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"Analysis the Productivity of Heavy Equipment Cut and Fill Work" (Case Study: Package 6th Leuwikeris Dam Project Tasikmalaya-Banjar)

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Abstract
This research examines the productivity of heavy equipment used in the Cut and Fill work at the Leuwikeris Dam Project in Tasikmalaya, Indonesia. The study highlights the importance of efficient resource utilization and the environmental and social impacts associated with dam construction. A time study method was employed to analyze productivity, focusing on various heavy equipment such as excavators, dump trucks, bulldozers, and vibratory rollers. The findings indicate that factors such as equipment breakdowns, weather conditions, and material supply delays significantly impact productivity. The results aim to inform civil engineering practices and improve the understanding of heavy construction equipment efficiency in development projects. The findings show that machine productivity is reduced by up to 20% during the rainy season due to wet field conditions and limited visibility. In addition, the optimal requirement of heavy equipment based on the analysis is 8 excavators, 87 dump trucks, 4 bulldozers, and 2 vibratory rollers to complete the work in 207 days. However, the realization in the field shows deviations due to technical and non-technical factors. The study provides practical recommendations to improve efficiency, including improvements to equipment maintenance schedules and weather impact mitigation strategies.

Keywords: Heavy equipment productivity; Leuwikeris Dam; time study method; civil engineering; environmental impact; resource efficiency.

INTRODUCTION

The Leuwikeris Dam is one of the important infrastructure projects in West Java. This dam is intended to provide a sufficient and reliable water source for the surrounding community. Quarry embankment work on the Leuwikeris Dam Project uses a rockfill-type dam construction with an upright core zone (Choiriyah, 2023). The construction of this dam involves various stages, including *landfill* work such as *cut and fill* operations, excavation, transportation, and material compaction. Embankment work on dams not only has significant technical implications but also considerable environmental and social impacts (Basar et al., 2024).

Previous research by Pawiro (2015) emphasized the importance of the time study method in analyzing heavy equipment productivity, highlighting its role in optimizing project timelines and resource allocation. Similarly, Jones (2021) conducted a comprehensive review of construction equipment productivity, identifying key factors such as equipment maintenance, operator skill, and environmental conditions as critical determinants of efficiency. However, these studies primarily focused on general construction contexts, leaving a gap in understanding the unique challenges faced in large-scale civil engineering projects such as dam construction.

The urgency of this research lies in addressing frequent disruptions encountered in the Leuwikeris Dam Project, such as equipment breakdowns, adverse weather conditions, and material supply delays, which significantly hinder productivity (Rachman et al., 2022). By examining these factors, this study aims to fill the gap in existing literature and provide actionable insights for improving heavy equipment efficiency in similar projects across Indonesia (Putri & Nayono, 2024).

The novelty of this research is underscored by its focus on a specific large-scale dam project, integrating real-time field data with advanced productivity analysis techniques. Unlike previous studies that relied on theoretical models, this research employs a practical approach, using Microsoft Excel for data analysis and incorporating direct observations and interviews with project stakeholders. This methodology ensures that the findings are both relevant and applicable to real-world scenarios (Sharifzadeh & Taghipourtalesh, 2023).

The embankment work on the Leuwikeris Dam Project often encounters various obstacles, including damage to heavy equipment, challenging field conditions, and weather disturbances. Its implementation also considers the availability of existing materials, namely the use of quarry rocks obtained from *Gunung Pangajar*. The productivity of the machines used at this stage has a direct impact on project progress, resource efficiency, and environmental sustainability. Therefore, research on the productivity of heavy equipment in the context of quarry stockpile work is highly important. One of the methods used in productivity analysis is the time study method, which is a work measurement technique that collects data based on the time required to complete a task and is used to calculate the standard time of a job (Pawiro, 2015).

Based on the background described, it is necessary to conduct an analysis of the productivity of heavy equipment in this construction project to determine the factors affecting the *cut and fill* work at the Leuwikeris Dam Project. The focus of this study is to analyze the productivity of heavy equipment used in the *cut and fill* work of the Leuwikeris Dam Project in Tasikmalaya. Based on this background, the formulation of the problem is as follows: What is the productivity of heavy equipment in the Leuwikeris Dam Project? How many units of heavy equipment are used in this project? What is the duration of one activity cycle in the project? What are the influencing factors related to sediment in this project?

The purpose of problem identification is to address the issues present in the research topic, where the identification includes the need to apply knowledge gained during lectures and to understand the concept of heavy equipment productivity in construction work. The limitations of this study include analyzing the productivity of heavy equipment used in embankment excavation work in Package 6 of PT PP *Persero*, observing equipment such as excavators, dump trucks, vibrator rollers, bulldozers, and crawler rock drills, and using data regarding the type of heavy equipment and working hours. The study does not discuss quality or labor aspects, and the research is conducted over a period of two weeks.

The objectives of this research are to determine the productivity of heavy equipment in the *cut and fill* work of the Leuwikeris Dam Project, the number of heavy equipment units used, the duration of one activity cycle, and the causal factors influencing the work. The expected benefits of this analysis are to provide input for academic studies in understanding issues related to civil engineering, especially regarding heavy construction equipment, to enhance the author's knowledge, and to offer readers insights into the productivity of heavy construction equipment in development projects. This study aims to analyze the productivity of heavy equipment using software and project data, including location and regional data relevant to the research.

METHOD

The research design for this study was implemented using Microsoft Excel to calculate and analyze the productivity of heavy equipment in *cut and fill* work at the Quarry of the Leuwikeris Dam Project, Tasikmalaya. The literature study began by collecting relevant data regarding heavy equipment productivity, which served as the object of analysis. This data collection involved gathering references and methods necessary for a literature review from books, journals, previous theses, and online sources.

The data types were categorized into primary data, which was generated by the researchers specifically to address the problems at hand—such as the type of equipment used, working hours, and specifications—and secondary data, which included information previously collected for different purposes, sourced from literature, articles, journals, and relevant internet sites.

The data collection techniques employed included direct observation in the field to closely examine the objects under study, as well as interviews with contractors and relevant project stakeholders. In addition, theories and methods were explored through library research. The analysis was conducted qualitatively, as data was gathered from literature studies, interviews, and field observations, allowing for a comprehensive examination of the issues.

The stages of data analysis involved calculating production capacity based on the volume of each cycle, the time per cycle, and the number of cycles per hour, using specific formulas for different types of equipment such as excavators, dump trucks, graders, and crawler rock drills. Tables and graphs were created to compare equipment productivity, and the factors influencing productivity were described in detail.

The conclusions drawn from this analysis highlighted both the results of productivity calculations and the causal factors affecting them. The presentation of the final assignment report adhered to the guidelines established by the Department of Civil Engineering, Gunung Jati Swadaya University, ensuring systematic structuring and appropriate language use throughout.

The research location was the construction site of the Leuwikeris Dam Project. Administratively, the Leuwikeris Dam is situated in two regencies: Tasikmalaya Regency and Ciamis Regency. On the left side of the Citanduy River flow is *Handapherang Village*, *Cijeungjing Subdistrict*, Ciamis Regency, West Java Province; on the right side of the Citanduy River flow is *Ancol Village*, *Cineam Subdistrict*, Tasikmalaya Regency, West Java Province. The location of the Leuwikeris Dam construction project can be seen more clearly in the accompanying figure.

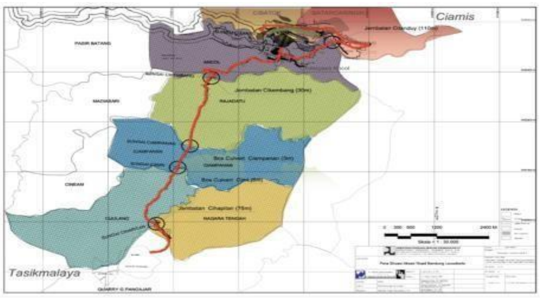

Figure 1. Project Location

Source: Internal documents of PT. PP Perseo (Package 6 Leuwikeris Dam Project), 2025

RESULT AND DISCUSSION

Data Description

In this study, namely regarding research concerning the Analysis of heavy equipment in civil works, the basic principle of calculating heavy equipment productivity is calculating the production of heavy equipment is calculating the production of heavy equipment (m3) then the number of heavy equipment used can be determined and the causal factors in the Leuwikeris Dam construction project. In the description of the data that will be presented from the results of this study is to provide a general overview of the data obtained in the field. Based on the survey conducted, several data were obtained in the field in the form of data on the volume of work on Quarry material excavation and embankment, namely blasting work.

1. Project Overview

Leuwikeris Dam construction project Quarry excavation and embankment work, consists of several work items including:

1) Blasting work

Blasting work includes land clearing, blast hole drilling, detonation, stemming, charging, and Final checking.

Before the implementation of productive blasting, the blasting location is cleaned from soil and plants. Furthermore, in the next stage, pre-cutting is carried out to form a bench face by blasting unwanted parts. So that for the next blasting implementation, a good flat location is obtained for tool access and material loading.

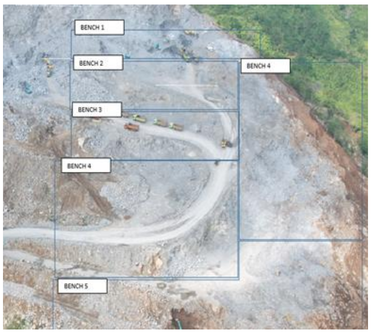

Figure 2. Multi Benches for Access and Material Loading

Source: Results of field documentation by the research team, 2025

After the location is cleared, the process of determining the drilling hole point is carried out by the survey team based on the weekly production plan. Then marking is carried out at the points that have been determined according to the predetermined blasting geometry. Before drilling is carried out using the Crawler Rock Drill heavy equipment. The drilling process of the drill hole point that has been marked according to the predetermined geometry.

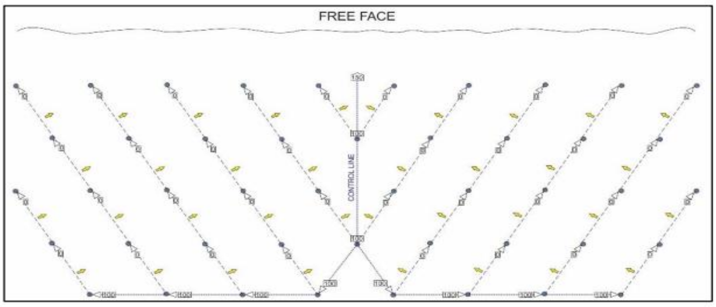

Figure 3. Blasting pattern geometry

Source: Adaptation of *Indonesian National Standard (SNI 2825:2020)* for blasting geometry

To obtain the blasting pattern according to specifications, namely between 20 to 60 cm for rock fragmentation in the Zone 3 Rockfill Embankment and 60 to 80 cm fragmentation for the Rip-rap Embankment, referring to the trial results conducted in the field, the drilling pattern used is 2.5 m spacing and 3 m burden, with a drill hole depth of 6 m.

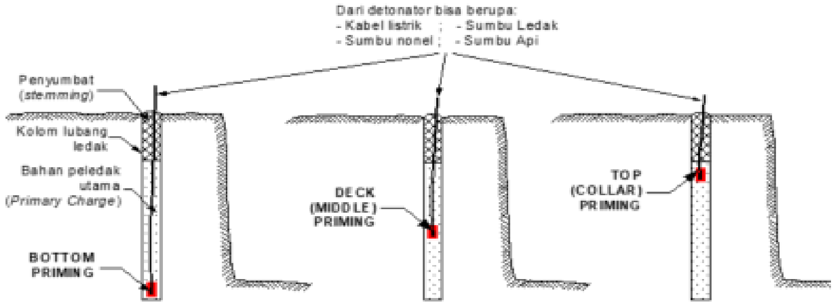

Figure 4. Priming illustration

Source: PT. Construction Dynamics (Blasting Contractor), 2025

All drill holes must be checked one by one, both the depth and the water pool in the hole. If there is a hole that is blocked / damaged, then it is immediately marked, so that re-drilling can be done at that point.

Figure 5. Drilling Stage

Source: Field documentation by the research team, 2025

Continued installation of the detonator (priming) into the available blast hole. After ensuring that all drill holes can be used, explosives are inserted into each hole, with the following arrangement:

Bottom Priming (Explosive mount), thick	: 1,5 m s.d 2,0 m.
Explosive Material, thick	: 3,0 m.
Stemming (Cover), thick	: 1,5 m s.d 2,0 m

Figure 6. stemming stage

Source: Atlas Copco Rock Drills technical guide, 2023

The process of filling the main explosives (explosive concoctions; Bulk Emulsion, Ammonium Nitrate Fuel Oil (ANFO), etc.) into the blast hole that already contains a primer. If the ground is wet, the explosives to be inserted must be wrapped using a plastic condom. Filling the explosives into the blast hole must be carried out by an experienced blaster who has an active KIM (Blasting Permit Card).

Figure 7. Checking Detonator

Source: Safety inspection documents of PT. PP Perseo, 2025

Blasting is done using the Staggered Pattern method, where the holes are positioned in a zigzag pattern. For the assembly of each blast hole, an electric detonator surface delay is used.

After the detonator in each hole has been completely assembled, the assembly is connected to the blasting machine or expoder. The blasting machine is operated by an experienced blaster on the instructions of the Master Blaster and based on the approval of the HSE.

Figure 8. Master Blasting Instructions

Source: Results of an interview with the project's Master Baller, 2025

Before the blasting is carried out, a final check of the circuit is carried out by the Blaster at the location to be blasted, and it will be confirmed to the Master Blaster that the quarry area is ready to be blasted. If there is a condition of the circuit that is disconnected or unsafe, then repairs are carried out until it is confirmed that the location is safe for blasting.

Figure 9. Final checking exploitation

Source: HSE (Health, Safety, Environment) Leuwikeris Dam Report, 2025

2) Material Excavation work

In the next stage, rock material will be loaded using a bulldozer and/or excavator at the blasting location. The pre-cutting material is loaded into a dump truck to be taken to the nearest disposal. Meanwhile, the blasting material that meets the embankment specifications will be hauled for Zone 3 Rockfill Embankment Work (Fragmentation 20-60 cm) and Zone 4 Rip-rap Embankment (Fragmentation 60-80 cm) in the Dam Area (Maindam).

Figure 10. Loading Material
Source: Research team field documentation, 2025

3) Material Embankment Work

The material embankment work consists of preparation work for Excavator equipment, dump trucks, Vibrator rollers, Bull dozers.

The blasting material that has been transported to the dump truck will be hauled to the dam (maindam). The access road that is 13 km long passes through a rigid access road worked on by the Leuwikeris Dam Service Provider Package 4.

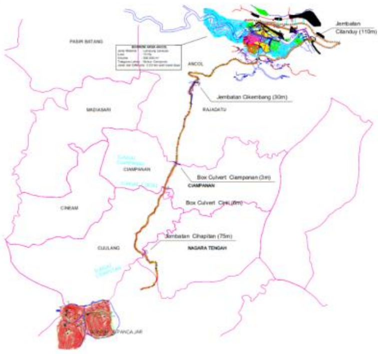

Figure 11. Access Hauling material to main dam
Source: Project access map from the contractor Package 4 Leuwikeris Dam

The steps and stages of Spreading and Cleaning are as follows:

The material taken from the quarry is then unloaded into the dam area. Furthermore, the implementer accompanied by a quality officer carries out quality control on the material that has been unloaded.

Figure 12. Dumping Material Rockfill Quarry
Source: Documentation of the quality control team of PT. PP Perseo, 2025

The material is spread using a Bulldozer with a spreading thickness of 100 cm. The direction of spreading carried out by the bulldozer is done outward, so that the material that tends to be larger shifts outward away from the dam axis.

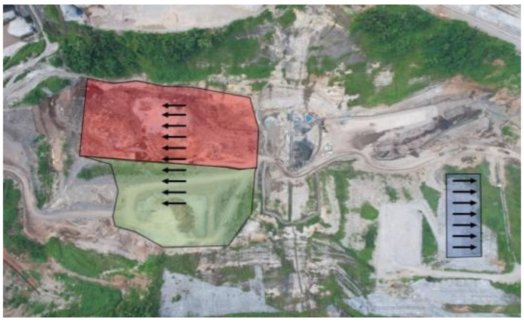

Figure 13. Direction of Rockfill Material Spread Zone 3
Source: Best Practices for Dam Construction (Ministry of PUPR, 2023)

After being spread out, the waste is then transported - the stages of compaction are as follows: The material that has been spread out and cleaned is compacted with a total of 8 passes using a 12 Ton capacity vibro roller.

Figure 14. Rockfill Compaction Using 12 Ton Vibro Roller
Source: Sakai SV512D Vibratory Roller operating manual, 2022

Before starting the implementation of the filling of Zone 3 Rockfill Material, a trial compaction process was carried out which was continued with testing of gradation, density, and permeability in each scheme of the number of passes used to determine the effectiveness of the number of compaction passes in accordance with the technical specifications during the implementation process of the filling of Zone 3 Rockfill Material..

2. Project Data

The volume of work on embankment material for the Leuwikeris Dam Project Package 6 is 1,347,085.86 m3 for Zone 3 Rockfill embankment 1,249,084.90 m3 and Riprap 98,000.96 m3.

Heavy Equipment Productivity Analysis Results

In this study, the volume of work on excavation and embankment work is 1,347,085.86 m3 for Zone 3 Rockfill embankment 1,249,084.90 m3 and Riprap 98,000.96 m3. The heavy equipment used in this work is an Excavator as a digging tool and material loader, a dump truck as a transport tool, a bull dozer as a spreading tool, a vibrator roller as a compactor, and a Crawler rock drill as a Drilling tool. The cycle time of heavy equipment is obtained from observations of the duration of time in the field using the time study method and the working hours are 12 hours/day. After all cycle time data has been obtained, data processing is then carried out to determine the results of the study. Analysis of heavy equipment productivity in spreading aggregate material in the Embankment Excavation Work is as follows.

1) Excavator Productivity Analysis Results

Used to transport excavated material into the dump truck body to the material disposal area (Loading). Excavator productivity is calculated using the following equation:

Figure 15. Excavator hitachi zaxis

Source: Hitachi Construction Machinery official catalog, 2024

Excavator Type : Hitachi Zaxis 350

Area Loading In accordance with the information of the tool catalog, the technical specifications of the tool in question are as follows:

Figure 16. Excavator Hitachi

Source: *Hitachi Zaxis 350 technical catalog*, 2024

Tabel 1. Excavator Hitachi zaxis specification

Bucket capacity, q'	**1,38 m3**
Bucket factors, K	0,80
Work efficiency, E	0,75
Working hours	10 hours
Dig time	16 seconds
Dumping time	6 seconds
Swelling time	4 seconds
Depreciation Factor	1,4

Source: Hitachi Zaxis 350 catalogue and field observations, 2025

Cycle time (Cm) : digging time + (2 x swelling time) + dumping time

: 16 + 8 + 6

: 30 sec

Cyclical production (q): q' x K

: 1,38 x 0,80

: 1,10 m3

Hourly production (Q) : q X 3600 X ECm x Fks

: 1,1o X 3600 X 0,75 30 x 1,4

: 70,97 m3/hours

Production per day : 70,97 x 12 hours

: 851,64 m3/day

2) Dump Truck Productivity Analysis Results

Used to move excavated products from the excavated area to the material disposal area (hauling). Dump truck productivity is calculated using the following equation:

Dump Truck type : BGS-133

Upstream Loading and Exhaust Area In accordance with the information of the tool catalog, the technical specifications of the Loader in question are as follows:

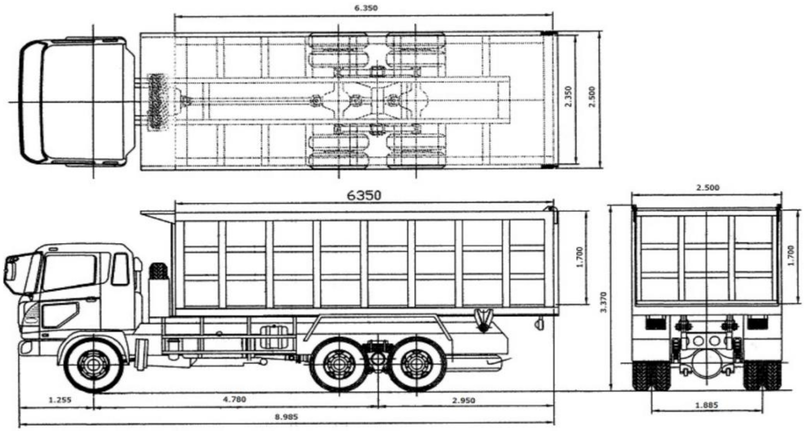

Figure 17. Dump truck capacity

Source: Specification of the tool BGS-133 from PT. United Tractors, 2023

Tabel 2. Dump truck Specification

Body capacity, c	**20 m3**
Loader Capacity, q'	1,38 m3
Faktor bucket loader, K	0,80
Work efficiency, E	0,75
Hauling distance, D	14 km
Time without load, t	55 minutes
Charging time, t'	43 minutes
Waste time, t1	1.44 minutes
Waiting time, t2	35.42 minutes
Loader cycle time, Cms	30 seconds ≈ 0.50 minutes
Working hours	12 hours

Source: BGS-133 technical data from PT. United Tractors, 2023

Loaded Speed Calculation (v): Dt

: 140,92
:15,27 Km/hour
≈254.55 m/minute
Unladen speed (v’) : Dt'
: 140,72
: 19,53 Km/hour
≈ 325,58 m/minute
Number of exca cycles (n) : cq'x K
: 201,38 x 0,80
: 18,12 ≈ 19 cycle
Percyclic production (Q) : n x q’ x K
: 18,12 x 1,38 x 0,80
: 20 m3
Cycle time (Cm)
: n x Cms + Dv +Dv' + t1 + t2
: 18,11 x 0,50 +14000254,55 +14000325,58 + 1,44 + 35,42
: 143,92min
Hourly productivity (Q) : c x 60 x ECm
: 20 x 60 x 0,75143,93
: 6,254 m3/hours
Productivity in a day : 6,254 x 12
: 75,04 m3/day

3) Bull dozer Productivity Analysis Results

Used to perform cleaning and stripping of the top layer (clearing grubbing) at the job site. This tool is located in the material discharge area, Zone 3 Rockfill. To slap the material. The bulldozer activity product is calculated using the following equation:

Figure 18. Bulldozer Komatsu
Source: Komatsu D85ESS-2 brochure, 2023

Komatsu D85ESS-2 is an angle blade dozer crawler and has an operating weight of 21-tons that can be used in almost various sectors such as the construction sector, mining sector, and forestry sector. This unit can also be paired with a towing winch so that it can be used for extracting and logging processes.

Figure 19. Komatsu D85E-SS

Source: Komatsu maintenance manual, 2023

Upstream Zone 3 Area In accordance with the information of the tool catalog, the technical specifications of the tool in question are as follows:

Tabel 3. Bull dozer Komatsu D85E-SS Specification

Bulldozer type	**Komatsu D85E-SS**
Propulsion, Pw	215 HP;
Width/span of blade, L	3,62 m;
Height blade, H	1,3 m;
Blade Capacity, q	L x H2 = 6,11 m3.
Displacement Distance, D	10 m;
Work efficiency, E	0,65
Blade factor, a	0,60
Working hours/day,	9 hours;

Source: D85ESS-Manual, Komatsu 2 2023

Forward speed, F1 = Forward time/ distance
= 0,2233/10
= 44,78 m/minute ≈ 2,69 km/hours
Reverse Speed, F2 = Backward time/ distance
= 0,3/10
= 33,33 m/ minute = 2,00 km/ hours
-Perseneling change time, Z = 0,05 minute

Cyclical production (q) : H2 x L x a
: 1,68 x 3,62 x 0,60
: 3,64 m3

Forward speed (F) : 2,69 x 0,65
: 1, 75 Km/hour ≈ :29,10 m/min

Reverse Speed (R) : DF+ DF+Z
: 1029,10+ 1021,67 + 0,05
: 0,86 min

Hourly Bulldozer Productivity (Q) : q x 60 x ECm
: 3,64 x 60 x 0,650,86
: 166,1241 m3

Bulldozer Productivity per Day (Q) : 166,1241 x 9 hours
: 1495, 12 m3/day

4) Vibrator roller Productivity Analysis Results

Tabel 4. Vibrator Roller Sakai SV 512D Specification

Tool Type: Sakai SV 512D			
Effective width of compaction (Be)	:	2,30	m
Average speed (v)	:	2,00	km/jam
Thick Solid Overlay (T)	:	0,65	m
Tool efficiency factor (Fa)	:	0,75	
Number of trajectories (N)	:	8,00	

Source: Tool specifications from *Sakai Heavy Industries*, 2022

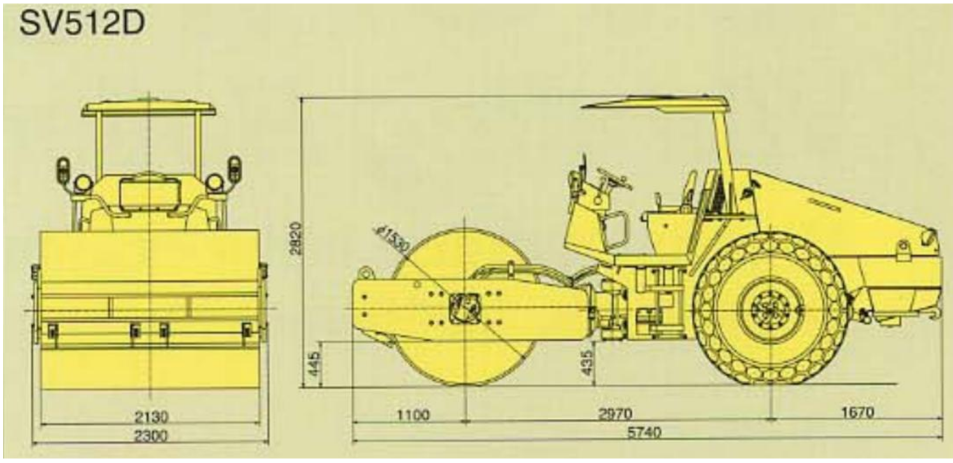

Figure 20. Vibrator roller Sakai 512D Specification

Source: Sakai Heavy Industries white paper, 2022

Q	**=**	**(be**	**x**	**v**	**x**	**1000)**	**x**	**t**	**x**	**Fa**
					n					
	=	2,30	x	2,00	x	1000	x	0,65	x	0,75
					8,00					
	=	280,31	m³/hour							

Daily Productivity					
Q	=	Daily productivity		x	Work hour
	=	280,31	m³/hour	x	12
	=	3363,75	m³/day		

5) Crawler Rock Drill Productivity Analysis Result

Used to make explosive holes. Explosives are used in rock excavations using the blasting method. The drill tool used is a CRD top hammer type with a rotary percussion drill motion system. This tool is driven by a compressor which is still part of the drill with a pressure of 10.5 kg/cm2 and can circulate air at 6.8 m3/minute. The traveling speed of this drill is 0-3.5 km/hour.

Figure 21. Furukawa crawler rock drill

Source: Furukawa Rock Drill PC200 operational guide, 2021

The productivity of the drill tool is a value that determines the workability of the drill tool. This productivity is expressed in units of m3/hour, which means the drill can dismantle rock (m3) in one hour. Drill tool productivity is calculated using the following equation:

Tabel 5. Crawler rock drill specification

Tool Name & Type	Furukawa Rock Drill PC200
Burden, B	2.75 m
Space, S	3.25 m
Positioning time, Ct	2 minutes
Drill time, Bt	4.5 minutes
Stop time, St	7.82 minutes
Delay time, Dt	9 minutes
Average borehole depth, Hr	5.44 m
Work efficiency, E	0.75

Source: Furukawa Rock Drill PC200 operational data, 2025

Average cycle time (Ct) :
Ct + Bt + St + Dt : 2 + 4.5 + 7.82 + 9 : 23.32minutes
Average Drilling Speed (Drr) : Hr / Ct
: 5.44 / 23.32
: 0.23 m/min
Rock volume exposed (V) : B x S x Tj
: 2.75 x 3.25 x 6
: 53.625 m
Equivalent volume value (Veq) : V/H
: 53.625/5.44
: 9.85m2
Tool productivity (P) : E x Veq x Drr x 60
: 0.23 x 60
: 103.48 m3/hour

Results Of Analysis Of Heavy Equipment Requirements And Work Duration

After the analysis of heavy equipment productivity is carried out, the next step is to analyze the need for heavy equipment and the duration of work based on the production value of each heavy equipment. The results of heavy equipment productivity can be seen in the following table:

Tabel 6. Heavy equipment productivity

No	Heavy equipment	Hourly productivity (m³/hours)	Hourly Site out (m³/day)
1	Excavator	70,97	851,64
2	Dump Truck	6,254	75,04
3	Bull dozer	166,1241	1495, 12
4	Vibrator Roller	280,31	3363,75

Source: Results of field data analysis using the time study method, 2025

can be seen the productivity value of each heavy equipment. Excavators have the highest productivity value compared to other heavy equipment and for the need for the equipment is calculated as 1 unit. So in calculating the number of other heavy equipment, an analysis is carried out by dividing productivity with other equipment (excavators, dump trucks, and vibrator rollers). The analysis of heavy equipment needs is as follows:

Daily production target 207 days = 1.347.085,86 m3/ 207 day
= 6.507,66 m3

With the following heavy equipment requirements:

Excavator daily productivity = 851,64 m³/day
= 1 unit

Number of Excavator heavy equipment:
= Daily production target/daily productivity
= 6.507,66/ 851,64 m3
= 7,64 ≈ 8 unit

For Excavator tools are 8 units and the duration of work is 1 day. Furthermore, to find out the number of Dump Truck heavy equipment, the following analysis is carried out:

Dump truck daily production = 75,04 m3/day
= 1 unit

Number of Excavator heavy equipment
= Daily production target/daily productivity
= 6.507,66 m³/day / 75,04 m³/day
= 86,72 ≈ 87 unit

Based on the analysis results, the number of Dump truck heavy equipment was 87 units and the duration of time that had been analyzed was 1 day. Furthermore, to find out the number of Bull dozer heavy equipment, the following analysis was carried out:

Bull dozer daily production = 1495, 12 m3/day
= 1 unit

Number of Excavator heavy equipment
= Daily production target/daily productivity
= 6.507,66 m³/day / 1495, 12 m³/day
= 4,35 ≈ 4 unit

Based on the analysis results, the number of Bull dozer heavy equipment is 4 units and the duration of time that has been analyzed is 1 day. Furthermore, to find out the number of Vibrator roller heavy equipment, the following analysis is carried out:

Vibrator roller Daily Production = 3363,75 m3/day

= 1 unit

Number of Excavator heavy equipment

= Daily production target/daily productivity

= 6.507,66 m^3/day / 3363,75 m^3/day

= 1,93 ≈ 2 unit

Based on the analysis results, the number of Vibrator roller heavy equipment is 4 units and the duration of time that has been analyzed is 1 day. After all the analysis of heavy equipment needs is obtained, a comparison is made according to the reality in the field.

Comparison Of Field Analysis Results

In the Quarry excavation and embankment work of the Leuwikeris dam, the Quarry Work Volume is 1,347,085.86 m3 for the Zone 3 Rockfill embankment of 1,249,084.90 m3 and Riprap 98,000.96 m3. With a work duration of 207 days, the daily work volume target is 6,507.66 m^3/day. So that in this study the work volume refers to the work volume that has been done. So that for a comparison of tool requirements based on analysis and reality in the field can be seen in the table:

Tabel 7. analysis heavy equipment

No	Type of heavy equipment	Total	
		Analysis	range
1	*Excavator*	8	8
2	*Dump Truck*	87	84
3	*Bull Dozer*	4	4
4	*Vibrator Roller*	2	2

Source: Comparison of field data and productivity calculations, 2025

In the table, you can see the comparison of heavy equipment needs based on analysis and reality in the field. From the analysis, the number of excavators is 8 units, dump trucks are 87 units, bulldozers are 4 units, and vibrator rollers are 2 units. While in the field, the heavy equipment used is 8 units, dump trucks are only 84 units, bulldozers are 4 units, and vibrator rollers are 2 units. This makes the analysis and reality in the field not far apart. For more details, see the picture:

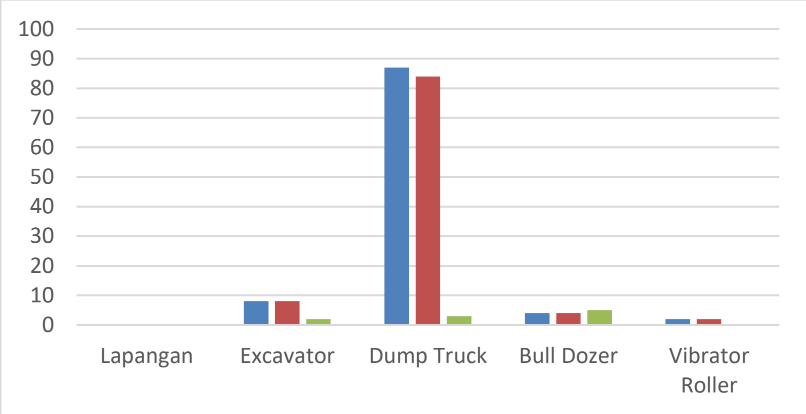

Figure 22. Diagram analysis heavy equipment

Source: Field data analysis by researchers, 2025

In the picture, you can see a comparison chart starting from excavators, dump trucks, motor graders, and vibrator rollers based on the analysis results and the reality in the field. The need for tools also affects the duration of the work. Based on the analysis, the realization of the duration of work in the field can be analyzed as follows:

Average Dump truck on site = 84 unit

Average daily production in the range :

= Daily productivity x Number of Dump truck units

= 525,336 m3/day x 84 units

= 6304,1 m3/day

Duration of work required = Volume of material / Production in the field

= 1.347.085,86 m3 / 6304,1 m3/day

= 214 days or 236 effective days

To achieve the desired work volume of 1,347,085.86 m3, the duration of work required is 236 effective days because the work progress is delayed, then interviews and discussions were conducted regarding the factors that influence the productivity of heavy equipment in the excavation and embankment work of the Leuwikeris Tasikmalaya Dam Construction Project. Discussions were conducted with several parties directly involved in the field.

Heavy Equipment Rental Cost

Table 8. Calculation of tool productivity

Unit	Number of tools	Tool productivity	
	N units	Hourly (m^3/hour)	per day (m^3/day)
Excavator Hitachi Zaxis	8	70.97	851.64
Dump Truck	87	6.254	75.048
Bull Dozer Komatsu	4	166.124	1495.116
Vibrator Roller	2	280.31	3363.72
Crawler Rock Drill	2	103.48	1034.8

Source: Analysis of tool productivity calculations based on field data

Table 9. Heavy equipment rental costs

Length of work time		Rental Fees	
T (hour)	**Total Days**	**Rental/hours**	**Cost**
12	207	Rp 560.000,00	Rp 11.128.320.000,00
12	207	Rp 588.000,00	Rp 127.071.504.000,00
9	207	Rp 836.400,00	Rp 6.232.852.800,00
12	207	Rp 438.000,00	Rp 2.175.984.000,00
10	207	Rp 414.000,00	Rp 1.713.960.000,00
Total			**Rp 146.608.660.800,00**

Source: Heavy equipment rental price list from contractors

Factors That Influence The Productivity

One way to find out the causal factors that affect the productivity of heavy equipment in the excavation and embankment work of the Leuwikeris Tasikmalaya Dam construction project. Discussions were conducted with several parties directly involved in the field. Based on the results of discussions and questions and answers in the field, there are causal factors that affect productivity, namely:

1) Weather and climate

At the time of data collection in the field which was carried out at the end of the year. At the time of data collection in the field the humidity and rainfall levels were very high. In one week it could rain about 3 to 4 times and for a long duration. This causes the work area in the field to become wet and the work process has to be stopped. If it rains at night, then automatically the morning work must be postponed and moved to the afternoon work. This is due to the humid field conditions and the risk that Blasting cannot be carried out or postponed to the next day. In addition, it takes a long time to dry the area, one way to make the work area dry is to wait for the sun to shine again and the area to dry evenly.

2) Tool breakdown

Heavy equipment failure is one of the most significant problems in construction projects. When heavy equipment fails, project productivity can be significantly disrupted. Damaged heavy equipment can cause delays in project completion, increase operational costs and can even compromise worker safety.

At the time of data collection, there were several heavy equipment that were experiencing damage, the Kobelco Excavator experienced sensor damage for several days, but in repairing it, the subcontractor had a solution, namely renting other heavy equipment that could temporarily replace the heavy equipment being repaired. Other heavy equipment that often experiences damage is the 20-ton Excavator such as damaged sensors, service, and Repair Bucket excavator.

The Right Time for Maintenance and Care:

1. Before the project starts, to ensure that all heavy equipment is in good condition and ready to use.
2. During the project, to perform routine maintenance and care and prevent damage.
3. After the project is completed, to perform final maintenance and care and ensure that all heavy equipment is in good condition for the next project.

Solutions to Overcome Heavy Equipment Damage:

a. Perform routine maintenance and care, such as checking and replacing worn parts.

b. Use advanced technology, such as monitoring and data analysis systems, to monitor the condition of heavy equipment and prevent damage.
c. Train workers to use heavy equipment properly and perform proper maintenance and care.
d. Develop contingency plans to deal with heavy equipment damage, such as having spare parts ready to use and having a trained maintenance team.

4. Delays in material entry

When data was collected in the field, there were several days when blasting was not carried out because the explosive material for charging activities was late in arriving. So the blasting activities must be held for that reason.

CONCLUSION

From the research and discussion on the analysis of heavy equipment productivity in the excavation and embankment work of the Leuwikeris Dam Project, Tasikmalaya, it was concluded that there was a change in the duration of the excavation and embankment work at the *Gunung Pangajar* Quarry, which was initially planned for completion in 207 working days but extended to 214 or even 235 effective working days. The total number of heavy equipment units used in the project consisted of 8 excavators, 84 dump trucks, 4 bulldozers, 2 vibrator rollers, and 2 sets of crawler rock drills. The total cost for selecting and operating heavy equipment for quarry work in the excavation and embankment activities amounted to Rp. 146,608,660,800.00. It is recommended to subcontractors that the efficiency factor of the equipment used should be aligned with the condition and state of the equipment, the operator's capabilities, proper maintenance practices, and actual field conditions.

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