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Work Productivity Analysis of Conventional Floor Structure and Hollow Core Floor Panel (HCFP)

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Abstract: **The time pressing of construction is one of the obstacles often faced by professionals in the construction field. As a result, many companies are making efforts to speed up the cycle time of the project so that the distribution process can be shortened. Therefore, the selection of appropriate construction methods used with the aim of meeting the needs of the achievement of an effective and efficient time. The research methodology is done by identifying the methods of work through observation of the implementation work installation then determine the work task, duration, and resource requirements at their respective jobs. After getting the required data simulated with the operating system WebCyclone through coding results that have been made. In this study used a simulation by the WebCyclone to know the value of productivity, duration and cost of construction operations. From both methods, the result of analysis by the conventional method of installation productivity of 0,276 units/hour or 2,208 units/day with total time required for 100 units is 46 days at a cost IDR 1.957.361.309,- while the Hollow Core Floor Panel (HCFP) method is 0,354 units / hour or 2,832 units / day with the total time required for 100 units is 36 days at a cost of IDR 2.103.968.736,-. Of the two alternatives compared to the most efficient methods of the time is a method of Hollow Core Floor Panel (HCFP). In terms of cost, Hollow Core Floor Panel (HCFP) method is more expensive than the conventional method, but when compared to the overall duration of the completion of the project, the time taken by conventional methods costs that tend to be more expensive.**

Keywords: **Productivity, Floor, HCFP, Time, Cost, WebCyclone.**

1. INTRODUCTION

In buildings, floor structure is identical repetitive work. Typically, the work floor will cost 20-30% of the total cost. The demand to built the building in the shortest possible time is a requirement of the project owner to be met. The limited time and budget of a construction project requires an effective production process and efficient. This can be achieved when using the proper construction methods and is accompanied by the optimization of the construction method.

There are several methods used in the implementation of construction which is very dependent on the problems of limited time and cost. In this study, precast or the product is called Hollow Core Floor Panel (HCFP) has been used to improve their method. Therefore, the productivity of each method must be known in order to compare the time and cost ratio.

2. LITERATURE REVIEW

2.1 Construction Methods:

Construction technology developments now is quite fast, ranging from construction technology tools, materials technology and materials and methods of implementation. Generally, the application of these technologies are widely applied in the methods of construction work. The use of appropriate methods, practical, fast, and safety, very helpful in the completion of work on a construction project. Thus, the target time, cost and quality as defined will be achieved. This construction method is a procedure implementing the construction work by using certain techniques, tools and certain materials. The combination and interaction of the three elements interactively form the framework of ideas and concepts

of the optimal method applied in the construction implementation. The concept of implementation methods includes selection and determinations relating to the overall aspect of the job including needs of facilities and infrastructure eventhough it's temporary (Istimawan Dipohusodo, 1996). The construction technology studies the methods or techniques used to realize the physical building within the project site. Technology comes from techno and logic, can be interpreted as a sequence of every step of the activity (procedure), for instance activity X must be implemented first then new activities Y, and so on; while techno is the way to be used logically (I. Ervianto, 2002).

2.2 Concrete Construction:

At this time the concrete is still the dominant construction materials used in construction projects in several regions of Indonesia. Floor structure is now generally known as two way construction method that is conventionally (cast in situ) where concrete direct casted in place a structure that has been formed by formwork and the other way is the precast method which is made in plant and after hardening and strength qualify it can be installed as a building structure. This method obviously require much labor and time is more than the precast concrete. The conventional concrete cycle is shown in Figure 1 below.

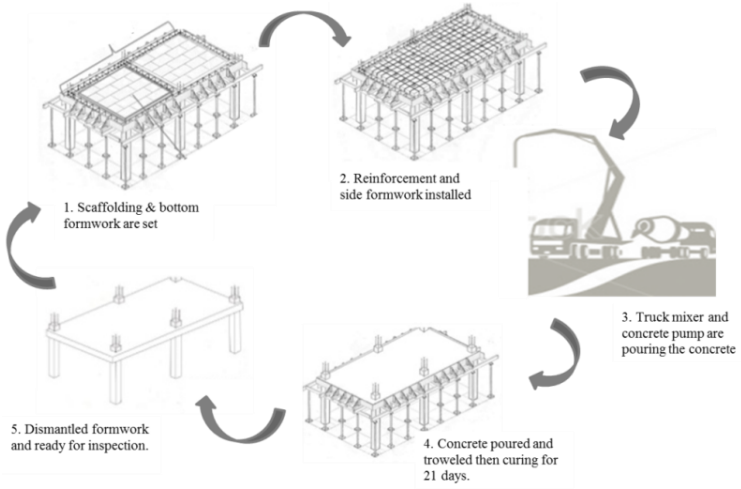

Fig 1: Conventional Concrete Cycle

2.3 Precast Concrete:

Precast utilization has been used in many construction projects because of the level of efficiency attained. Precast is a method of printing components mechanization in the factory or workshop to give time hardening and gain strength before installation. (Widden, 1992). Following the development of precast concrete, precast concrete elements are standardized. This standardization reduces costs and makes precast concrete products become more economical, because it can be done in standard steel molds and supervised by experienced people so as to ensure good quality control (Preston, 1984). The conventional concrete cycle is shown in Figure 2 below.

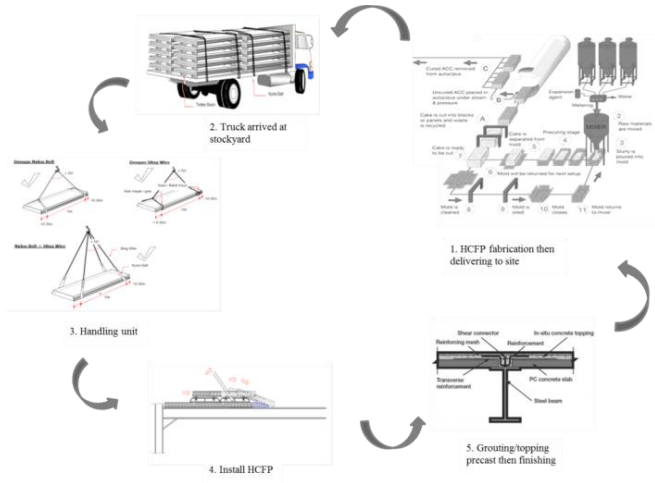

Fig 2: HCFP Concrete Cycle

One type of precast concrete that is used in this study are Hollow Core Floor panels (HCFP) or can be called with Hollow Core Slabs (HCS). HCFP plate precast system uses a system of pre-tensioning (prestressing) where the prestressing wires drawn beforehand on a special holder that has been prepared and then carried out the casting. Therefore making this product must be in place that provides a special fabrication intended holder. The existence of the middle plate hole to effectively reduce the weight of its own without reducing the bending capacity. So this precast is relatively mild compared slab solid even as the use of prestressed then greater carrying capacity. The existence of holes in slab is very useful when applied to high-rise buildings because it reduces the weight floor.

2.4 Construction Operations Simulation:

Simulation is one technique that has long been proposed for use in the design of construction operations. Some computer applications have been developed for this simulation, as MicroCyclone, Cost, Stroboscope. However, the application has a relatively low utilization rate. In this paper will be discussed modeling Cyclone and simulation of construction operations using modeling Cyclone web-based a called WebCyclone. method Cyclone discovered by Halphin in 1973. Cyclone is an acronym for Construction Cyclic Operation Network.This method is a model that can be simulated in the form of a computer simulation.

2.5 Basic Element Modeling MicroCyclone & WebCyclone:

Programming WebCyclone developed by the Construction Engineering and Management Purdue University, USA. WebCyclone is programming MicroCyclone informs, webs users do not need to install or have the program simply by accesing website. Here are the stages of process flow analysis methods work by using Cyclone:

1. Identification of the work processes
2. Determination components Cyclone that include the determination of the activity of employment/worktask, the duration of each work process, and resource requirements.
3. Modeling diagram Cyclone based on components and process jobs.
4. Translate diagram into code input (coding input).
5. Run the program.

In modeling Cyclone there are some elements used in describing a construction operation. Way to be able to enter the data that is already known is to access https://tomcat.itap.purdue.edu/WebCYCLONE/Cyclone.jsp.

3. METHODOLOGY

3.1 Research Method:

The research method is how to collect data and then process the data to produce data that can solve the problems of research. Methods and techniques of research was in fact also a pattern that functions to direct the thinking process, so that these studies produce objective truth. The method of research was conducted using field observations and studies literature. Field observations focused more directly with data-gathering as much data as possible on the field while the literature search for materials and information from reference books, journals and brochures that have been there and also observations that can be accessed through browsing internet related discussion this final project and inputs and additional lecturers to complete it.

In this study, requires two data that can support data analysis project is divided into two forms, namely primary data and secondary data. Primary data is data obtained by the authors directly in the field, either by field observations, interviews with the parties concerned, the data administration projects such as reports progress weekly and monthly, time schedule,minutes of meetings, shop drawing and RKS. Secondary data in this case is information that has been collected by others. Secondary data were obtained from data obtained on the spot by the study. This data is in the form of archives and documents related to the company, the total area, timing of completion and others. The study of literature obtained from reference books and journals also include secondary data used in this study. The data is used as the basis for the theory can be applied in identifying emerging issues and assist in reviewing its completion strategy. Stages of research compiled in this study the authors describe the flow diagram as follows:

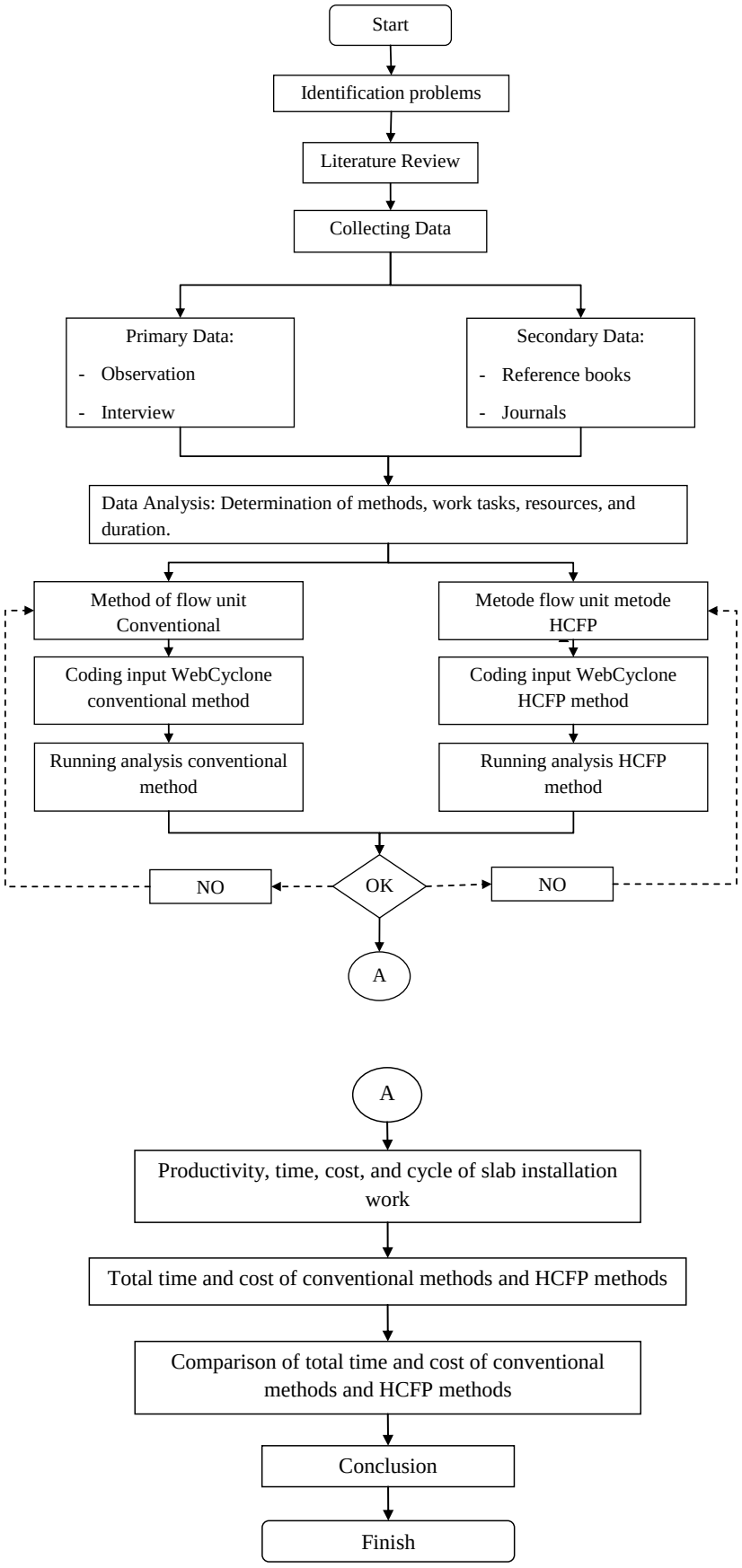

Fig 3: Flowchart of completion of the research

4. RESULT

4.1 Modeling and Input Code WebCyclone with Conventional Methods:

In calculating productivity using WebCyclone, it takes three main components of the job description/worktask, the duration of the work, and the need resources. After worktasks, durations, and resources obtained, make flow cycle modeling unit or flow charts to be able to facilitate change in the programming language WebCyclone.

TABLE I: TASK DURATION OF CONVENTIONAL METHOD

CONCRETE SLAB CAST IN SITE						
CYCLONE ACTIVE ELEMENTS STATISTICS INFORMATION						
Activity Type	No.	Name	Access Counts	Average Duration	Maximum Duration	Minimum Duration
COMBI	3	INSTALL SCAFFOLDING	5	549.1	582.3	519.7
COMBI	6	INSTALL REINFORCEMENT	3	315.6	342.3	279.7
COMBI	9	INSTALL FORMWORK	6	121.2	162.3	81.8
NORMAL	11	TRUCK TRAVEL	7	298.6	342.3	261.8
COMBI	14	TRK LOAD	17	173.7	222.3	123.6
NORMAL	15	TRK BACK	17	86.8	111.1	61.8
COMBI	19	POURING CONC	3	120.0	120.0	120.0
NORMAL	20	CONC PUMP UP	3	67.8	81.1	49.8
NORMAL	21	CONC PUMP DOWN	2	65.5	81.1	49.8
COMBI	27	TROWEL	2	120.0	120.0	120.0
COMBI	28	CURING	3	10080.0	10080.0	10080.0
COMBI	31	DEMOULDING	100	148.7	172.0	121.8
NORMAL	34	CHECKLIST	101	88.7	112.0	61.8

Table I shows the average duration, minimum (fastest) and maximum (longest) from any activity undertaken. In each activity are the number of cycles experienced by each activity, such as we review the install scaffolding,which has a number of activities that is 5 times, with an average duration of 549.1 minutes, the maximum duration was 582.3 minutes and the minimum length is 519.7 minute.

TABLE II: TOTAL PRODUCTIVITY WORK FLOOR CONVENTIONAL METHOD

Total Sim. Time Unit	Cycle No.	Productivity (per time unit)
21637.91	100	0.004621513406854179

Table II above shows total productivity over 100 cycles in which the productivity of work with the conventional method is 0.004621513406854179 units/minute or rounded to ≈ 0.0046 units minute with total simulation time unit is 21637.9. Results obtained from modeling WebCyclone shows that the level of productivity in one cycle obtained at 0.0046 cycles per minute or equal to 0.276 cycles per hour. If in one day there are 8 hours of work, then one cycle for mounting one unit with the conventional method can be completed within 217 minutes.

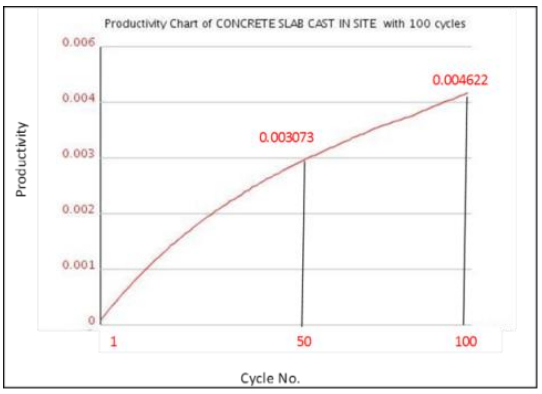

Fig 4: Productivity Chart of Conventional Method

Figure 4 shows a graph of productivity conventional method floor structure of the first cycle of up to 100 cycles, and it can be seen that productivity has increased gradually.

TABLE III: STATISTICAL INFORMATION FOR RESOURCES CONVENTIONAL METHOD

CONCRETE SLAB CAST IN SITE									
CYCLONE PASSIVE ELEMENTS STATISTICS INFORMATION									
Type	No.	Name	Average Units Idle	Max. Idle Units	Times not empty	% Idle	Total Sim Time	Average Wt Time	Units at end
QUEUE	1	LABOR	0.7	2	222.8	1.03	21637.9	54.7	0
QUEUE	2	SCAFFOLDING	0.5	3	552.0	2.55	21637.9	44.9	3
QUEUE	4	SCAFF READY	0.0	2	53.5	0.25	21637.9	0.0	2
QUEUE	5	TEAM STEEL	2.2	3	924.4	4.27	21637.9	337.7	0
QUEUE	7	T. SCAFFOLDING IDLE	0.0	3	0.0	0.00	21637.9	0.0	0
QUEUE	8	T. STEEL READY	0.0	3	0.0	0.00	21637.9	0.0	0
QUEUE	10	TEAM STEEL IDLE	7.2	10	1331.2	6.15	21637.9	0.0	10
QUEUE	12	BATCH PLANT AVAIL	0.0	1	0.0	0.00	21637.9	0.0	1
QUEUE	16	TRUCK WAIT AT PLANT	6.4	10	2740.0	12.66	21637.9	651.4	0
GEN	17	TRUCK WAIT	114.1	252	2819.7	13.03	21637.9	0.0	252
QUEUE	18	CONC PUMP READY	3.0	3	239.5	1.11	21637.9	119.7	0
QUEUE	22	CONC PUMP IDLE	1.2	3	293.4	1.36	21637.9	119.7	2
QUEUE	24	TROWEL WAIT	0.0	1	0.0	0.00	21637.9	0.0	1
QUEUE	25	TEAM CONC	1.9	2	432.0	2.00	21637.9	210.3	0
GEN	29	TROWEL IDLE	0.9	1	9528.0	44.03	21637.9	2382.0	0
QUEUE	30	TEAM CONC WAIT	0.5	2	10080.0	46.58	21637.9	105.9	2
QUEUE	32	INSPECTOR	0.0	1	117.4	0.54	21637.9	1.2	0
QUEUE	33	CREW IDLE	1.3	2	16453.9	76.04	21637.9	275.2	1

In table III results obtained idle from each queue. Idle with the highest percentage found in idle crew amounted to 76.04% where the idle crew had to wait for all the work completed can only do its job because each foundry work finished there will be a lot of crew idle.The percentage of idle busy indicates whether or not a resource, the greater the percentage idleof itsthen resource thehas plenty of time to wait before the next activity takes place.

TABLE IV: TASK DURATION OF HOLLOW CORE FLOOR PANEL METHOD

PRECAST CONCRETE HCFP						
CYCLONE ACTIVE ELEMENTS STATISTICS INFORMATION						
Activity Type	No.	Name	Access Counts	Average Duration	Maximum Duration	Minimum Duration
COMBI	3	TRUCK ARRIVED	2	15.9	18.5	13.3
COMBI	5	HANDLING UNIT	2	31.8	37.0	26.6
NORMAL	7	UNIT MOVED	2	7.0	8.9	5.1
NORMAL	8	UNIT PLACED	2	4.4	5.4	3.3
COMBI	10	PRECAST INSTALLATION	1	24.9	24.9	24.9
NORMAL	12	UNIT LIFTED	1	13.6	13.6	13.6
NORMAL	13	UNIT INSTALLED	1	6.1	6.1	6.1
COMBI	15	MOVE TO NEXT SEGMENT	1	8.3	8.3	8.3
COMBI	20	GROUTING	150	14.9	19.5	10.3
NORMAL	21	FINISHING	149	30.0	30.0	30.0
NORMAL	22	CURING	110	1440.0	1440.0	1440.0
COMBI	24	UNLINK CRANE	100	19.5	29.3	10.0
NORMAL	26	CHECKLIS	100	19.5	29.3	10.0

Table IV shows the average duration, minimum (fastest), and maximum (longest) from any activity undertaken. In each activity are the number of cycles experienced by each activity, such as we review the truckarrived,which has a number of activities which are 2 times, with the average value of the duration of 15.9 minutes, the maximum duration is 18.5 minutes and the minimum length is 13.3 minute.

TABLE V: TOTAL PRODUCTIVITY WORK FLOOR HCFP METHOD

Total Sim. Time Unit	Cycle No.	Productivity (per time unit)
16970.2	100	0.005893

Table V above shows total productivity over 100 cycles in which the productivity of work with the HCFP method is 0.005893 units/minute or rounded to ≈ 0.0059 units minute with total simulation time unit is 16970.2. Results obtained from modeling WebCyclone shows that the level of productivity in one cycle obtained at 0.0059 cycles per minute or equal to 0.354 cycles per hour. If in one day there are 8 hours of work, then one cycle for mounting one unit with the conventional method can be completed within 169 minutes.

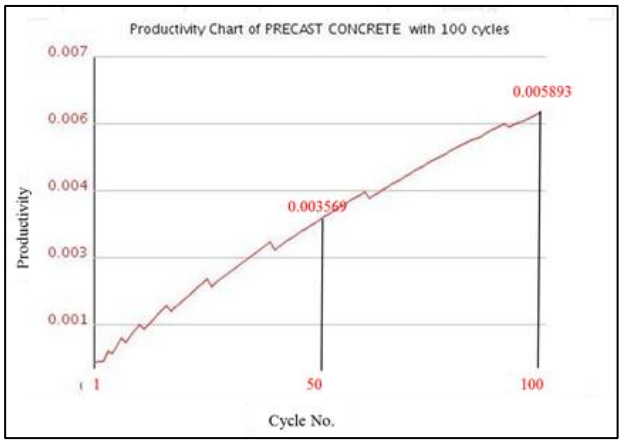

Fig 5: Productivity Chart of Conventional Method

Figure 5 shows a graph of productivity conventional method floor structure of the first cycle of up to 100 cycles, and it can be seen that productivity has increased gradually.

TABLE VI: STATISTICAL INFORMATION FOR RESOURCES HCFP METHOD

CONCRETE SLAB CAST IN SITE									
CYCLONE PASSIVE ELEMENTS STATISTICS INFORMATION									
Type	No.	Name	Average Units Idle	Max. Idle Units	Times not empty	% Idle	Total Sim Time	Average Wt Time	Units at end
QUEUE	1	HCFP FABRICATION	0.0	1	0.0	0.00	16970.2	0.0	0
QUEUE	2	TRUCK	0.3	1	33.4	0.20	16970.2	11.1	1
QUEUE	4	WAITING MOB CRANE	0.0	1	0.0	0.00	16970.2	0.0	0
QUEUE	6	MOB CRANE	0.4	1	56.7	0.33	16970.2	18.9	1
QUEUE	9	WAITING CRANE	0.0	1	0.0	0.00	16970.2	0.0	1
QUEUE	11	CRANE	1.0	1	48.4	0.29	16970.2	24.2	0
QUEUE	14	WAIT LABOR 1	0.0	1	0.0	0.00	16970.2	0.0	0
QUEUE	16	LABOR 1	1.0	1	93.0	0.55	16970.2	46.5	0
QUEUE	18	WAIT LABOR 2	0.0	1	761.1	4.48	16970.2	5.0	0
QUEUE	19	LABOR 2	0.9	1	14732.2	86.81	16970.2	96.9	0
GEN	23	DUMMY	0.6	10	3164.4	18.65	16970.2	91.2	9
QUEUE	28	INSPECTOR	0.8	1	13062.9	76.98	16970.2	128.1	0

In table VI results obtained idle from each queue. Idle with the highest percentage found in Labor 2 amounted to 86.81%where labor 2 must wait until all work is completed can only do its job. The percentage of idle busy indicates whether or not a resource, the greater the percentageidlenya then resource of thehave plenty of time to wait before the next activity takes place.

4.3 Summary Analysis Program WebCyclone:

Both analyzes Webcyclone floor structure work processes with conventional methods and Hollow Core Floor Panel (HCFP) obtained the following results:

TABLE VII: SUMMARY ANALYSIS PROGRAM WEBCYCLONE

No.	Method Type	Productivity (unit/minute)	Cost (Rp/minute)
1	Conventional Method	0,0046	88.648,61
2	Hollow Core Floor Panel (HCFP) Method	0,0059	121.757,45

TABLE VIII: CALCULATION OF TIME AND COST WORK FLOOR

No.	Method Type	Qty	Calculation	Total Time Completion
1	Conventional Method	100	$\frac{100}{0.0046*60*8}$ = 45.2	46 days
2	Hollow Core Floor Panel (HCFP) Method	100	$\frac{100}{0.0059*60*8}$ = 35.3	36 days

TABLE IX: SUMMARY RESULTS TIME AND COST BOTH CONVENTIONAL AND HCFP METHOD

No.	Method Type	Total Time Completion	Total Cost
1	Conventional Method	46 days	IDR 1.957.361.309
2	Hollow Core Floor Panel (HCFP) Method	36 days	IDR 2.103.968.736

5. CONCLUSION

Based on the modeling work floor structure with conventional methods/cast in site and Hollow Core Floor Panel(HCFP) that have been performed using the simulated operating WebCyclone, we can conclude several things, namely:

1. Productivity resulting from the employment structure floor with conventional methods amounted to 0,276 units/hour or 2,208 units/day, while productivity resulting from the work floor structure with methods Hollow Core floor Panel (HCFP) amounted to 0354 units/hour or 2,832 units/day.
2. The time required to complete the work of 100 units of the floor structure with the conventional method is 45 days at a cost of IDR 1.957.361.309, while the method of Hollow Core Floor Panel (HCFP) is required within 35 days at a cost of IDR 2.103.968.736
3. Of the two alternatives compared to the most efficient methods of the time is a method of Hollow Core Floor Panel (HCFP). In terms of cost method of Hollow Core Floor Panel (HCFP) is more expensive than the conventional method, but when compared to the overall duration of the completion of the project, the time taken by conventional methods costs that tend to be more expensive.

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