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Analysis Of Labor Productivity in Ironwork Floor Plate for Main Substation Construction Project for Cable Lines High Voltage at BKMS – JIIPE

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Abstract

Productivity is an important factor in carrying out construction work. The level of labor productivity is directly proportional to the amount of work that can be completed; the higher the productivity, the faster the work can be completed. In floor slab installation work that has a large volume and requires a lot of labor, optimizing productivity is an important step to reduce costs and implementation time in order to obtain maximum results. This study uses the Work Sampling method through direct observation in the field to obtain data on labor, time, and work volume in the floor slab reinforcement installation process. Data collection was carried out during normal working hours at 08.00–16.00 with a break time at 12.00–13.00, without involving overtime. The data obtained were then processed to calculate labor productivity and compared with the standards set out in PUPR Ministerial Regulation No. 8 of 2023. The results showed that the average productivity in the field for reinforcement work reached 687.637 kg/OH, while the productivity value based on the analysis according to PUPR Ministerial Regulation No. 8 of 2023 is 400 kg/OH. The comparison shows that the average productivity in the field is 1.719 times higher than the applicable standard.

Keywords: **Productivity, Labor, Floor Plates, Work Sampling.**

1. Introduction

Labor productivity reflects the ability of workers to carry out their duties. A high level of productivity plays a significant role in the success of construction projects [1]. Productivity plays a crucial role in determining the competitiveness of the construction sector, as the speed of project completion is highly dependent on worker performance. Various factors such as project site conditions, weather, implementation techniques, and workforce size also influence productivity levels [2]. However, productivity realization in the field often does not meet the standards stipulated in PUPR Ministerial Regulation No. 8 of 2023.

Maintaining workforce productivity at optimal levels is crucial for the smooth running of a project. Lack of attention to this aspect can lead to work delays. Factors that influence productivity include project conditions, supporting facilities, worker age, wage level, work experience, health, project management, contract type, and field coordination. One frequently used productivity measurement method is work sampling, which involves random observations to record worker activities. This method helps assess productivity, workload, and workforce requirements.

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1.1 Productivity

In construction projects, productivity is generally underappreciated, even though it is a key factor in the success of a project. This is because the speed of project completion depends on productivity planning [3]. Productivity is the value of a production project. A more general definition of productivity is the ratio between output, activity volume, equipment input, and labor. Equipment is all the tools used during a series of project activities. Equipment is divided into two types: 1) simple equipment, which is operated by human power, and 2) modern equipment, which is not operated by human power but uses machines [4] Therefore, work using modern equipment can produce higher productivity compared to simple equipment. This is possible because using machines does not reduce the amount of labor used, resulting in high productivity [5]

$$\text{Productivity} = \frac{\text{activity results (output)}}{\text{input}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2.1)$$

Based on Equation 2.1, productivity is influenced by output and input. Output is the result obtained from a construction activity during ongoing observation, while input is the factors that influence that output , such as the number of workers and working hours [6]

1.2 Work Sampling

Work sampling can generally be defined as a technique that involves making numerous instantaneous observations over a period of time on a group of workers, machines, or processes [7]. This work sampling method generally has a very simple implementation procedure observing work activities for a random interval on one or more machines/operators and then recording them. This method is very suitable, used in observing work that does not repeat it self and has a relatively long time cycle [8]

2. Research Methods

The method used to collect data in this study was work sampling. The work being reviewed is the plate construction for the SKTT BKMS – JIIPE Gresik Substation Construction Project.

Observations were carried out directly in the field by recording the number of workers, volume of work, time (working hours) or duration of the wire mesh reinforcement installation work. Observations were carried out for 8 days during working hours, namely from 07.00 – 11.00 WIB. There was a break from 11:00 AM to 1:00 PM WIB, followed by a break from 1:00 PM to 4:00 PM WIB. Recording and measurements were taken at the end of the working day, at 4:00 PM WIB. Data obtained in the field was then recorded and processed to determine labor productivity on the project.

The subject of this research is the blacksmith work group on the Wiremesh reinforcement installation work on the SKTT BKMS – JIIPE Gresik Main Substation Construction Project. The objective of this research is to determine labor productivity in the installation of plate reinforcement. This will then be compared with productivity according to PUPR Ministerial Regulation No. 8. 2023.

3. Results and Discussion

3.1. Floor Slab Work Productivity Analysis

To determine the results of the productivity analysis for this floor slab work, measurements and observations can be made directly at the project site while work is in progress [5]. This productivity analysis specifically applies only to the reinforcement work/installation of the Floor Slabs at Elevation 17.00 m. Observations and measurements are conducted at the beginning and end of each working day. The implementation process adheres to the project's predetermined working hours. The project's working day is 7 hours, from 7:00 AM to 11:00 AM WIB. There is a break from 11:00 AM to 1:00 PM WIB and then from 1:00 PM to 4:00 PM WIB, except during casting work, as casting on this project typically takes place at night. Casting is usually carried out at night from 21.00 until finished with a predetermined number of workers.

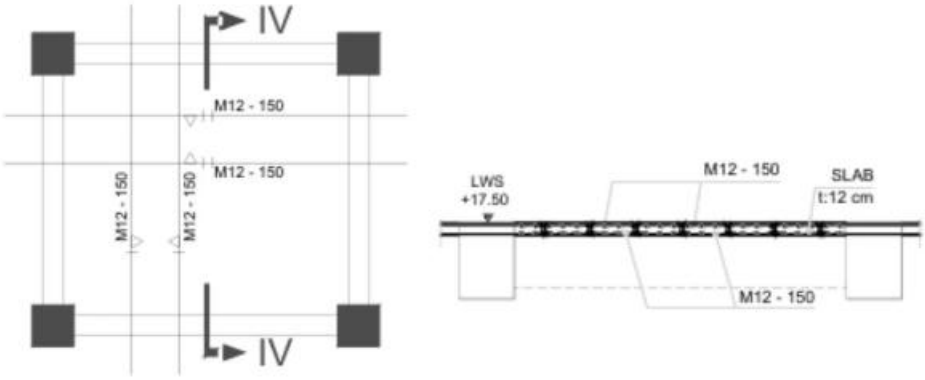
3.2. Volume Observation

The volume of work on the reinforcement/plate reinforcement installation was obtained from direct field observations. The method used was to measure the length of the beam reinforcement that had been completed [14]. From the observations and measurements carried out during the research, the following measurement data were obtained:

Table 1. Volume Observation

Job Observation		Volumen data obtained
1	Roof Floor Plate (18-16)	122.4 m2
2	Roof Floor Plate (16-12)	183.6 m2
3	Roof Floor Plate (12-10)	91.8 m2
4	Roof Floor Plate (10-7)	153 m2
5	Roof Floor Plate (7-4)	214.2 m2
6	Roof Floor Plate (4-1)	153 m2

Once the installed reinforcement length data is obtained, it is then calculated to determine the required volume of the roof slab reinforcement work. Details of the roof slab reinforcement can be seen in the image below:



Figur 1. Details of the roof slab reinforcement

Based on the reinforcement details above, the floor plate reinforcement used is 2. stack wiremesh M12 – 150 with a height of 12cm.

Table 2. Wiremesh conversion

No	Diameter Iron	Code	Form	Weight	Size
1	4 mm	M4	Roll	154,50 kg	2.1 m' x 54 m'
			Sheet	15,45 kg	2.1 m' x 5.4 m'
2	5 mm	M5	Roll	241.40 kg	2.1 m' x 54 m'
			Sheet	24,14 kg	2.1 m' x 54 m'
3	6 mm	M6	Roll	347.60 kg	2.1 m' x 54 m'
			Sheet	34,76 kg	2.1 m' x 5.4 m'
4	7 mm	M7	Roll	473,10 kg	2.1 m' x 54 m'
			Lembar	47,31 kg	2.1 m' x 5.4 m'
5	8 mm	M8	Lembar	61,79 kg	2.1 m' x 5.4 m'
6	9 mm	M9	Lembar	78,20 kg	2.1 m' x 5.4 m'
7	10 mm	M10	Lembar	96,54 kg	2.1 m' x 5.4 m'
8	12 mm	M12	Lembar	139,02 kg	2.1 m' x 5.4 m'

To make the wiremesh support corset, use 13D threaded iron with a length of 1m for each corset.

Table 3. Iron Conversion

No	Form	Diameter (mm)	Nominal Weight per m' (kg/m')
1	Thread	6	0,222
2	Thread	8	0,395
3	Thread	10	0,617
4	Thread	13	1,04
5	Thread	16	1,58
6	Thread	19	2,23
7	Thread	22	2,98
8	Thread	25	3,85
9	Thread	29	5,18
10	Thread	32	6,31
11	Thread	36	7,99
12	Thread	40	9,88
13	Thread	50	15,40
14	Thread	54	17,90
15	Thread	57	20,00

Day 1 Observation

M12 Wiremesh Calculation
Calculation of 30cm wiremesh overlap
= (5.4 – 0.3) × (2.1 – 0.3) = 9.18

Floor area
= 122.4 m2

Number of wire mesh required (2 stacks)
= Floor area × Wiremesh overlap area 30 cm
= 122.4 ÷ 9.18 = 13.334
= 13,334 × 2 = 26,667 ~ 27 Sheets

Total weight of iron required
= Number of wire mesh × Weight of M12 SNI wire mesh
= 26.667 × 139.02 kg = 3707.286 kg

Amount of unused wiremesh
=(Purchase of wire mesh - Amount of wire mesh used) × Weight of SNI wire mesh
= (27 Sheets – 26,667) × 139.02
= 0.333 × 139.02
= 46.294 kg

13mm Threaded Iron Corset Calculation

Number of corsets Length 1m
= 150 corsets

Number of rods used
= 150 m ÷ 12m = 12.5 rods

Weight of iron used
= Total Length × Weight of iron per m (SNI)

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= 150 × 1.04 kg/m
= 156 kg

Total Overall Weight
= Wiremesh Weight + Corset Weight
= 3707.286 kg + 156 kg
= 3863.286 kg

The results of the volume calculations from day 2 to day 6 are summarized as follows:

Table 4. Observation data of Reinforcement Work

Observation of the day	Working hours	Output Volume (Kg)	Number of Workers
1	7	3863,286	7
2	7	5794,93	7
3	7	2874,064	7
4	7	4.821.292	7
5	7	6705,907	7
6	7	4821,292	7

Source : Researcher Processing (2025)

From the data obtained, the productivity of the work group in the 1st observation was calculated as follows: It is known that:

Number of working hours per day = 7 hours
Work volume = 3863,286

The results of the work group productivity calculations for the following day until the end are summarized as follows:

Table 5. Observation data of Reinforcement Work

Observation of the day	Working hours	Work Volume (Kg)	Productuvity of the fam. Work (Kg/hour)
1	7	3863,286	551,898
2	7	5794,93	827,847
3	7	2874,064	410,580
4	7	4821,292	688,756
5	7	6705,907	957,986
6	7	4821,292	688,756
Average			601,682

Source : Researcher Processing (2025)

Labor productivity is calculated by dividing output (volume of work) by the number of workers. The following is a calculation of a blacksmith's productivity in kg/OH on the first day. From the calculation above, the blacksmith's productivity on the first day was 551,898 kg/OH. The results of the blacksmith's productivity calculations on days 2 to 6 can be seen in table 4.6 regarding blacksmith productivity data.

Table 6. Blacksmith Productivity data

Observation of the day	Amount Craftsman	Work Volume (Kg)	Productuvity Craftsman (Kg/OH)
1	7	3863,286	551,898
2	7	5794,93	827,847
3	7	2874,064	410,580
4	7	4821,292	688,756
5	7	6705,907	957,986
6	7	4821,292	688,756
Average			687,637

Source : Researcher Processing (2025)

Productivity Calculation of PUPR Ministerial Regulation No. 8 of 2023. Regulation of the Minister of Public Works and Public Housing (Permen PUPR) No. 8 of 2023 contains an analysis of unit prices as a comparison of productivity values in the field.

Table 7. AHSP for installation of PUPR wiremesh no. 8 2023

No	Description	Code	Unit	Coefficient	Price Unit (Rp)	Amount Price (Rp)
A	POWER					
	Worker	L01 OH		0,00250		
	Blacksmith	L02 OH		0,00250		
	Foremen	L03 OH		0,00016		
	Foremen	L04 OH		0,00016		
				Total Power Price Work		
B	MATERIALS					
	Wire Mesh		Kg	1,020		
	Bendrat Wire		Kg	1,5		
				Total Material Price		
C	EQUIPMENT					
	Concreate iron cutter			0.00001		
	Crane			0.00025		
				Total Equipment Price		
D	Total (A+B+C)					
E	General costs and profits (overhead & profit) maximum 15%					
F	Unit Price of Work (D+E)					

Source: PUPR Ministerial Regulation No. 8 of 2023

Based on the data above, the productivity calculation based on PUPR Ministerial Regulation No. 8 of 2023 is calculated as follows:
Productivity of craftsmen = 400 kg/OH
Comparison of Field and PUPR Regulation = 1,379 times

The comparison results above are based on the reference data from the first day. The results of the comparison calculations for days 2 through 5 can be seen in the table:

Table 8. Results of comparison of Field productivity & PUPR Regulation

Day	Field Productivity	Productivity of PUPR Ministerial Regulation No. 1 of 2002	Comparison of Field Productivity & PUPR Regulation
1	551,898	400	1,379745
2	827,847	400	2,0696175
3	410,58	400	1,02645
4	688,756	400	1,72189
5	957,986	400	2,394965
6	688,756	400	1,72189
Average	687,637	400	1,7190925

Source : Researcher Processing (2025)

4. Conclusions

Based on the results of the analysis and discussion obtained in the previous chapter, the following conclusions can be drawn from this study:

1. From the results of this research analysis, the average productivity of the work group was obtained at 687.637 kg/hour and the average productivity value of the workforce was 687.637 kg/OH in the work of installing plate reinforcement on the High Voltage Cable Channel Substation construction project - BKMS JIIPE Gresik.
2. The productivity calculation results according to PUPR Ministerial Regulation No. 8 of 2023 for labor are 400 kg/ OH. From the results of data analysis in this study, the average comparison between productivity in the field and productivity according to PUPR Ministerial Regulation No. 8 of 2023 is 1.719 times. Therefore, based on the standards of PUPR Ministerial Regulation No. 8 of 2023, the productivity value in the field is sufficient fromhe established standard value.

5. Declarations

5.1. Author Contributions

Conceptualization, M.A.N. and A.C.; methodology, I.T.H.; software, M.A.N.; validation, M.A.N., A.C., and I.F.S.; formal analysis, M.A.N.; investigation, I.T.H.; resources, I.T.H.; data curation, M.A.N.; writing—original draft preparation, A.C.; writing—review and editing, I.F.S.; visualization, I.F.S.; supervision, I.T.H.; project administration, I.T.H. All authors have read and agreed to the published version of the manuscript..

5.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.:

5.3. Funding

Funding information is not available:

5.4. Acknowledgements

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5.5. Conflicts of Interest

The authors declare no conflict of interest.:

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