

ANALYSIS OF HEAVY EQUIPMENT PERFORMANCE ON THE PROBOLINGGO-BANYUWANGI TOLL ROAD PROJECT KM SECTION KM 09 + 125 TO KM 09 + 725

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ABSTRACT

Infrastructure projects, especially in flexible pavement works, are highly dependent on the utilization of heavy equipment. The use of such heavy equipment is an important element that determines the success of asphalt road construction, with the production capacity of heavy equipment being a major factor in the progress of project implementation. Therefore, the analysis of production volume capacity is very important. This study aims to determine the production volume capacity of construction works on the Probolinggo - Banyuwangi Toll Road KM 09+125 to KM 09+725, including an analysis of the capacity of asphalt finisher, dump truck, pneumatic tire roller, and tandem roller. The volumetric method was applied in this study to calculate the volume capacity and productivity of heavy vehicles. The results of the analysis showed that the calculated volume and productivity of the heavy equipment had met the target according to the planned schedule.

Keywords: Heavy Equipment, Productivity, Infrastructure, Toll Road, Production Volume

INTRODUCTION

In the execution of large-scale civil engineering projects, the use of heavy equipment is a very important aspect and plays a decisive role in the successful completion of the project. This applies not only to the construction sector, but also includes the agriculture, forestry and mining sectors. The operational effectiveness of heavy equipment is not only able to significantly increase work productivity, but also relies heavily on a comprehensive understanding of various factors, such as routine maintenance costs, daily operational costs, as well as the technical specifications and specific functions of each equipment used. In addition, machine productivity is also affected by various external factors such as the duration of the project work, the topography and terrain conditions of the project site, and the type of technical specifications of the selected machine. Therefore, the selection of heavy equipment that is inappropriate or not in accordance with project needs can have a negative impact, such as hindering the smoothness of the construction process and potentially increasing the cost and time of project implementation significantly. Earthwork on the Probolinggo - Banyuwangi Toll Road project is carried out with the main objective of elevating the existing land surface so that the position of the road surface becomes higher and free from the risk of puddles that can interfere with the smooth flow of traffic and accelerate damage to the road structure. This work is carried out by stockpiling soil whose material is obtained from the external location of the project or comes from excavation results at other locations that have gone through a selection and approval process beforehand. The series of processes in this earthwork include loading of materials from the original location, transportation to the project site using special vehicles

such as dump trucks, spreading the material evenly in the designated area, and compaction carried out until it reaches a density in accordance with the required technical specifications. To support the smoothness and efficiency of the entire earthwork process, heavy equipment such as Excavators are used to excavate and load soil, Dump Trucks to transport materials, Dozers to level the soil stockpile, Motor Graders to smooth the surface of the stockpile to make it flat, and Vibratory Rollers that function to compact the stockpile optimally.

METHOD

The research method used in this project is explained through a flow chart or research stages presented in the form of the following flow chart, which in detail shows the systematic steps taken starting from the preparation stage, data collection, data processing, to the analysis of research results.



Figure 1. Research Flow Chart

Literature study, conducting literature studies from various literature books related to heavy equipment on projects, especially those related to road projects. Field data is directly related to the field. The field data are as follows: heavy equipment cost, work implementation plan, scope of work. The heavy equipment used by the contractor company to work on projects in the field is as follows:

- 1) Asphalt Finisher;
- 2) Asphalt Mixing Plant;
- 3) Asphalt Sprayer;
- 4) Compressor;
- 5) Dump Truck;
- 6) Hydraulic Excavator;
- 7) Motor Grader;

- 8) Pneumatic Tired Roller;
- 9) Stone Crusher;
- 10) Tandem Roller;
- 11) Tronton Truck;
- 12) Vibration Roller;
- 13) Wheel Loader.

The cycle periods to be calculated are the cycle periods of the dump truck, hydraulic excavator, wheel loader.

1) Dump truck

The equation below can be used to calculate the dump truck cycle time:

$C_m = C_{m1} + C_{m2} + C_{m3}$; where C_m = cycle period, C_{m1} = fixed period (minutes), C_{m2} = load period, C_{m3} = travel period.

2) Hydraulic excavator

Based on Figure 2 below, the excavator cycle time can be determined.



Figure 2. Excavator Cycle Period

3) Wheel loader

Wheel loaders have a fixed period or fixed time of about 10.9 seconds. The charging process is determined using the V-loading method: $C_m = 2 \left(\frac{D}{F} + \frac{D}{R} \right) + z$; where C_m = cycle period (minutes), D = haul route (m), F = forward rate (m/min), R = reverse rate (m/min); Z = fixed time (minutes).

The specifications of the heavy equipment used in this project are as follows, namely:

1) Asphalt finisher

Sanding width: 2.5 m - 6 m

Hooper capacity: 10 tons

Type: Mitsubishi MF55H

2) Hydraulic excavator

Type : Komatsu PC500LC-10 R

Bucket capacity: 3,8 m³

Net engine output: 360 HP

RESULTS AND DISCUSSION

The project realization schedule is prepared through a systematic method by paying attention to the detailed stages of work. This schedule aims to provide clear guidance on the sequence of activities, duration of implementation time, and allocation of resources required for the project to run effectively and efficiently. Based on the planning that has been prepared and agreed upon, the implementation of the Probolinggo - Banyuwangi Toll Road Project in the

KM 09 + 125 to KM 09 + 725 segment is targeted to be completed within a period of 160 effective working days, taking into account various supporting factors and potential obstacles that may occur during the implementation of the project. The mobility of heavy equipment used in this project is expected to take approximately 45 effective working days, covering the period of moving heavy equipment from the original location to the work site as well as initial preparation so that the equipment is ready for optimal use at the project site. After the mobilization process is completed, the finishing work stage which includes final activities such as fireplace, surface refinement, and final evaluation of the quality of the work will take an additional time of approximately 15 effective working days. Thus, the total time required for mobilization of heavy equipment as well as completion of finishing works is estimated to be approximately 60 effective working days.

This entire time has been factored into the project schedule, allowing the works to be completed on time as originally planned. Therefore, the calculation of the volume and productivity of heavy equipment is very important so that the main work can run smoothly according to the planned target schedule, as listed in Table 1 below.

Table 1. Production Capacity of Operational Activities

No.	Tipe Aktivitas	Waktu Efektif Pekerjaan	Kapasitas Produksi	
			/ hari (m ³)	/ jam (m ³)
1	Galian	41	717,75	86,80
2	Timbunan	21	411,93	49,29
3	Lapis Pondasi Agregat	20	47,71	5,92
4	Perkerasan Aspal	8	77,99	8,75

The production volume capacity analysis in this study was conducted with the main objective of evaluating the effectiveness and efficiency of heavy equipment in completing earthworks. This analysis includes calculating the production capacity of heavy vehicles used in the project, taking into account various aspects such as equipment specifications, operational conditions, work duration, and field conditions at the project site. An important stage in this analysis is the calculation of cycle time, machine capacity per cycle, and equipment operational efficiency. An in-depth understanding of the cycle time and production volume capacity of the heavy equipment will greatly assist in achieving project targets in a timely and effective manner according to a predetermined schedule.

Table 2. Cycle Time Analysis of Land Excavation Work

No	Peralatan yang dipakai	Cycle time (menit)
1	Dump Truck	0,43
2	Hydraulic Excavator	7,55

Production volume capacity analysis is a calculation to determine the working capacity of heavy equipment per hour adjusted to the topographic conditions of the field. It is important to conduct a cycle time analysis first because it is fundamental in analyzing the production capacity of heavy equipment. This heavy equipment volume capacity analysis is carried out by considering in detail the actual use of the equipment in various project activities in the field, including technical aspects, operational conditions, work duration, and equipment efficiency.

The complete and detailed results of the heavy equipment volume capacity analysis are presented in tabular form for ease of understanding, as shown in Table 3 below.

Table 3. Analysis of Heavy Vehicle Volume Quantity in Landfilling Activities

No	Kendaraan Berat	Kuantitas Volume Kendaraan Berat	
1	<i>Dump Truck</i>	21,54	m ³ /jam
2	<i>Motor Grader</i>	15,37	m ³ /jam
3	<i>Vibration Roller</i>	1977	m ³ /jam
4	<i>Wheel Loader</i>	50,86	m ³ /jam

The productivity of heavy equipment used in this project has been calculated in detail based on real conditions in the field, including operational activities that include work cycle time, geographical and topographical conditions of the location, and the level of efficiency of each machine in carrying out its duties. The results of the productivity analysis are summarized in Table 4 below, which clearly illustrates the actual productivity of heavy equipment based on field activities as described in the previous analysis, so that the data can be used as a reference in evaluation and decision making during project implementation.

Table 4. Average Quantity of Heavy Vehicles in Land Excavation Activities

N o.	Peralatan berat yang dipakai	Volume pekerjaan	Kapasitas Volume Peralatan berat	Waktu kerja efektif	Jumlah alat
		(m ³ /jam)	(m ³ /jam)		
1	<i>Dump Truck</i>	77,86	151,51	39	2
2	<i>Hydraulic Excavator</i>		55,77		5

CONCLUSIONS

From the above discussion, we can formulate some important conclusions, including that the most effective and productive period of time to complete this project is approximately 110 effective working days, which has been calculated by considering the optimal production capacity and realistic duration of work activities. In addition, this project also requires the use of several production operational vehicles that have been specially selected based on the specific needs of the work and field conditions, which include the following:

- 1) Asphalt finisher;
- 2) Dump truck;
- 3) Hydraulic excavator;
- 4) Motor grader;
- 5) Pneumatic tired roller;
- 6) Tandem roller;
- 7) Vibration roller;
- 8) Wheel loader.

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