficiency of the beam on the overall cost of the work is 0.28 % for the ground floor, 1.23% for floor 2 and floor 3, 0.4% for roof floor 1 and 0.35 for roof floor 2. For structural components, the efficiency gained will be greater if the column dimension is larger and the number of columns becomes more. The efficiency of the column on the overall work cost is 0.66% for floor 1, 0.71% for floor 2 and floor 3, and 0.00 for roof floor 1. For the floor plate components, the efficiency gained will be greater when plate module is more spacious and the number of plates with the same module is more abundant. The efficiency of floor plates and roof plates towards the overall work cost is 0, 54% for floor 2 and floor 3, 0.27% for roof floor 1, and 0.23% for roof floor 2.

Table 6 Comparison of Cost and Efficiency Patterns between Conventional Concrete and Precast Concrete

No	Job Description	Conventional Concrete (Rp)	Precast Concrete (Rp)	Efficiency			Efficiency Pattern of Beam (%)	Efficiency Pattern of Column(%)	Efficiency Pattern of Plate (%)
				Efficiency Total (Rp)	Thd. Pek (%)	Thd. Kes (%)			
I	**STRUCTURE WORK FLOOR 1**								
1	Tie Beam TB1 30x50	306,269,086.02	296,971,908.60	9,297,177.41	3.04	0.19	0.19		
2	Tie Beam TB2 25x40	85,894,123.90	81,607,565.71	4,286,558.19	4.99	0.09	0.09		
3	Kolom K1 45x45	246,232,458.89	215,708,956.51	30,523,502.39	12.40	0.64		0.64	
4	Kolom K2 30x30	11,588,931.75	10,786,603.67	802,328.08	6.92	0.02		0.02	
	TOTAL STRUCTURE WORK FLOOR 1	649,984,600.56	605,075,034.49	44,909,566.07		0.94	0.28	0.66	0.00
II	**STRUCTURE WORK FLOOR 2**								
1	Balok B1 30x60	361,657,111.84	327,876,291.08	33,780,820.77	9.34	0.71	0.71		
2	Balok B2 30x50	187,703,431.49	167,182,668.48	20,520,763.01	10.93	0.43	0.43		
3	Balok B3 25x40	69,683,765.01	62,842,528.54	6,841,236.47	9.82	0.14	0.14		
4	Balok B4 20x30	6,454,074.51	8,864,483.03	-2,410,408.52	-37.35	-0.05	-0.05		
5	Pelat Lantai 12 cm	660,471,422.92	634,629,096.54	25,842,326.39	3.91	0.54			0.54
6	Kolom K1 45x45	207,720,517.60	174,471,165.51	33,249,352.09	16.01	0.70		0.70	
7	Kolom K2 30x30	8,125,829.75	7,323,501.67	802,328.08	9.87	0.02		0.02	
	TOTAL STRUCTURE WORK FLOOR 2	1,601,816,163.12	1,383,189,734.86	118,626,418.27		2.49	1.23	0.71	0.54
III	**STRUCTURE WORK FLOOR 3**								
1	Balok B1 30x60	361,657,111.84	327,876,291.08	33,780,820.77	9.34	0.71	0.71		
2	Balok B2 30x50	187,703,431.49	167,182,668.48	20,520,763.01	10.93	0.43	0.43		
3	Balok B3 25x40	69,683,765.01	62,842,528.54	6,841,236.47	9.82	0.14	0.14		
4	Balok B4 20x30	6,454,074.51	8,864,483.03	-2,410,408.52	-37.35	-0.05	-0.05		
5	Pelat Lantai 12 cm	660,471,422.92	634,629,096.54	25,842,326.39	3.91	0.54			0.54
6	Kolom K1 45x45	207,720,517.60	174,471,165.51	33,249,352.09	16.01	0.70		0.70	
7	Kolom K2 30x30	8,125,829.75	7,323,501.67	802,328.08	9.87	0.02		0.02	
	TOTAL STRUCTURE WORK FLOOR 3	1,601,816,163.12	1,383,189,734.86	118,626,418.27		2.49	1.23	0.71	0.54
IV	**STRUCTURE WORK ROOF FLOOR 1**								
1	Balok B1A 30x60	46,089,541.37	41,036,988.93	5,052,552.44	10.96	0.11	0.11		
2	Balok B2A 30x50	261,512,119.50	251,687,935.26	9,824,184.23	3.76	0.21	0.21		
3	Balok B3A 25x45	49,056,733.47	43,040,623.14	6,016,110.33	12.26	0.13	0.13		
4	Balok B4A 25x40	35,528,611.68	34,765,213.35	763,398.33	2.15	0.02	0.02		
5	Balok B5A 20x30	4,738,596.51	7,316,597.04	-2,578,000.54	-54.40	-0.05	-0.05		
6	Pelat Atap 12 cm (area non Roof Tank)	260,363,829.11	247,163,526.14	13,200,302.97	5.07	0.28			0.28
7	Pelat Atap 12 cm (area Roof Tank)	41,678,042.58	42,234,509.02	-556,466.44	-1.34	-0.01			-0.01
8	Kolom K1 45x45	39,220,031.70	39,275,198.87	-55,167.17	-0.14	0.00		0.00	
	TOTAL STRUCTURE WORK ROOF FLOOR 1	738,187,506.92	706,520,591.76	31,666,914.16		0.66	0.40	0.00	0.27
V	**STRUCTURE WORK ROOF FLOOR 2**								
1	Balok B2A 30x50	144,491,606.16	132,212,875.50	12,278,730.66	8.50	0.26	0.26		
2	Balok B3A 25x45	30,434,569.62	26,394,679.38	4,039,890.24	13.27	0.08	0.08		
3	Balok B4A 25x40	22,773,418.88	22,368,053.56	405,365.32	1.78	0.01	0.01		
4	Pelat Atap 12 cm	181,517,974.21	170,698,461.35	10,819,512.87	5.96	0.23			0.23
	TOTAL STRUCTURE WORK ROOF FLOOR 2	379,217,568.86	351,674,069.77	27,543,499.09		0.58	0.36	0.00	0.23
	GRAND TOTAL	4,771,021,981.58	4,429,649,166.71	341,372,816.38		7.16	3.50	2.08	1.58

3. Results and Discussion

Cost Percentage for each component of the structural work can be seen in Table 7. Beam work is the work that has the largest portion in the order of structural work, then it is followed by the floor plate work, column work, and Tie Beam work. The structural component that has the biggest work cost will have an enormous impact on the overall cost efficiency. The efficiency values of Tie Beam Type TB1 and TB2 work towards the overall cost of structural work are 0.19% and 0.09% or in other words, it can save the cost of IDR 13,583,736.60. When it is compared to other structural elements, Tie Beam's work efficiency is not very large in value. This is due to the calculation of formwork which has two sides Tie Beam closed formwork. The efficiency of structural work with precast method is usually obtained from the use of repeatable formwork, so that Tie Beam work is not so maximal as well as caused by the volume of work that is not large when compared to the second ground beams and third ground beams.

Table 7 Cost Percentage of Structural Work towards Overall Cost of Structure

No.	Work item	Conventional Concrete	Precast Concrete
1	Tie Beam Work	8.22%	8.54%
2	Column Work	15.27%	14.20%
3	Beam Work	38.68%	38.20%
4	Floor Plate Work	37.82%	39.04%
	Total	**100%**	**100%**

The highest efficiency value for each work component is obtained from work item of Column Floor 2 and Column Floor 3 with efficiency value of 16.01%. It is caused by the cost of formwork on conventional concrete column calculations, which is very large and has four sides that must cover with formwork. The calculation of formwork precast concrete cost is done by only calculating three sides. When compared to the overall efficiency value work of Column Floor 2 and Column Floor 3, it only has an efficiency value of 0.7% or is ranked second in the overall efficiency of structural work which only contributes 2.08% efficiency. This is because the volume of column work is not too large, so that it influences less on the overall efficiency of the cost of structural work. The work efficiency of the column will give a significant influence if the volume amount of column work is quite large as in the work of building Flats or Hotels with dense column modules. In this library building, the building column modules are made loose for the movement freedom of library visitors.

The highest percentage of efficiency for the overall work is got from beam work. This is due to the cost of beam work which is the highest cost work in structural work or about 38.68%. Overall efficiency in beam work is 3.5% or about 48.88% of overall efficiency total which is 7.16%. This shows that the beam work greatly affects the overall cost of structural work. From the calculation of beam efficiency, it also obtained the result of efficiency that has a negative value (inefficient). It is caused by the beam work item having a negative value has a small dimension, so that it is inefficient because in the analysis of the unit cost of the beam work, the elevation and casting are also counted that do not depend on the amount of the concrete volume, but it depends on the number of structural component units. The calculation example of B5A type 1 on Roof Floor 1 amounting 7 members is presented in Table 8.

Table 8 Precast Beam Unit of B5A Type 1

Coefficient	Unit	Description	Unit Price (IDR)	Total Price (IDR)
0.0414	M^3	K-250 Concrete	1,375,000.00	56,925.00
1.0000	Unit	Cost of Concrete Pour	72,060.00	72,060.00
134719	Kg	Threaded steel	21,778.38	293,395.15
56595	Kg	Plain steel	20,728.38	117,311.62
0.4140	M^2	Formwork	43,519.05	18,016.89
1.0000	Unit	Install + Open Formwork	13,550.00	13,550.00
1.0000	Unit	Concrete Unloading ± 20m	105,804.50	105,804.50
1.0000	Unit	Erection	368.165,00	368.165,00
				1,045,228.15

Source: calculation results

Beam type B5A is a concrete beam that has dimensions 20cmx30cm (beam with small dimensions). From the calculation example of unit price analysis in the table above, it can be seen that the costs incurred on the work per unit of the beam consists of several components with unit of unit, so it is very influential on the beam of small dimension. It can also be seen that the beam erection is the biggest cost of B5A beam price-forming, even greater than the main works which are concrete work, formwork, and reinforced steel. From this data, it can be concluded that if it will perform the efficiency of the work with precast concrete method, it must be ascertained that the beam dimension of the structure must be at least greater than 20cmx30cm. Ground plates have the second highest cost portion or as much 37.82% which is IDR 1,804,505,691.75. But in the efficiency of precast concrete work on conventional concrete, ground plate work is in the final order in the cost efficiency of the whole work. The total plate efficiency is 1.58%. Special for the work of this plate, the plate formwork is done to obtain the results of flat plate ground surface because it has a wide plate span. Unlike the beam that only counts the beam wall, the lower part of the beam uses the work ground as the base of the formwork of the beam. It is same as the column; formwork columns are only counted two sides of the column, so that it can save the use of formwork column.

4. Conclusion

From the results of research, it can be concluded that the building efficiency price between precast method and conventional method in Library Building Project of Samarinda State Islamic Institute is IDR 341,372,815.86 or as much 7.12%, the biggest efficiency pattern was obtained from the Structural Work of Floor 2 and Floor 3, this is because the first floor only has two main items: works of Tie Beam and Column. The highest efficiency pattern was obtained from the work of the ground beam as much 3.5% and the column beam was 2.08% and the last ground plate was 1.58%, from the calculation data result, the maximum efficiency for structural components is from the dimensions of the structural components having large dimensions. The larger the dimensions of structural components, the more efficient it is; in contrast, the smaller the dimensions of the structure components, the more inefficient it is.

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