THE USAGE OF MINING VOID IN LIMESTONE MINING FOR MICRO HIDRO POWER PLAN IN PT. SEMEN BATURAJA (PERSERO) TBK

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Research Paper

The Usage of Mining Void in Limestone Mining for Micro Hidro Power Plan in PT. SEMEN BATURAJA (PERSERO) Tbk

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Abstract
Pt. Semen Baturaja TBK Persero is one of the state-owned companies engaged in the cement industry, since 1974 located in West Baturaja, Ogan Komering Ulu, South Sumatra Province. PT Semen Baturaja utilizes limestone as the main raw material in making cement by applying surface mining and blasting methods. Every end of the mining activity must implement reclamation. One of the post mining activity plans by PT Semen Baturaja Tbk is to utilize voids as a micro hydro power plant. One of the parameters that must be met is the quality of water. The results of water sample testing indicate that the water content in the limestone mining area has a suspended solid content of 17-22 mg/L, with the metal content contained in the water still below the water quality standard. With a void area of 53.94 Ha, it is capability to storing of water, void in the area of the former limestone mining at PT Semen Baturaja has the potential as a source of water for micro-hydro power plants

Keywords
reclamation, post mining, voids, micro hydro power plant

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1. INTRODUCTION

Rapid infrastructure development in Indonesia needs to be supported by the availability of adequate raw materials, one of them are cement. PT Semen Baturaja (Persero) Tbk is a cement producer that contributes in supplying national cement needs. The main raw material in making cement is limestone. PT Semen Baturaja (Persero) Tbk to meet the need for limestone to carry out limestone mining activities located in Pusar Village, West Baturaja, Ogan Komering Ulu. Production Operation Mining Permit (Production Operation IUP) of PT Semen Baturaja (Persero) Tbk for limestone mining is Number: 01 / K / IUP-II.A3 / XXVII / 2010 with an area of 103.4 Ha on March 23, 2010.

Mining commodities have non-renewable characteristics, so that the use of mining has a limited period of time, in accordance with its potential reserves. Another feature of mining activities has a relatively higher physical and social impact on the environment. Mining activities can lead to environmental degradation problems that originated from the loss of vegetation and topographic changes which are generally followed by the negative impact of decreasing the ability of water infiltration and erosion, will lead to degradation of soil fertility and hydro logical systems. Topographic changes caused by mining activities are the emergence of mine voids. Problems that arise as a result of mining activities are the emergence of diseases caused by mining waste that are not handled properly, there is a decline in environmental quality (Djakamihardja and Mulyadi, 2013; Munir et al., 2017).

The final environmental that is usually caused by limestone mining is in the form of ex-mining land and also mine pit (void). Void can be grouped into three parts, there are (a) existing void, is a void found in the mining area during the mine's operation; (b) residuals void, are voids that occur during mine closure; and (c) the final void, is a void formed after the end of all mining production operations in the end of the mine's operational life (Juniah, 2014).

The mine excavation pit at the end of mining will become a reservoir area for runoff and rainwater because the topography tends to be lowers with compacted soil structure. Stagnant land will gradually become a new artificial water reservoir (Iriadenta, 2016).

One of the important issues for the government and the mining industry in Western Australia is the void formed after the mine or at mine closure. Voids in the long term have the potential to cause environmental impacts. Some of the previous studies on the use of post mining include the use of post coal mining land at PT Adaro Indonesia for freshwater aquaculture, water tourism, drinking water; PT Kaltim Prima Coal and PT Bukit Asam for tourism, aquaculture. These research have studied the utilization of voids, but there has been no research on the use

of limestone void as a micro-hydro power plant (Juniah, 2014; Moersidik, 2014).

Reclamation activity is an activity to organize, restore, and improve the environment so that it cans function according to its usage (ESDM, 2014).

2. EXPERIMENTAL SECTION

This research was carried out on 27 August to 23 October 2018 in the limestone mining at PT Semen Baturaja located in West Baturaja, Ogan Komering Ulu, South Sumatra. The methods used include: literature study, data collection, data processing, data analysis and conclusions

2.1 Study of Literature

At this stage researchers are looking for literature sources related to the subject matter of limestone mining and utilization of voids as micro hydro power plants. The literature in question includes journals, books, and institutional documents.

2.2 Data Retrieval

Collecting data activities begin with field observations. Field observations were carried out to find out the actual conditions. Data retrieval activities consist of:

1. Primary Data: the primary data in this study is the samples of water and soil samples at the limestone mining. Water samples were obtained from the limestone mine inlet and the outlet of a mine drainage channel. The soil used as the sample test is top soil in the area of wild vegetation where there is no disturbance in mining activities. Questionnaires were also made to residents of the surrounding area.
2. Secondary Data: Secondary data obtained from observation at PT. Semen Baturaja (Persero) Tbk. are as follows: initial environmental condition, ultimate pit limit map, mining final condition map, and rainfall data.

2.3 Processing Data

Primary data and secondary data that have been obtained in the form of water quality samples are tested to determine the content of mine water. Ultimate map, final environmental conditional map, rainfall data is processed to determine the volume of voids of the post limestone mining. The sample results of the questionnaire for residents around the mining area were processed as data that represented the overall population.

2.4 Data Analysis

Data analysis was carried out by analysing the results of mine water quality testing on water quality standards set by the Governor of South Sumatra. Questionnaire data is used as a reference for public opinion on the plan to use voids as a micro-hydro power plant.

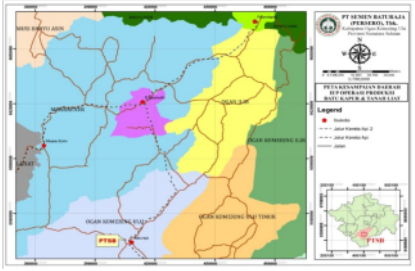

Figure 1. Research Location Map

3. RESULTS AND DISCUSSION

3.1 Research Location

The area of Production Operation PT Semen Baturaja IUP is located in West Baturaja, Ogan Komering Ulu, South Sumatra. PT Semen Baturaja has an area of Production Operation IUP covering an area of 103.4 Ha. The IUP area has bumpy geomorphology to the highlands. Morphological conditions in the Batukapur Mining area of PT Semen Baturaja can be seen in Figure 1.

The research location is in West Baturaja Ogan Komering Ulu, South Sumatera. The location can be reached by using road trough Palembang-Prabumulih-Baturaja Provincial Road with a distance of ± 200 km from Palembang City.

3.2 Initial Environment Condition

Limestone mining area at PT. Semen Baturaja (Persero), Tbk has a hilly topography with a height varying from 40 meters to 60 meters above sea level (masl). The topography of the mining area in the Pusar area is characterized by Karst topography with an average height of 45 meters above sea level. The PT Semen Baturaja Mining Business Area is limited by the population area to the west and east. North of the mining area, the Kemene River flows, the sub of Ogan River that has an elevation of 42 meters above sea level. The Ogan River flows to the south with an elevation of 37 meters above sea level.

Based on data from the Feasibility Study document, the research area is located on the Palembang sheet geological map. In Palembang sheet, there are stratigraphic units of Telisayang rock and Palembang group, both of which are formed in tertiary times. The Telisayang group is formed in the phase of sea inundation, while the Palembang group is formed in the phase of sea shrinkage.

Based on drilling data and surface geological observations, rock types in the study area are included in the Baturaja Formation which is a carbonate deposit composed of carbonate limestone and limestone and marl-coated calcarenite. The top of the formation is hanging out with the Gumai Formation. The geological structure that develops in the study area is a rising fault.

The research area based on descriptive morphology division has four morphological units, those are:

1. Low Corrugated Morphology Unit

Figure 2. Taking Water Sample in Inlet (S : 04°07'41" ; E : 104°09'09") and Outlet S : 04°07'37,7" ; E : 104°09'16,6"

2. The Wavy Corrugated Morphology Unit
3. High Corrugated Morphology Unit
4. The Unit of Steep Hill Morphology

Research locations are generally included in tropical regions. Data on climatology and meteorology in the study area were obtained from PT Semen Baturaja's RPT in 2017, which is vulnerable to data collection over the past ten years, from 2006 to 2015 shown in Table 1. Based on the data obtained shows that the annual rainfall ranges from 87 to 201 days. The largest number of rainy days occurred in December and January, namely 21 days / month. The least rainfall data in August is 61.3 mm and the highest is 350 mm in December. Wet months occur from October to April, dry months occur from May to September, last for five months.

In the study area tested the surface water quality. Water sample collection includes taking at the mine water inlet and outlet, shown in Figure 2. The results of the data obtained become parameters of the feasibility of mine water to be used by the community around the mining area. Feasibility is based on water quality standards that have been determined by the decision of Governor Ordinance of South Sumatera number 8 of 2012 concerning Liquid Waste Quality Standards for Industrial Activities, Hotel, Hospital, Domestic and Coal Mining (SouthSumatraGovernment, 2012).

The hilly topography conditions make the type of vegetation found in the form of dry land vegetation. Based on the results of the field survey, the type of vegetation found in the area around the research in Batukapur mining PT. Semen Baturaja is a shrub and plantation crop in the form of rubber plants. Vegetation of Batukapur mining area of PT Semen Baturaja is shown in Figure 3.

Figure 3. Vegetation condition in Mining area at PT Semen Baturaja

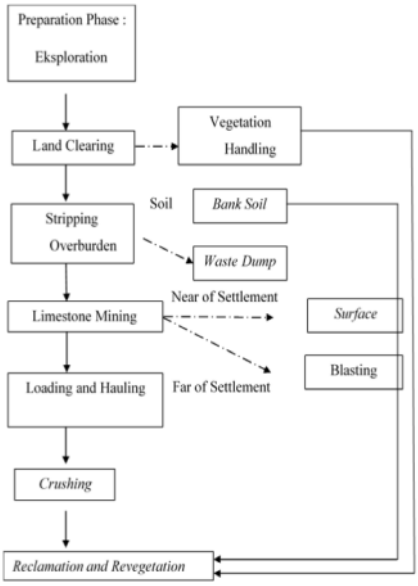

Figure 4. Flowchart of Mining Activity at PT Semen Baturaja

3.3 Mining Plan

3.3.1 Technical Mining

The number of mined reserves in limestone is 35 million tons, with estimated mined reserves in the first five years being 16,560,647 tons or 7,200,281 BCM, with overburden amounting to ± 3,999,695 BCM.

Based on the investigation, batukapur deposits are found in the Gumai Formation and Baturaja Formation with a depth of 25 meters. Based on the characteristics of the overburden and limestone layer, the mining applied is an open pit mine using the open pit method. PT Semen Baturaja Flow Chart activity can be seen in Figure 4.

Mining activities in an effort to utilize limestone non-renewable natural resources are carried out by open-pit mining with quarry mining systems such as in England mining. The activities planned for mining operations at PT Semen Baturaja include: (Eugene and P, 2014)

1. Land Clearing Land Cleansing Activities aim to open mining sites from vegetation that covers the land so that it is possible to carry out further activities. The work tool used is a bulldozer.
2. Stripping Overburden The overburden stripping activity is carried out by taking the top soil, peeling rocks that cover the commodity material. Topsoil are dug and stockpiled into the bank top soil for further distribution to reclama-

Table 1. Result of Water Analysis

No	Parameter	Unit	Maximum Allowed Rate[10]	Result		Examination Method
				Inlet	Outlet	
	A. Physic					
1	Temperature	C	38	25.4	26.8	SNI 06-6989.23-2005
2	Solid Dispension	mg/L	2000	31	20	Direct Reading
3	Solid Suspension	mg/L	200	22	17	Direct Reading
	B. Anorganic Chemical					
1	pH	#	6-9	6.07	6.07	SNI 06-6989.11-2004
2	Iron (Fe)	mg/L	5	0.12	0.08	SNI 6989.4-2009
3	Mangan (Mn)	mg/L	2	0.05	0.05	SNI 6989.5-2009
4	Barium (Ba)	mg/L	2	0.001	0.001	SNI 06-6989.16-2004
5	Copper (Cu)	mg/L	2	<0.003	<0.003	SNI 6989.6-2009
6	Zinc (Zn)	mg/L	5	0.03	0.001	SNI 6989.7-2009
7	Chrom total (Cr)		0.5	<0.018	<0.018	SNI 06-6989.17-2004
8	Cadmium (Cd)	mg/L	0.05	<0.0015	<0.0015	SNI 6989.16-2009
9	Mercury (Hg)	mg/L	0.002	<0.0001	<0.0001	AAS-MVU
10	Lead (Pb)	mg/L	0.1	<0.003	<0.003	SNI 6989.8-2009
11	Arsene (As)	mg/L	0.1	<0.0009	<0.0009	AAS-HVG
12	Selenium (Se)	mg/L	0.05	<0.0012	<0.0012	AAS-HVG
13	Sianida (CN)	mg/L	0.02	0.004	0.002	Spektofotometri
14	Cobalt (Co)	mg/L	0.4	0	0	SNI 6989.68-2009
15	Flourida (F)	mg/L	2	0.25	0.17	SNI 06-6989.29-2004
16	Ammonia (NH_3−N)	mg/L	1	0.33	0.32	NI 06-2479-1991
17	Nitrat, as N (NO_3)	mg/L	20	2.92	2.9	SNI 06-2480.1991
18	Nitrit, as N (NO_2)	mg/L	1	0.18	0.174	SNI 06-6989.9-2004
19	Needed BOD5	mg/L	50	2.62	2.51	SNI 06-2503-1991
20	Needed COD	mg/L	100	19	15	SNI 6989.2-2009
21	Disolved Oxygen (DO)	mg/L	-	2.07	2.01	SNI 06-6989.14-2004
22	Sulfide (H_2S)	mg/L	0.05	<0.03	0	SNI 698970-2009
	C. Organic Chemical					
1	Oil and Fat	mg/L	5	0.19	0.13	SNI-06-6989.10-2004
2	Fenol	mg/L	0.05	0	0	SNI 06-6989.21-2004

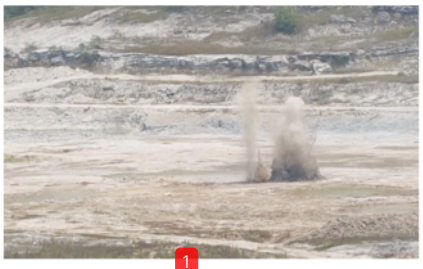

Figure 5. Blasting Activity in Limestone Mining at PT Semen Baturaja

Figure 6. Surface Mining Activity

tion activities. The planned mechanical devices are:

(a) One unit of class 20 T excavator for top soil and 1 unit of class 30 T excavator for overburden
(b) One unit bulldozer to push the topsoil material.

3. Disassembly Mining activities at PT Semen Baturaja carried out two methods of dismantling, namely the method of unloading without blasting and the method of dismantling with blasting, shown in Figure 5 and Figure 6. The mechanical tools used in the unloading method are class 500 surface miners and 30 T excavators. The class miner T 500 has a cutting tool on the bottom of the machine that functions as crockery which then fragments the material to be loaded by a 30 T excavator into the hauling machine.
4. Loading and Hauling Loading and transporting activities include loading of limestone into crushing plan and topsoil to be stored in bank soil to be used again in reclamation activities. The excavator and conveyor planned for limestone mining are:
   (a) 1unit excavator class 20T for top soil material
   (b) 1 unit excavator class 30T to dig overburden and limestone
   (c) dump truck class 30T for transporting the limestone to the crusher or ROM

3.3.2 Usage Mining Void for Micro Hydro Power Plan

Surface water at the end of the limestone mining activities at PT Semen Baturaja will be arranged based on the water flow pattern and the final morphological conditions of the mine. The quality of surface water will change both physically and chemically during the development of limestone quarrying.

Water sampling at the research location includes water at the inlet and outlet, with the results of testing in the lab, can be seen in table 1. The results of testing the samples in the inlet water samples showed results similar to the water outlet samples, both in physical properties, chemical content both inorganic and organic chemistry. The pH level of both samples is 6.07, where the allowed pH threshold is 6-9.

Metal content in samples such as iron, mercury, sulphide, copper and other metals is still below the maximum permissible level. Based on the results of the permit value, it can be noted that the quality of mine water in the limestone mining of PT Semen Baturaja has met the water quality standard, both in physical and chemical properties.

The water quality classification is divided into four classes, covering the first to fourth grades. The results of the comparison of water quality sample data in the PT Limestone Baturaja limestone mine with water quality classification standards, it is known that water samples taken from the limestone mine inlet and outlet are second class water. Water with second class quality criteria has the use of water as a means of water recreation, freshwater fish cultivation, livestock, and water to irrigate landscaping, and or other uses that require the same water quality as these uses (IndonesianRepublicGovernment, 2001).

The results of testing water samples show that the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) exceed the threshold of the first class standard. High levels of biochemical oxygen (BOD) and chemical oxygen (COD) indirectly indicate water pollution caused by domestic waste, agricultural waste or mining waste (Juniah and Rahmi, 2017).

The test results of water samples sulphide in the inlet and outlet of the water quality standard second-class show different results. The sulphide content in the inlet water sample is less than 0.03 mg/L, far exceeding the second class sulphide threshold of 0.002 mg/L. Testing of water samples at the outlet was not found in sulphides.

Plans for inundation of mining void can be seen in (Figure 7). With a void area of 53.94 Ha, it is capable of storing water as much as m^3, void in the area of the former coking stone at PT Semen Baturaja has the potential as a source of water for micro-hydro power plant.

4. CONCLUSIONS

Conclusions that can be expressed from the explanation of previous chapters are as follows:

1. Characteristics of the initial hue in limestone mining in West Baturaja, Ogan Komering Ulu has a tropical climate, with susceptible monthly rainfall between 4 mm to 715 mm. The dominant vegetation encountered was scrub.
2. The results of testing water samples in the limestone mine of PT Semen Baturaja TBK taken from two locations, inlet and outlet, water samples are still in a safe zone from the maximum limit that has been determined, both from

Figure 7. Final Condition Environmental Map of Limestone Mining in PT Semen Baturaja

physical and chemical properties. Void that will be formed at the end of mining has an area of 53.94 hectares has the potential as a water reservoir. Based from these two variables, limestone mining voids at PT Semen Baturaja (Persero) have the potential as micro-hydro power plants.

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