

Analysis of Blast Fragmentation Results of the Top Air Decking Method in Coal Mines

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Abstract

This research aims to find out what influences the results of blasting fragmentation in the top air decking method. The method used in this research is a quantitative method. The data collection techniques used in this research came from literature studies and field data collection. Processing data analysis is carried out by considering several factors, such as rock characteristics, fragmentation results, and digging time results. After analysis, it can be seen that the design for determining the ADF, ADL, and stemming values is adjusted to the hole depth and PF used so that the fragmentation and digging time obtained are better in order to increase production activities. Based on the research results, it was found that the factors that influence the fragmentation results from top air deck blasting are the powder factor, blasting geometry (burden and spacing), air deck length (ADL), stemming depth, and wet hole conditions. The greater the PF value used, the smaller the fragmentation resulting from blasting and vice versa. The greater the ADL value used, the stemming depth will decrease and there will be potential for stemming injection and producing boulders. More holes in wet conditions will potentially result in greater fragmentation as well. The optimal ADF value to use is 0.3. With an ADF value of 0.3, the ADL used is 0.4-1.47 meters, resulting in better fragmentation. The previous boulder percentage of 18% changed to 7% and the previous digging time of 11.87 seconds changed to 10.57 seconds.

Keywords: air deck length, digging time, kuz-ram, stemming.

INTRODUCTION

In general, mining activities using an open mining system start with land clearing, stripping top soil, stripping overburden, and coal extraction. Stripping the overburden layer is carried out in two ways, namely by using mechanical tools or by blasting. Stripping the covering layer using mechanical tools is only done on soft materials, whereas for materials that tend to be hard, it must be done using a blasting process (Hasruddin et al., 2022). Blasting is the process of scattering large volumes of rock using explosives so that the rock mass is easy to excavate and transport. Several factors that influence the success of blasting are the use of explosives, blasting geometry, and the characteristics of the rock mass. These factors will influence the size of the fragmentation and the productivity of the mechanical tool.

Fragmentation is a measurement that shows each piece of rock resulting from blasting. The fragmentation material resulting from blasting needs to be adjusted to the bucket size of the digging tool and the digging time because the fragmentation resulting from blasting affects the excavation time and the excavation time affects the productivity of the tool (Marpaung & Kopa, 2019).

The overburden at the research location has a low rock compressive strength (UCS) with a value of 0.5–6 MPa. However, to dismantle the overburden layer using the blasting method, this is done with the aim of speeding up and increasing production activities in overburden excavation activities. Blasting activities carried out at the research location used explosives in the form of ammonium nitrate and fuel oil (ANFO) with a powder factor (PF) ranging from 0.12 to 0.18 kg/bcm. With a relatively small PF, the resulting fragmentation is not optimal and varies. One of the efforts made to improve fragmentation in conditions with a small number of explosives is by adding empty space (air) or air decking in the blast hole. The medium used to add water decking is a ball deck. This ball deck functions to support the stemming material so that there is air space between the explosive filling and the stemming, so this method is called top air deck (TAD) (Pradatama & Toha, 2018).

For its application, the top air deck (TAD) method requires determining the value of the air deck factor (ADF) and air deck length (ADL) and analyzing the resulting blast quality results in the form of fragmentation and digging time. The rock mass rating (RMR) and the ADF value both have an impact on the deck water column length (ADL), which is a crucial parameter in the application of decking water blasting (Sadiq, 2021). However, the blasting activity carried out at the research location using the top air deck method has not yet determined the ADF value, where the ADF value is needed in determining the ADL to be used. The ADL height used is the remainder of the explosive filling height and stemming height. At different blast hole depths, the stemming height used is always around 2–2.5 m for each hole, so the expected results are still not optimal because there are no ADL provisions applied to each hole. The optimal ADL value can be determined by determining the air deck factor (ADF) value (Lee et al., 2016).

METHOD

The method used in this research is a quantitative method. Quantitative methods are research methods based on the philosophy of positivism, used to research certain populations or samples, collect data using research instruments, and analyze quantitative or statistical data with the aim of testing established hypotheses. The data collection techniques used in this research came from literature studies and field data collection. To be able to determine the fragmentation of blasting results, it can be obtained by taking pictures of the fragmentation on the surface after the blasting activity using a cellphone camera with a 48-megapixel camera quality. And use a helmet or ball deck as a comparison for the size of the material. Taking pictures in the field has a big influence on calculating the distribution of fragmentation that is obtained.

Actual geometric data is obtained by taking measurements using a meter. Spacing is obtained by measuring the distance between holes in the same row. The burden is obtained by measuring the perpendicular distance between two holes in the same row. The depth of the hole, height of filling, and stemming are measured by inserting a 15-meter-long roll meter with a weight at the end. The hole diameter is measured at the surface of the hole. Digging time data was obtained by calculating digging time using a stopwatch application on a cellphone. The time starts when the excavator bucket starts to touch the blasted material and stops when the excavator bucket is lifted from the material. The method used is a top air deck (TAD), where the empty space is between the explosive filling and the stemming. The

determination of the length of the air deck is obtained by calculating the ADF value, which comes from weighting the rock mass. ADL is determined by positioning the ball deck from the hole surface to support the stemming material. Analyze data obtained in the field or from other sources and compare ADL proposals to previous blasting. Processing data analysis is carried out by considering several factors, such as rock characteristics, fragmentation results, and digging time results. After analysis, it can be seen that the design for determining the ADF, ADL, and stemming values is adjusted to the hole depth and PF used so that the fragmentation and digging time obtained are better in order to increase production activities.

RESULT AND DISCUSSION

From the results of the analysis using split desktop software to determine the fragmentation of blasted rocks from observation blasting carried out 17 times in the KGS Pit, the average fragmentation size (P80) was 76.34 cm, the average escape percentage at the 75 cm size was 78.6 % and the average boulder percentage was 21.4%. Observations from blasting activities show that the desired boulder percentage target has not yet been achieved, which is less than 10%. The proposal was made by giving an ADF value of 0.3. Maximum fragmentation results are proven by the average fragmentation (P80) of 55.25 cm and the percentage of escapes at a size of 75 cm is 93%. This can be seen from the influence of the blast hole geometry, which is less than optimal with an ADF value > 0.4 and the ADL used, which is too large so that the blasting is less than optimal and the resultant rock fragmentation still contains boulders with 21.4%. With the proposal made, it is proven that ADF 0.3 can maximize the fragmentation obtained with the average fragmentation (P80), which was previously 76.34 cm, to 55.25 cm, so that the size is reduced by 21.73 cm and the percentage passes at the previous size of 75 cm. 78.6% became 93% so the pass percentage increased by 14.3%.

From Kuz-Ram's calculations in observation blasting, the average fragmentation value obtained was 42.39 cm with a uniformity index of 1.75 and rock characteristics measuring 52.24 cm, and the average fragmentation retained on a 75-size sieve was 15%. The PF value is the thing that most influences the size of fragmentation. The Kuz-Ram calculation only takes into account the use of explosives based on geometry and PF without taking into account the stemming and ADL used. From observational blasting, the percentage error in fragmentation resulting from blasting was 47%, while in proposed blasting, the percentage value decreased to 20%. The higher the percentage of error in the data, the more it indicates that there are problematic factors in an activity. If you look at the two tables, the influence of the blast hole geometry is the cause of the large error value. The influence of ADF, ADL, and stemming is the main factor in the high error value. However, in the proposed explosion on October 23, the error factor was quite high. This was caused by the influence of rain during assembly so the entire location was wet and the blasting was postponed until the rain stopped so firing could be carried out. And on October 23, wet hole conditions amounted to 62% of the total holes. So, the influence of hole conditions and rain during blasting also causes the percentage of error in an activity.

A comparison of observational and proposed blasting was carried out by comparing the ADF, ADL, and stemming values of the average fragmentation and boulder percentage. It shows that by reducing the ADF value, the ADL value obtained will also be small so that it can reduce the boulder percentage and average fragmentation size. This is because using an ADF that is too large can make the ADL value also large, which will affect the stemming height, making the stemming value smaller, causing the blasting energy to be imperfectly confined (confined), potentially causing stemming ejection, which affects energy loss in the blasting, which causes flyrock and airblast. It is necessary to carry out further research on rock characteristics and RMR values so that when determining the ADF value, there is no deviation

from the top air deck blasting design. So, the proposal is made to readjust the ADF value to determine the ADL value and adjust the stemming. This can be seen from the explosion table of the proposed error percentage decreasing to 20% after the design of the ADF, ADL, and stemming values.

Digging time data starts when the bucket touches the material and stops when it is lifted from the excavated material in the form of blasting. From blasting, observations of digging data were taken for 17 blasts, where the digging time values ranged from 11.18 seconds to 13.64 seconds, with an average of 11.87 seconds. Meanwhile, in blasting, the proposed digging values range from 10.15 seconds to 12.06 seconds, with an average of 10.57 seconds. This shows that the proposed design of the hole geometry in the form of ADF, ADL, and stemming values has an influence on digging time. This recommendation for blast hole geometry was obtained from experimental analysis of 5x blasting with an ADF value of 0.3, which is the maximum compared to the observation blasting carried out. Therefore, ADF 0.3 was determined as the initial recommendation in determining the ADL value based on PF, hole depth, and stemming depth to be used.

From the recommendations provided, the value of each parameter used, including PC, ADL, and stemming, will be adjusted to the PF and depth of the blast hole that will be used. The greater the PF value, the greater the ADL value that will be used. Determining the stemming height still takes into account the SDoB value to create controlled energy with a value of 0.92–1.40 m/kg^{1/3}. With a minimum stemming height of 2.5 m, the SDoB value obtained is 0.95 m/kg^{1/3} so it includes controlled energy. Controlled energy is needed to prevent stemming ejection, which affects energy loss in blasting, which causes flyrock and airblasts. This recommendation produces an ADL value that is smaller than the previous blast and a stemming height that is greater than the previous blast. Thus, it was able to produce an average fragmentation size of 69.98 cm to 55.25 cm by reducing the boulder percentage from 21.4% to 7% and the previous digging time of 11.57 seconds was changed to 10.35 seconds.

CONCLUSION

Factors that influence the fragmentation results from top air deck blasting are the powder factor, blasting geometry (burden and spacing), air deck length (ADL), stemming depth, and wet hole conditions. The greater the PF value used, the smaller the fragmentation resulting from blasting and vice versa. The greater the ADL value used, the stemming depth will decrease and there will be potential for stemming injection and producing boulders. More holes in wet conditions will potentially result in greater fragmentation as well. The optimal ADF value to use is 0.3. With an ADF value of 0.3, the ADL used is 0.4–1.47 meters. Resulting in better fragmentation, the previous boulder percentage of 18% changed to 7% and the previous digging time of 11.87 seconds changed to 10.57 seconds. Further research is needed on the weighting of RMR values in order to determine the range of ADF values to be used. Hole sounding should use a meter for more accurate sounding. It is necessary to use a stick to compact the stemming material so that the covering material can control the blasting energy more optimally.

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