COMPARISON OF COST AND TIME OF FLOOR SLAB WORKS ON CONVENTIONAL AND BUBBLE DECK SLAB METHODS

(Case Research Of Central Control Building, Muara Tawar Power Plant Project, Bekasi, West Java)

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ABSTRACT

Floor slab is one of the most important structure members in a building and one of the largest members consuming concrete. Conventional floor slab has been used for years and has disadvantages that can be improved with alternate methods. There is lot of alternative methods that have been used in the construction world such as precast slab, half precast, hollow core slab, and many more. One of the alternative methods is bubble deck slab. The spherical hollow reinforced concrete slab has been patented named Bubble Deck Slab is a method that removes concrete from the center part of a slab which doesn't do any structure functional, so it can reduce the dead load significantly. High-density polyethylene hollow sphere is used to replace the ineffective part of the slab, so it reduces the dead load and increases efficiency. With the HDPE ball substitution, there will be differences in cost and time compared to the conventional method. This research is taking the case research in Central Control Building of Power Plant Muara Tawar Project with quantitative method approach. The analysis is calculating the budget plan and scheduling with Microsoft Project. After the analysis, there is differences in cost and time between the methods. The bubble deck slab method has the advantages which have the cheaper cost of IDR. 142,128,506.44 or 14,442% and 1 day or 3,846% faster compared to the conventional. Even so, the conventional method is still the first choice because the very common methods in Indonesia and the ease of execution.

***Keywords**: Floor Slab, Bubble Deck Slab, Cost Comparison, Time Comparison*

INTRODUCTION

The development of construction projects in Indonesia continues to increase accompanied by the use of the latest innovations as a substitute for the old bad ways in order to provide the best construction results and provide more benefits. In planning a construction project, the choice of work method is crucial because it can have an impact on many things including the cost and time of implementing a construction project.

Floor slabs are very important structural members in buildings and one of the largest consuming concrete components. Conventional concrete slabs have been used for many years and have some drawbacks that can be improved using alternative methods (W. Jigme and S. Q. Adenan, 2017). Many alternative methods have been used in the construction world such as precast plates, half precast plates, hollow core slabs, and many more. Another alternative method is bubble deck slab. The patented spherical hollow reinforced concrete slab called Bubble Deck Slab is a method that removes concrete from the center of a floor slab, which does not perform any structural function, thereby significantly reducing dead loads. High-density polyethylene (HDPE hollow spheres) are used to replace ineffective concrete in the center of the slab, thereby reducing dead loads and increasing efficiency (N. Fatma and V. Chandrakar, 2018).

By replacing the concrete in the center of the floor slab with a hollow polyethylene ball, there will be a difference in price compared to the use of conventional slabs. In addition, there will be differences in methods and work steps between conventional and Bubble Deck which will also affect the duration of work of each method.

The aim of this research is:

1. Analyzing the comparison of the cost of floor slab work with conventional methods and bubble deck slabs.
2. Analyzing the comparison of floor slab work time with conventional methods and bubble deck slabs.

In the process, this research has several limitations, namely as follows:

1. Calculations are only carried out on conventional floor slabs and bubble decks carried out on the Central Control Building floors 1 – 4 floors of the Muara Tawar POWER PLANT project
2. Analysis of the bubble deck using high-density polyethylene (HDPE hollow spheres)
3. Calculations are carried out on the same plate thickness and do not include structural analysis
4. Research work using Microsoft Office, Microsoft Project, AutoCAD, and Sketchup programs.

Precast concrete (precast) is a collection of precast elements which form a 3-dimensional framework that is able to withstand gravity and wind loads (or even earthquake loads) when combined together. Precast concrete is ideally suited for buildings such as offices, retail units, parking buildings, schools, stadiums and other buildings that require minimal internal obstruction and multifunctional rental space. The amount of concrete in the precast frame is less than 4% of the gross volume of a building, and two-thirds of it is on the floor slab (K. S. Elliott, 2017).

Floor slabs that use the conventional method are floor slabs whose entire work is carried out at the project site starting from formwork work, installation of reinforcement to casting. The conventional floor slab working method requires scaffolding or scaffolding that is used as a temporary structure to support the construction materials and people on it during the construction stage until the casting is complete and the concrete has hardened, thus requiring relatively longer material costs and additional time (A. Budiawan, 2018).

Biaxial hollow slab is a reinforced concrete slab that has voids that can reduce the volume of concrete. The discovery of the first hollow plate that is in the 1950s. There are several variations of the type of hollow plate system that already exist from around the world, namely as follows (A. Churakov, 2014):

1. Airdeck. The concept of the Airdeck was first patented in 2003 and consists of a plastic injection element that vibrates on the bottom plate in the production process with a robotic arm. The advantage of this system is that there is no need for a retaining net to hold the cavity elements during the second layer pouring at the field site. Static calculations were carried out according to the standard norms of Eurocode 2.
2. Cobiax. The Cobiax system uses the hollow slab principle which drills holes in the concrete slab to lighten the structure of the building. The hollow plastic parts used are elliptical and torus-shaped, as cavity-forming, held in place with a lightweight metal net to facilitate installation of the upper and lower reinforcement on the concrete slab.
3. U-Boot. In 2001 an Italian engineer, Roberto Il Grande, created and patented a new system of hollow plates, to reduce transportation costs (and carbon dioxide production). The U-Boot is a modular element made from recycled plastic for use in building lighter cast-in-place concrete structures. The first project to use U-Boot was in 2002 and since then it has been used all over the world. The U-Boot system can be combined with other technologies such as pre-fabricated plates or pre-stressed iron.
4. Bubble Decks. In the mid-1990s, a new system was discovered in Denmark. A technology called Bubble Deck invented by Jorgen Breuning, holds the ball between the mesh reinforcement at the top and bottom, thus creating a natural cell structure that acts as a solid plate. For the first time biaxial hollow slabs are made with the same capabilities as solid slabs, but still with reduced weight due to reduced concrete material. The design of this plate type is based on the Euro and British Codes.

At the same amount of concrete and steel reinforcement, bubble decks have 40% greater span and are 15% cheaper. With the same span, the use of bubble deck concrete is 33% less than solid slabs and thus can reduce costs by up to 30% (R. R. Vakil and M. M.

Nilesh,2017). In another research, it was explained that the use of bubble deck slabs in construction projects did not experience an extreme decline in prices. The decline in prices that occurred sektiar 6% to 20% (W. Jigme and S. Q. Adenan, 2017). There are 3 versions or types of bubble deck slabs, namely reinforcement modules, filigree elements, and finished planks [7].

1. Reinforcement Modules. The bubble deck slab version of the reinforcement modules consists of a prefabricated bubble deck slab where the plastic balls are well positioned between the reinforcing bars, as shown in Figure 1. These components are then transported to the field, laid on conventional scaffolding joined with additional reinforcement before being concreted using conventional method. The advantage of this type is that it is suitable for small construction areas because the components can be stacked in the field before installation (M. S. and N. S, 2017).

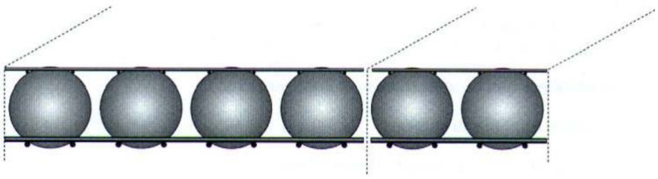


Figure 1. Reinforcement Modules *(*M. S. and N. S, 2017)

2. Filigree Components. Filigree components are a combination of precast and in-situ construction, where the 60mm thick undercoat is pre-cast and transported to the field with plastic balls and steel reinforcement not installed. Then the elements are cast in place, as shown in Figure 2. For the casting of plastic balls on a layer of concrete, temporary reinforcement is used to hold the plastic balls together. This type may require additional iron depending on the design of the building. This type is suitable for new constructions, where the designer has the flexibility to place plastic balls and reinforcing steel. This type is best used for plates that have openings such as openings for stairs [7].

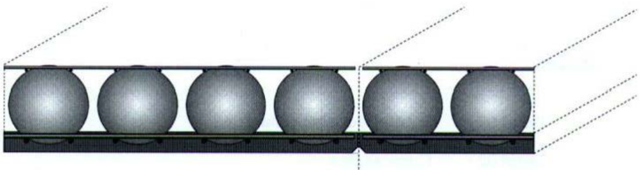


Figure 2. Filigree Components *(*M. S. and N. S, 2017)

3. Finished Plank. Finished plank is a type where all the metrial has been fabricated as its finished form by the manufacturer. Then the final product is transported to the field, as shown in Figure 3. However, this type has a disadvantage compared to the other types because it requires support beams or bearing walls. This type of bubble deck slab is suitable for short spans and fast construction (M. S. and N. S, 2017).

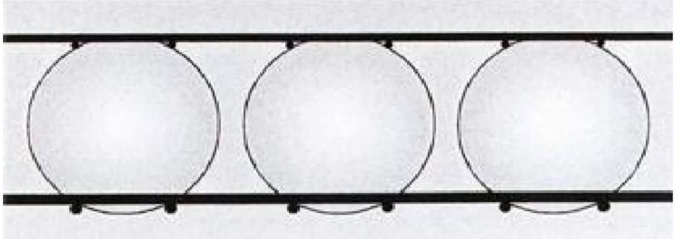


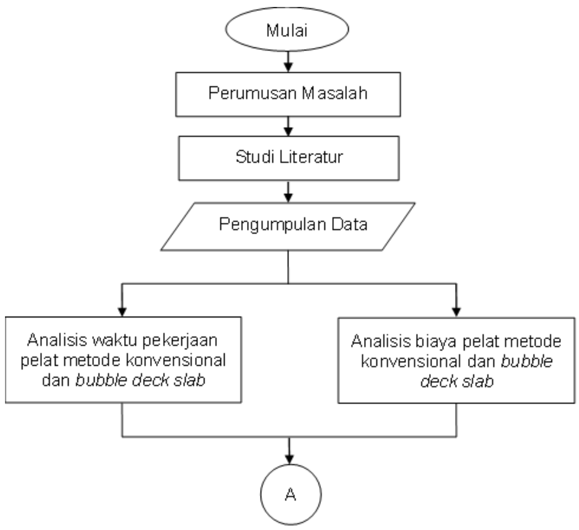
Figure 3. Finished Plank *(*M. S. and N. S, 2017)

METHODS

This research is using a research method approach in the form of quantitative research methods. This is because the research carried out uses various data in the form of numbers and the analysis to be carried out is quantitative. In addition, this research has a research approach in the form of a deductive approach because this research uses processed concrete data which is then drawn conclusions.

The initial stage of this research begins with determining the problems to be discussed. The formulation of the problem was obtained through the findings of a number of previous studies on the internet. After getting the problems that will be raised into research, a literature research is carried out to find theoretical foundations that can support the problems to be raised.

The data collected for conducting research is divided into two types of data, namely primary data and secondary data. After the data is collected, it can be continued with an analysis based on the background and objectives that have been determined at the beginning of the writing stage. After the analysis is carried out on the two plate methods that will be discussed, conclusions will be obtained which are the answers to the formulation of this research problem.



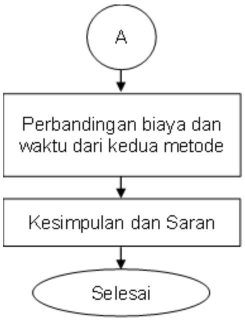


Figure 4. Research Flowchart

The main source of data obtained to conduct this research was obtained from the Muara Tawar Development Unit which is a Steam Gas Power Plant and is managed by PT. Pembangkitan Jawa-Bali which is located on Jl. Muara Tawar No.1, Segarjaya, Tarumajaya District, Bekasi, West Java. The building that is the case research in this research is the Central Control Building which consists of 4 floors.

The Muara Tawar Power Plant Unit is a Steam Gas Power Plant consisting of 5 blocks. Block 1 and Block 5 are blocks that work in a combined cycle while Blocks 2, Block 3, and Block 4 are currently still working in an open cycle which are in the additional stage for the construction of HRSG (Heat Recovery Steam Generator) and steam turbine.

Figure 5. Site Plan Muara Tawar Power Plant

RESULTS AND DISCUSSION

This research has a discussion about the comparison of costs and time on floor slab work with conventional methods and bubble deck slab methods. The object used as research material is the Central Control Building on the Muara Tawar Power Plant project. The Central Control Building has 4 floors and has a floor slab area of 1700.23 m2. The plate with the conventional method is used in the Central Control Building as a case research of this research which will then be compared to the cost and time difference if the conventional plate is replaced by using a bubble deck slab at the same thickness of the plate, which is 150 mm.

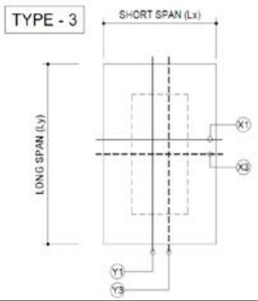
Figure 6. Image of the Central Control Building

In the Central Control Building of the Muara Tawar Power Plant project, the floor plates used have the following technical specifications:

1. Concrete Compressive Strength (f'c): 30 MPa
2. Concrete Elasticity Modulus (Ec) : 25,743 MPa
3. Concrete Density (wc): 24.0 KN/m3
4. Reinforcement Melting Strength (fy): 420 MPa
5. Modulus of Reinforcement Elasticity (Es): 200,000 MPa.

In the floor slab design there are several types that are distinguished on each floor. What distinguishes it from one type to another is the length of the span on the floor slab. This affects the reinforcement of the floor slab as can be seen below.

Table 1. Conventional floor slab reinforcement design



Tipe	Tebal	Bentang		Bentang Pendek (L_x)		Bentang Panjang (L_y)	
		Panjang	Pendek	X1	X3	Y1	Y3
1S1	150 mm	10,5 m	3 m	D13 @ 150	D13 @ 150	D10 @ 200	D10 @ 200
1S2	150 mm	6 m	3.5 m	D13 @ 200	D13 @ 200	D10 @ 200	D10 @ 200
1S3	150 mm	3,7 m	2 m	D10 @ 200	D10 @ 200	D10 @ 200	D10 @ 200
2S1	150 mm	10,5 m	3 m	D13 @ 150	D13 @ 150	D10 @ 200	D10 @ 200
2S2	150 mm	6	3,5 m	D13 @ 200	D13 @ 200	D10 @ 200	D10 @ 200
RS1	150 mm	10,5 m	3 m	D13 @ 200	D13 @ 200	D10 @ 200	D10 @ 200
RS2	150 mm	6 m	3,5 m	D10 @ 200	D10 @ 200	D10 @ 200	D10 @ 200
PRS1	150 mm	10,5 m	3 m	D10 @ 200	D10 @ 200	D10 @ 200	D10 @ 200
PRS2	150 mm	6 m	3,5 m	D10 @ 200	D10 @ 200	D10 @ 200	D10 @ 200

In the Bubble Deck method, the specifications of concrete and reinforcement used are the same as those used in conventional slabs. The specifications are as follows:

1. Concrete Compressive Strength (f'c): 30 MPa
2. Concrete Elasticity Modulus (Ec) : 25,743 MPa
3. Concrete Density (wc): 24.0 KN/m3
4. Reinforcement Melting Strength (fy): 420 MPa
5. Modulus of Reinforcement Elasticity (Es): 200,000 MPa.

In the previous journal, three plates with the same thickness were tested, namely 150 mm thick. One of them is a conventional slab and the other two are bubble deck slab slabs that use 90mm and 120mm diameter balls. From the results of his research, it was found that the conventional plate has a maximum compressive force of 424 KN with a deflection of 12.26 mm. While the bubble deck slab plate with a 90 mm ball obtained a maximum compressive force of 350 KN with a deflection of 12.65 mm while with a 120 mm ball it has a maximum compressive force of 398.2 KN and has a deflection of 13.3 mm. On the other hand, the bubble deck slab has a weight reduction of 10.55% and 17%, respectively (M. S. Mushfiq, et al, 2017). The results of this research can be seen in Figure 7 below, where BD1 is a bubble deck slab plate with a ball diameter of 90 mm while BD2 is a bubble deck slab plate with a ball diameter of 120 mm.

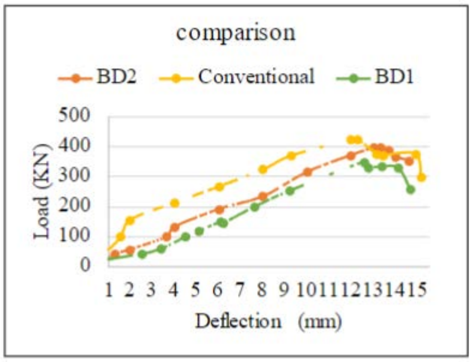


Figure 7. Comparison graph of load and deflection

Based on the results of the research above, this research will use a plate thickness of 150 mm and HDPE balls with a diameter of 120 mm which are known to have different compressive strengths that are not significantly different from conventional plates which have a difference of 6.08% smaller and have the deflection is 8.48% greater than that of the conventional slab. So that the design of the bubble deck slab plate is obtained as shown in Figure 8 below.

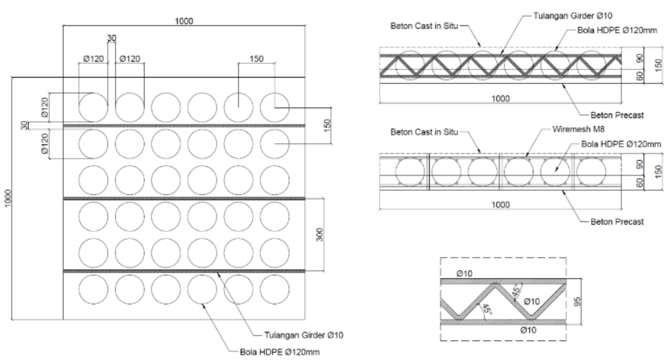


Figure 8. Bubble deck slab detail

Steel reinforcement is used as additional shear reinforcement in the bubble deck slab. The girder reinforcement used must have an angle not greater than 45˚ and have a maximum axle-to-axle distance of twice the plate thickness (BubbleDeck United Kingdom, 2008). Therefore, the properties used on the bubble deck slab are as follows:

1. Plate Thickness : 150 mm (60 mm precast, 90 mm
2. cast in situ)
3. Size of 1 Panel: 1 × 1 meter
4. Top Reinforcement: Wiremesh M8
5. Bottom Reinforcement: Wiremesh M8
6. Girder Reinforcement : 10 @ 300

Cost Analysis
Quantity Analysis

Before calculating the cost, it is necessary to know the volume of work. The calculation of the volume of work is carried out with an auxiliary program, namely Sketchup, where the building model is made into 3D then the volume of work will be obtained. After modeling in Sketchup, the volume of work will be obtained which then needs to be reprocessed so that the resulting data can be calculated further. The following is a recapitulation of the volume of work on a conventional method plate.

Table 2. Conventional method slab work volume recapitulation

Job Description	Quantity
Scaffolding installation works	1700,23 m^2
Formwork works	850115 m^2
Casting concrete works	254376 m^3
Reinforced bar works	35576,2 kg

Table 3. Recapitulation of the work volume of the bubble deck slab method

Job Description	Quantity
Concrete fabrication works	
Formwork	1114,14 m^2
Casting concrete	98,43 m^3
HDPE balls	9161 pcs
Wiremesh M8	12141,90 kg
Reinforced bar	6709,42 kg
Scaffolding installation works	1700,23 m^2
Bubble Deck installation works	249 pcs
Casting concrete	147,65 m^3

Unit Price Analysis

The prices of materials and wages are obtained from project data and the 2015 West Java Unit Price Journal Book. The following is a recapitulation of the unit prices of materials and wages that have been processed into a single unit in Table 4 below. The prices for HDPE balls are obtained from the alibaba.com site. The use of HDPE ball prices allows for additional costs such as tax fees due to imports from abroad and also exchange rates that can change at any time. However, this is ignored in the calculations of this research, so the price used is IDR 5,076.90 as of December 2021 (Alibaba, 2021).

Table 4. Unit price analysis recapitulation

Unit	Prices
Wages (daily)	
Labor	IDR. 62000
Stone labor	IDR. 76000
Head stone labor	IDR. 90000
Wood labor	IDR. 78000
Head wood labor	IDR. 92000
Reinforced labor	IDR. 78000
Head reinforced labor	IDR. 92000
Foreman	IDR. 105000
Heavy equipment operator	IDR. 109000
Operator helper	IDR. 62000
Materials	
Concrete casting (m^3)	IDR. 65000
Reinforced bar (kg)	IDR. 1300
Formwork (m^2)	IDR. 225000
Scaffolding (m^2)	IDR. 15000
Wire (kg)	IDR. 20000
HDPE balls (pcs)	IDR. 5076
Wiremesh M8 (kg)	IDR. 10800
Solar fuel (ltr)	IDR. 6500
Equipment (daily rent)	
Ready mix pump	IDR. 200000
Vibrator	IDR. 125000
Tower crane 35 tons	IDR. 2600000

Budget Plan

The calculation of Budget Plan is obtained from the volume of work multiplied by the AHSP. The calculation of the analysis of the unit price of work (AHSP) in this research refers to the Regulation of the Minister of PUPR Number 28/PRT/M/2016 with the assumption of overhead and profit of 15%. After the value of the volume of work and also the AHSP has been obtained, then after that a new budget can be obtained. The following is a recapitulation of the conventional method slab RAB and bubble deck slab.

Table 5. Conventional method Budget Plan recapitulation

Job Description	Prices
Scaffolding installation works	IDR. 74730209
Formwork works	IDR. 242667877
Casting concrete works	IDR. 43786937
Reinforced bar works	IDR. 623058442
Total	IDR. 984243466

Tabel 6 Bubble deck slab method Budget Plan recapitulation

Job Description	Prices
Concrete fabrication works	
Formwork	IDR. 318034605
Casting concrete	IDR. 18117686
HDPE balls	IDR. 46509480
Wiremesh M8	IDR. 164779515
Reinforced bar	IDR. 117504444
Scaffolding installation works	IDR. 74730209
Bubble Deck installation works	IDR. 77012916
Casting concrete	IDR. 25416101
Total	IDR. 842104960

Time Analysis

Productivity Analysis

The calculation of productivity is obtained from the AHSP coefficient number obtained from the Minister of PUPR Regulation Number 28/PRT/M/2016. For example, the calculation of the coefficient of workers and craftsmen of 1 kg iron with plain or screw iron is 0.07 OH and for the head of the craftsman it is 0.007 OH (Direktorat Jendral Bina Marga, 2016). Then the working hours in a day are assumed to be 7 hours per day, so it is obtained as follows:

$$Productivity = \frac{1}{coef \ \times work\ hours} = \frac{1}{0{,}007\ \times 7}$$
$$= 20{,}408\ kg/hr$$

Then it is obtained for the productivity of the head of the iron workman, which is 20,408 kg/hour and for workers and builders, it is 2,041 kg/hour. In the calculation, in 1 worker group there is 1 worker, 1 blacksmith and 1 head blacksmith, so the total productivity obtained is 24,490 kg/hour.

For the productivity of concrete casting using a concrete pump, it was obtained from interviews with the Muara Tawar POWER PLANT project staff, namely to cast floor slabs with a volume of 136 m3 it takes 5 hours of casting time in 1 working day where the assumption of working hours per day is 7 hours. Then the productivity of casting with a concrete pump is obtained as follows:

$$Productivity \ = \frac{136}{5\ \times 7}$$
$$= 3{,}886\ m^3/hr$$

So the productivity of concrete casting per 1 m3 using a concrete pump is 3.886 m3/hour. For the rest, the productivity of other jobs is calculated in the same way using the coefficient value of the AHSP as described above. In the bubble deck slab method there is work that does not exist in the conventional method, namely the installation of HDPE balls when fabricating bubble deck concrete slabs. The productivity of installing HDPE balls is assumed to be 500 pieces/hour. The following is a recapitulation of the calculation of the productivity of each job.

Table 7. Productivity recapitulation of conventional methods

Job Description	Productivity per hour
Scaffolding installation works	16429 m^2
Formwork works	16429 m^2
Casting concrete works	24490 kg
Reinforced bar works	3886 m^3

Table 8. Productivity recapitulation of the bubble deck slab method

Job Description	Productivity per hour
Concrete fabrication works	
Formwork	16429 m^2
Casting concrete	6429 m^3
HDPE balls	500000 pcs
Wiremesh M8	114286 kg
Reinforced bar	24490 kg
Scaffolding installation works	16429 m^2
Bubble Deck installation works	2132 pcs
Casting concrete	3886 m^3

Works Duration Analysis

The duration of work is calculated by multiplying productivity by the number of workers then multiplied by the volume of work. In the field data of the Muara Tawar Power Plant project, on the floor slab work there are 20 workers, the productivity obtained will be multiplied by the number of workers used. The following is a recapitulation table for calculating the duration of work per floor.

Table 9. Conventional method duration recapitulation

Job Description	# Labor	Duration
Ground, 1st, 2nd, and Roof Floor		
Reinforced bar	20	3 days
Concrete Pouring	1	3 days
PH floor		
Scaffolding installation	3	1 day
Formwork work	3	1 day
Reinforced bar	20	1 day
Concrete Pouring	1	1 day

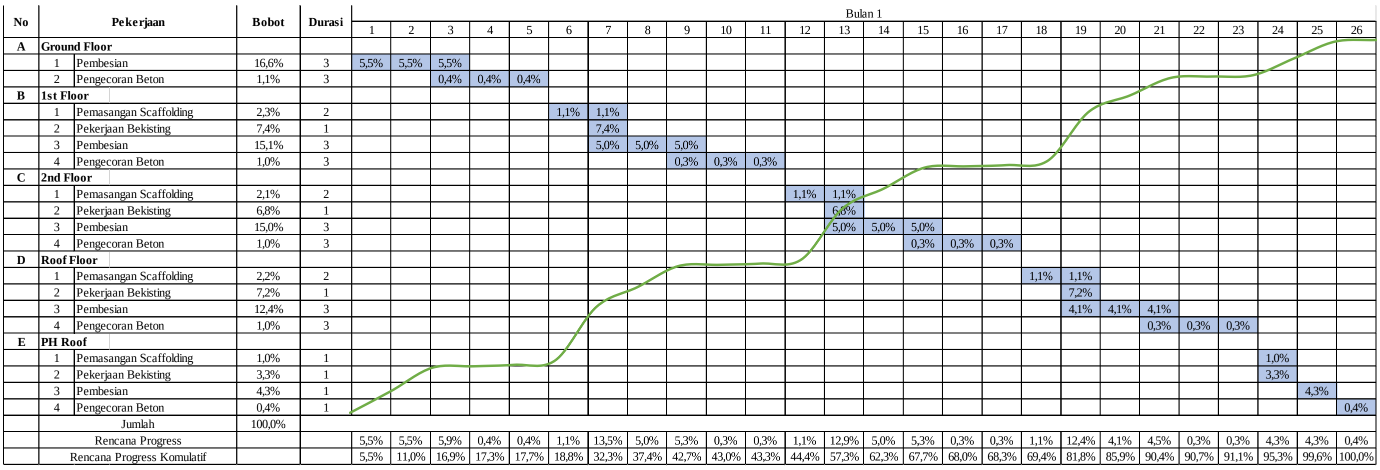
Table 10. Recapitulation of the duration of the bubble deck slab method

Job Description	# Labor	Duration
Ground, 1st, 2nd, and Roof Floor		
Concrete fabrication works		
Formwork	2	2
Casting concrete	5	2
HDPE balls	1	1
Wiremesh M8	2	2
Reinforced bar	1	1
Scaffolding installation works	3	2
Bubble Deck installation works	2	2
Casting concrete	1	2
PH floor		
Concrete fabrication works		
Formwork	2	1
Casting concrete	5	2
HDPE balls	1	1
Wiremesh M8	2	1
Reinforced bar	1	1
Scaffolding installation works	3	1
Bubble Deck installation works	2	1
Casting concrete	1	1

Schedulling

After getting the duration, the next step is scheduling. Scheduling is done by using an auxiliary program, namely Microsoft Project for making a bar chart, then a network diagram will be obtained from the output of the Microsoft Project program and followed by making an S curve using the Microsoft Excel program.

The work is carried out per floor without using zoning because the building area is not too large. The work scenario starts with the installation of scaffolding and then continues with the installation of formwork. After the formwork has reached 50%, the fabrication of reinforcement can be carried out in the finished formwork area, therefore the formwork and ironwork can be completed on the same day. After the reinforcement work is complete, the concrete casting can be carried out. The work scenario will be carried out until the work is completed. The following is the S curve of the conventional plate scheduling method.



No		Pekerjaan	Bobot	Durasi	Bulan 1												
					1	2	3	4	5	6	7	8	9	10	11	12	13
A		Ground Floor															
	1	Pembesian	16,6%	3	5,5%	5,5%	5,5%										
	2	Pengecoran Beton	1,1%	3			0,4%	0,4%	0,4%								
B		1st Floor															
	1	Pemasangan Scaffolding	2,3%	2						1,1%	1,1%						
	2	Pekerjaan Bekisting	7,4%	1							7,4%						
	3	Pembesian	15,1%	3							5,0%	5,0%	5,0%				
	4	Pengecoran Beton	1,0%	3									0,3%	0,3%	0,3%		
C		2nd Floor															
	1	Pemasangan Scaffolding	2,1%	2												1,1%	1,1%
	2	Pekerjaan Bekisting	6,8%	1													6,8%
	3	Pembesian	15,0%	3													5,0%
	4	Pengecoran Beton	1,0%	3													
D		Roof Floor															
	1	Pemasangan Scaffolding	2,2%	2													
	2	Pekerjaan Bekisting	7,2%	1													
	3	Pembesian	12,4%	3													
	4	Pengecoran Beton	1,0%	3													
E		PH Roof															
	1	Pemasangan Scaffolding	1,0%	1													
	2	Pekerjaan Bekisting	3,3%	1													
	3	Pembesian	4,3%	1													
	4	Pengecoran Beton	0,4%	1													
		Jumlah	100,0%														
		Rencana Progress			5,5%	5,5%	5,9%	0,4%	0,4%	1,1%	13,5%	5,0%	5,3%	0,3%	0,3%	1,1%	12,9%
		Rencana Progress Komulatif			5,5%	11,0%	16,9%	17,3%	17,7%	18,8%	32,3%	37,4%	42,7%	43,0%	43,3%	44,4%	57,3%

No		Pekerjaan	14	15	16	17	18	19	20	21	22	23	24	25	26
A		Ground Floor													
	1	Pembesian													
	2	Pengecoran Beton													
B		1st Floor													
	1	Pemasangan Scaffolding													
	2	Pekerjaan Bekisting													
	3	Pembesian													
	4	Pengecoran Beton													
C		2nd Floor													
	1	Pemasangan Scaffolding													
	2	Pekerjaan Bekisting													
	3	Pembesian	5,0%	5,0%											
	4	Pengecoran Beton		0,3%	0,3%	0,3%									
D		Roof Floor													
	1	Pemasangan Scaffolding					1,1%	1,1%							
	2	Pekerjaan Bekisting						7,2%							
	3	Pembesian						4,1%	4,1%	4,1%					
	4	Pengecoran Beton								0,3%	0,3%	0,3%			
E		PH Roof													
	1	Pemasangan Scaffolding											1,0%		
	2	Pekerjaan Bekisting											3,3%		
	3	Pembesian												4,3%	
	4	Pengecoran Beton													0,4%
		Jumlah													
		Rencana Progress	5,0%	5,3%	0,3%	0,3%	1,1%	12,4%	4,1%	4,5%	0,3%	0,3%	4,3%	4,3%	0,4%
		Rencana Progress Komulatif	62,3%	67,7%	68,0%	68,3%	69,4%	81,8%	85,9%	90,4%	90,7%	91,1%	95,3%	99,6%	100,0%

Figure 9. S Curve of conventional method plate scheduling

Scheduling in the bubble deck slab method has the same manufacturing method, namely using the Microsoft Project program to create bar charts and CPM diagrams and the Microsoft Excel program to create S curves.

Work is carried out per floor without using zoning. The work scenario begins with the fabrication of bubble deck plates that allow them to be worked outside the project area. Fabrication begins with the manufacture of molds and immediately proceeds with the installation of wiremesh reinforcement, girder reinforcement and HDPE balls. After that proceed with the casting of concrete with a thickness of 60 mm. While the concrete fabrication is being carried out, the installation of scaffolding can already be done because the fabrication is carried out outside the project area. After the fabrication and scaffolding have been completed, the installation of the bubble deck plate panels can be carried out. After the panel installation reaches 50%, the area that has been installed with bubble deck plate panels can already be done with overtopping and connection casting. The work scenario will be carried out until the work is completed. The following is the S curve of the bubble deck slab slab scheduling method.

No	Pekerjaan		Durasi	Bulan 1																								
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	**Ground Floor**																											
1	Fabrikasi Beton																											
a	Cetakan	8,9%	2	4,5%	4,5%																							
b	Tulangan Girder	3,5%	2		1,8%	1,8%																						
c	Bola HDPE	1,4%	1			1,4%																						
d	Wiremesh M8	4,6%	2			2,3%	2,3%																					
e	Pengecoran Beton	0,5%	1					0,5%																				
2	Pemasangan Bubble Deck	2,2%	2						1,1%	1,1%																		
3	Pengecoran Overtopping & Joint	0,8%	2							0,4%	0,4%																	
B	**1st Floor**																											
1	Fabrikasi Beton																											
a	Cetakan	8,6%	2						4,3%	4,3%																		
b	Tulangan Girder	3,0%	2							1,5%	1,5%																	
c	Bola HDPE	1,2%	1								1,2%																	
d	Wiremesh M8	4,5%	2								2,2%	2,2%																
e	Pengecoran Beton	0,5%	1										0,5%															
2	Pemasangan Scaffolding	2,7%	2									1,3%	1,3%															
3	Pemasangan Bubble Deck	2,1%	2											1,0%	1,0%													
4	Pengecoran Overtopping & Joint	0,6%	2												0,3%	0,3%												
C	**2nd Floor**																											
1	Fabrikasi Beton																											
a	Cetakan	8,0%	2											4,0%	4,0%													
b	Tulangan Girder	3,0%	2												1,5%	1,5%												
c	Bola HDPE	1,2%	1													1,2%												
d	Wiremesh M8	4,1%	2													2,1%	2,1%											
e	Pengecoran Beton	0,5%	1															0,5%										
2	Pemasangan Scaffolding	2,5%	2														1,2%	1,2%										
3	Pemasangan Bubble Deck	1,9%	2																1,0%	1,0%								
4	Pengecoran Overtopping & Joint	0,6%	2																	0,3%	0,3%							
D	**Roof Floor**																											
1	Fabrikasi Beton																											
a	Cetakan	8,4%	2																4,2%	4,2%								
b	Tulangan Girder	3,1%	2																	1,6%	1,6%							
c	Bola HDPE	1,2%	1																		1,2%							
d	Wiremesh M8	4,3%	2																		2,2%	2,2%						
e	Pengecoran Beton	0,5%	1																				0,5%					
2	Pemasangan Scaffolding	2,6%	2																			1,3%	1,3%					
3	Pemasangan Bubble Deck	2,0%	2																					1,0%	1,0%			
4	Pengecoran Overtopping & Joint	0,7%	2																						0,3%	0,3%		
E	**PH Roof**																											
1	Fabrikasi Beton																											
a	Cetakan	3,8%	1																					3,8%				
b	Tulangan Girder	1,3%	2																					0,6%	0,6%			
c	Bola HDPE	0,5%	1																						0,5%			
d	Wiremesh M8	2,0%	1																						2,0%			
e	Pengecoran Beton	0,2%	1																							0,2%		
2	Pemasangan Scaffolding	1,2%	1																								1,2%	
3	Pemasangan Bubble Deck	0,9%	1																									0,9%
4	Pengecoran Overtopping & Joint	0,3%	1																									0,3%
	Jumlah	100,0%																										
	Rencana Progress			4,5%	6,2%	5,5%	2,3%	0,5%	5,4%	7,3%	5,3%	3,6%	1,8%	5,0%	6,9%	5,1%	3,3%	1,7%	5,2%	7,1%	5,3%	3,5%	1,8%	5,5%	4,5%	0,5%	1,2%	1,2%
	Rencana Progress Komulatif			4,5%	10,7%	16,2%	18,5%	19,0%	24,4%	31,7%	37,0%	40,6%	42,4%	47,4%	54,3%	59,4%	62,7%	64,4%	69,5%	76,6%	81,9%	85,4%	87,2%	92,6%	97,1%	97,6%	98,8%	100,0%

Figure 10. S curve of slab scheduling method of bubble deck slab

Discussion

After the cost and time analysis is completed, some differences will be found in the two methods. The differences that occur in the two methods can be seen in the following table.

Table 10. Recapitulation of cost calculation and implementation time

Job Description	Conventional Methods
Concrete volume	254376 m^3
Cost	IDR. 984243466
Duration	26 days

Job Description	Bubble Deck Slab Methods
Concrete volume	246087 m^3
Cost	IDR. 842104960
Duration	25 days

From the table above, it can be concluded that the plate using the bubble deck slab method has some differences but not too significant. From the use of concrete, the bubble deck slab method uses 8,289 m^3 of concrete or 3,258% less than the conventional method. For the cost, the plate using the bubble deck slab method is IDR. 142,138,506.44 or 14.442% cheaper than the conventional method. Meanwhile, the implementation time only has a slight difference, namely the 1-day bubble deck slab method or 3.846% faster than the conventional method.

CONCLUSION

From the results of the analysis and discussion that has been carried out in this research, several conclusions are obtained, namely as follows:

1. Floor slab work on the Central Control Building of the Muara Tawar Power Plant project using the conventional method has a cost of IDR. 984,243,466.50. Meanwhile, using the bubble deck slab method has a cost of IDR. 842,104,960.06. Thus, the plate using the bubble deck slab method is cheaper by IDR. 142,138,506.44 or 14.442% compared to the conventional method.
2. Floor slab work on the Central Control Building of the Muara Tawar Power Plant project using the conventional method has an execution time of 26 days. Meanwhile, if you use the bubble deck slab method, the execution time is 25 days. Thus, the

plate using the bubble deck slab method for 1 day or 3.846% is faster than the conventional method.

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