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Application of Air Deck Method to Reduce the Impact of Ground Vibration and Optimization of Limestone Fragment Size in Blasting Activities at PT Semen Baturaja (Persero), Tbk.

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Keywords
Air Deck, Fragmentation, Ground Vibration, Blasting.

ABSTRACT
The field experiment of applying the air deck method to the limestone blasting activities of PT Semen Baturaja (Persero), aims to reduce the impact of ground vibration considering that mining activities are approaching residential areas. In addition, the size of the fragmentation of the blasting results is very important for the effectiveness of the crushing plant. To determine the effectiveness of the application of the air deck method in limestone mining (quarry), blasting planning activities are carried out by dividing the two blasting locations, namely blasting with the air deck method and without using an air deck. By using a zig-zag blasting pattern and the number of holes of 50 Lb, the depth of the drill holes is 9 meters (without air deck) and 13 meters and the type of explosive used is Nonel. From the results of the analysis of limestone blasting with data processing using the split desktop 2.0 demo application, the ground vibration value (micromater system) was obtained. The average value of ground vibration (pVS) shows a smaller value using the air deck method of 0.68 mm/sec while without air deck of 0.74 mm/sec. The results of limestone fragmentation analysis with the air deck method obtained size <75cm reached 91.93%, while for without air deck it was 80.27%. These results show that the air deck method can be applied as a method to assist the Company in reducing ground vibration and limestone fragmentation effectively and efficiently by considering natural factors including geographical factors.

INTRODUCTION

PT Semen Baturaja (Persero) Tbk. is a company with industrial commodities in the cement sector. The processed product is limestone. Limestone removal activities are carried out using two methods, namely using the Wirtgen 2200 Surface Miner tool and drilling and blasting activities. In blasting activities, there are many risks that can be caused as a form of effect from blasting activities, one of which is ground vibration (Cui et al., 2023; Poorghasem & Bao, 2023; Yan et al., 2020).

At PT Semen Baturaja (Persero) Tbk, the condition of the blasting location is very close to residential areas so that sometimes there are some inputs from the local community regarding the impact of ground vibration itself. This factor also becomes one of the prioritised focuses as an impact of blasting activities.

The air deck method is considered capable of reducing the impact of ground vibration generated by the blasting activity itself (Afrasiabian et al., 2021; Zarei et al., 2022). The current condition of the blasting location is very close to residential areas, so it is hoped that the utilisation of this method can be useful for mutual benefit and safety (Cheng et al., 2022; Ding et al., 2023). In addition to using the air

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deck method, it is also used to regulate the number of shootings depending on the number of blast holes assembled in one series, which ranges from a dozen holes in 1 series or can be called the application of Initiation Point (IP).

This method is done so that the vibration is directed away from residents' homes so that only the residual vibration from the blasting leads to residents' homes where the vibration is a vibration with a low vibration level (Ramadhan et al., 2020). This method is carried out so that the vibration is directed away from residents' homes so that only the residual vibration from the blasting leads to residents' homes where the vibration is a vibration with a low vibration level (Bhagade et al., 2021; Lou et al., 2020) The type of explosive used is Dabex. Dabex is a mixture of Ammonium Nitrate and emulsion in a ratio of 30% and 70% (Rezaeineshat et al., 2020). Dabex explosives are shown in Figure 1.

Dabex itself is distributed using a special tool called Mobile Manufacturing Truck (MMT). This tool can transport Dabex up to 5000 kg. The Mobile Manufacturing Truck (MMT) can be seen in Figure 2. In carrying out blasting activities, PT SMBR applies the top air deck method. Meanwhile, the air deck media used by PT DAHANA in carrying out blasting activities at PT SMBR is in the form of B3 waste products such as used cement sacks and used plastic ANFO packaging. This air deck media is used as an innovation in waste utilisation at PT. SMBR. An illustration of the use of the top air deck method is attached in Figure 3 (Kabwe & Banda, 2018).

Based on SNI 7571/2010, for the area around the mining site with masonry and cement mortar building types, including buildings with wooden foundations and cement mortar floors, it is determined that the maximum blasting vibration threshold is 3 mm/s (Kasbillah et al., 2023; Liu et al., 2023). Indonesian Government regulations governing the amount of ground vibration allowed to buildings can be seen in Table 1 (Hudaverdi & Akyildiz, 2021).

In addition, based on other research, it is known that the use of the air deck method is also effective in making the fragmentation of blasting results more uniform than the conventional blasting method. This is because this method maximizes the blasting energy in the blast hole so that when blasting is carried out, the resulting fragmentation will produce few boulders.

METHODS

The research was conducted for approximately 8 weeks at the mining site of PT Semen Baturaja (Persero) Tbk. The location and conveyance of the PT Semen Baturaja (Persero) Tbk. area can be seen in Figure 1.

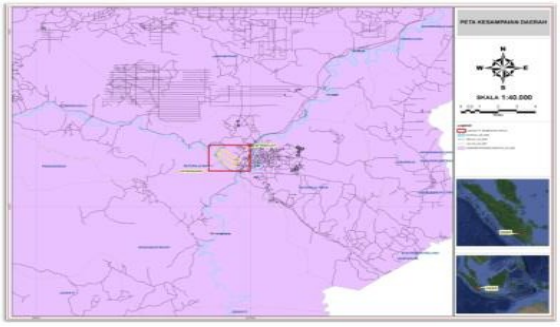

Figure 1. Location Map and Conveyance Area of PT Semen Baturaja (Persero) Tbk.

The research tools and equipment used focus on the tools needed in blasting activities including electric detonators, surface delay, in hole delay, lead wire, blasting machine, ohm meter and micromate. The necessary data were collected using direct observation method of blasting activities in the field.

Primary data in this study are blasting geometry, calculation of ground vibration value, and documentation of fragmentation of blasting results of air deck and non-air deck methods. While the secondary data are the characteristics and specifications of limestone, the type of air deck method used and the specifications of explosives.

The research sampling was conducted by dividing the blasting location into two, namely the location with air deck and without air deck. These two sample locations are marked with a predetermined blasting plan which is then adjusted between the blasting plan and the actual conditions at the blasting site.

The separation is also done using a safety line to facilitate the identification of fragmentation after the blasting activity is completed to obtain comparative data on the fragmentation of the blasting results of the air deck and non-air deck methods. In the process of measuring ground vibration values, PT SMBR uses a micromate. This tool can be used to capture 3 types of waves, namely vertical, transverse and longitudinal. From these three waves, the resulting vibration value calculation will be obtained or what can be called the Peak Vector Sum (PVS). The ground vibration value measurement tool is shown in Figure 5 (Apriansyah & Ramli, 2023).

Figure 2. Survey and field measurement activities (a) and the Micromate Vibration Measurement Tool (Purwaningsih, A. 2023) (b)

After the data is obtained, the next analysis is carried out in line with the objectives of the study. The analysis was carried out in the form of analysis of ground vibration values produced by air deck and non-air deck methods, comparison of ground vibration values with measurement distance, comparison analysis of the average fragmentation of blasting results of air deck and non-air deck methods and analysis of the influence of the air deck method on the use of explosives and stemming.

RESULTS

The blasting activities carried out at PT SMBR implement the echelon cut blasting pattern in the execution of its blasting activities. This echelon cut pattern is used because the blast area is close to residential areas so that with this pattern the vibration obtained will be minimized**.** In the blasting that is carried out, usually the number of rows of blast columns is 2-3 rows. The stages of blasting activities carried out at PT SMBR are explosive distribution, priming, charging, stemming, assembly and firing. The stages of blasting activities are listed in Figure 3.

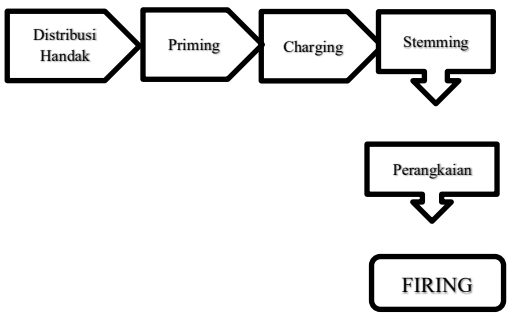

Figure 3. Stages of Blasting Activities

The results of 15 vibration measurements show that the measurement distance from the blasting location varies between 282-519 meters for blasting using an air deck and 282-535 meters for blasting without an air deck. It was also found that the ground vibration (PVS) value also varied between

0.37 - 1.13 mm/s for the blasting method using air deck and 0.41 - 2.56 mm/s for the blasting method without air deck. Data from the distance comparison value and also the ground vibration value can be seen in Figure 7 for the air deck method and Figure 8 for the non-air deck method.

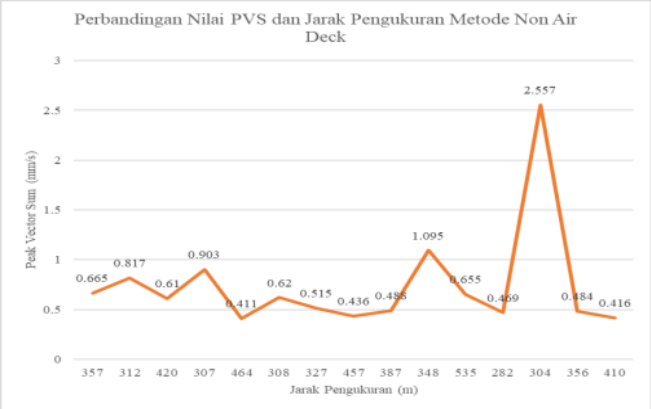

Figure 4.Comparison Chart of PVS Value and Distance Measured by Air Deck Method

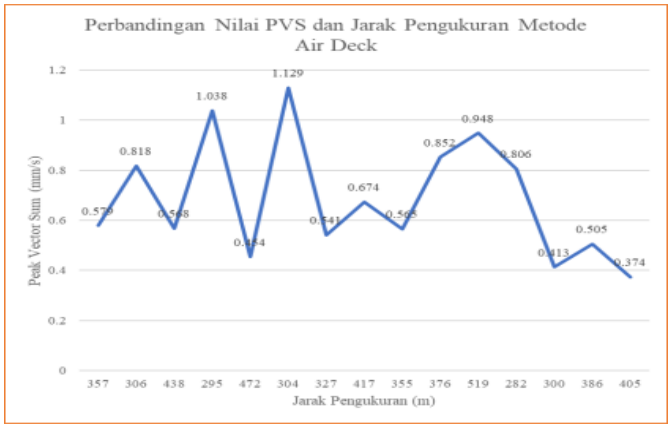

Figure 5. Comparison Chart of PVS Value and Distance Measurement of Non Air Deck Method

Data statistics show that most of the data on the distance between blasting locations and vibration measurements are less than 500 m (Figure 9). The difference in distance is caused by the measurement locations being set at two points only, because the main focus of vibration measurement is to minimize and routinely control the impact of vibrations generated on local residents, so vibration measurement points are taken in the vicinity of residents' homes.

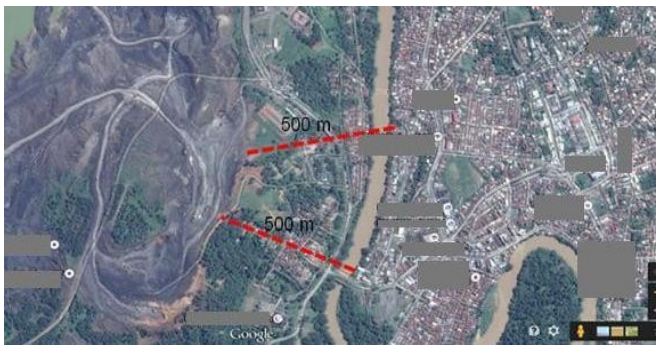

Figure 6. Safe Blasting Distance from Settlement (PT Semen Baturaja (Persero) Tbk., 2022)

One of the ways to minimize the impact that occurs due to the location that is very close to

settlements is to divide the blasting location into several zones. The zone that is less than 200 meters from the settlement is called the red zone. Where in this zone, no blasting activities are carried out but replaced using a grinding tool for limestone, namely Surface Miner.

Documentation of fragmentation of blasting results obtained after the blasting activity is safe and completed. Fragmentation samples from that will be analyzed in block 49 The calculation of fragmentation distribution is done with Split Desktop 2.0 Demo application.

Figure 7. Limestone Fragmentation SampleBlasting Results in Block 49

Calculation of rock fragmentation distribution of blasting results using Split Desktop 2.0 application. The demo is obtained by selecting the photo, then inputting the comparison scale value, then delineating, after delineating, graphs and output are performed to obtain the results of the blasting fragmentation distribution. The results of the calculation of the percentage of fragmentation passability of the blasting results using the Split Desktop 2.0 Demo application on the block 49 blasting sample are shown in Figure 8.

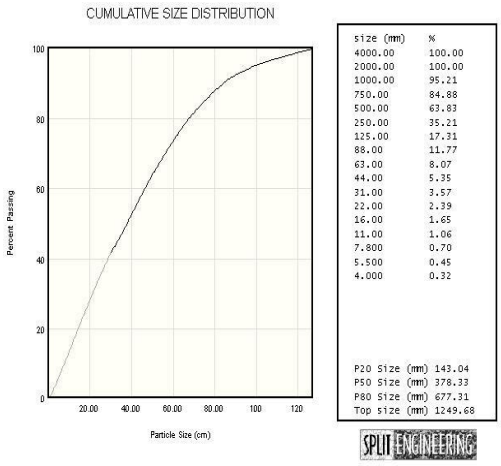

Figure 8. Percentage Calculation Result Fragmentation Passage of Blasting Results in Block 49

From the overall calculation carried out on 30 fragmentation data from the air deck and non-air deck blasting methods, for data with a diameter of <75 cm, the average fragmentation pass rate using the air deck method is 91.93% and the average fragmentation pass rate of the non-air deck method is 80.27%.

The air deck method also affects the use of explosives and stemming time. The research shows that the use of explosives for normal blast holes is about 7-8 kg per meter of blast hole, so that for the length of the fill column at the PT SMBR blasting site, which is 2 meters long, approximately 14-16 kg of explosives are needed for one hole. Using the air deck method means reducing the length of the fill column so that a blast hole that initially requires 14-16 kg of explosives for each blast hole, because the

length of the fill column is reduced, the need for explosives using the air deck method is also reduced to around 11.25-12 kg for one blast hole.

Blasting using emulsion explosives requires time for gassing or density adjustment of the emulsion in the blast hole. So without an air deck, usually after charging, approximately 15 minutes will be given for the emulsion to expand (gassing). If using the air deck method, with the air column created in the blast hole, the gassing process can adjust the air deck media and does not need to wait anymore so using the air deck method can also save stemming time and save the overall blasting activity time.

CONCLUSION

In conclusion, using the air deck method at PT SMBR Baturaja, South Sumatra, brings about significant benefits and proves effective in minimizing the impact of ground vibration during blasting activities. The air deck method reduces the need for explosives, cutting the initial requirement of 12-14 kg per blast hole to only 11.25-12 kg. This translates to cost savings and contributes to waste reduction by repurposing used ANFO plastic and cement sacks as air deck media.

Moreover, the air deck method accelerates the blasting process by eliminating the waiting period for emulsion explosives gassing in stemming. This time-saving aspect enhances the overall efficiency of blasting operations. The recorded average Peak Vector Sum (PVS) value for the air deck method is 0.68 mm/s, significantly lower than the non-air deck method's PVS value of 0.74 mm/s. This numerical difference underscores the effectiveness of the air deck method in minimizing ground vibration.

Additionally, fragmentation analysis using the Split Desktop 2.0 Demo application reveals a remarkable improvement in uniformity with the air deck method, as evidenced by a distribution passability of 91.93% for blasting results with a size <75 cm, compared to 80.27% for the non-air deck method. This signifies that the air deck method produces more uniform fragmentation with fewer boulders, further emphasizing its practical advantages in limestone blasting activities.

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