The Application of Deck Charge Technology in Hua Neng open pit Mine

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Abstract: In the modern mine development and construction, how to improve the effective utilization of explosive energy, while achieving the requirements of the blasting vibration , is the key problem of blasting research.In this paper, from the actual situation of Huaneng open pit mine, for the complaints of nearby residents, the blasting program will be improved.First of all, the principle of the deck charge technology is analyzed, and then the deck charge technology is applied to the open pit mine to reduce the vibration caused by the blasting, to appease the dissatisfaction of the nearby residents. Finally It has achieved good results.

1 Introduction

To improve the effective utilization of explosive energy, With less explosives to make the ore fully broken, while meeting the requirements of blasting construction, and reducing the cost of blasting, is a basic principle of mine blasting. At present, mining intensity is increasing. How to ensure the safety of mine production and cost control is an important problem for enterprises. By optimizing the structure of blasting charge, thus improving the energy efficiency is one of the solutions to the problem of security and cost control. Huaneng open pit mine is located in Wulan Mu Lun Village,in Inner Mongolia Autonomous Region Erdos City. At present, the open-pit mine with an annual output of 600,000 tons, use continuous column charge,and by hole detonation mining technology. But the mine is near the residential area (shown in Figure 1), recently about 300m. In the existing mechanical equipment and blasting process, the impact on seismic waves generated by blasting is relatively large, and vibration is more obvious. Near the villagers reacted more intense. There are many complaints occurred. Combined with engineering practice and engineering analogy, so the blasting scheme would be improved in the open pit mine. The solution is changing the continuous column charge for the axial air separation charge and the other blasting parameters unchanged.

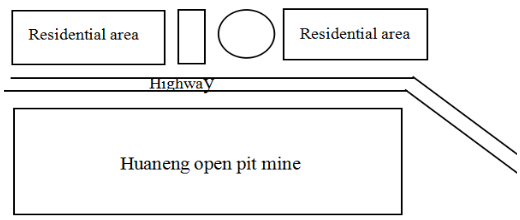

Fig.1. Schematic diagram of the mine area

Many model experiments and mine practice have proved that the axial air deck charge can be used to achieve the ideal blasting effect,compared with the continuous columnar charge. It not only can improve the effective utilization rate of the explosive energy, but also can control the blasting hazard and reduce the blasting vibration, and can reduce the cost of blasting.This paper is based on the deck charge blasting technology. The application of axial Air deck Charge in Huaneng Open pit mine is in order to reduce the vibration generated by the blasting, to appease the dissatisfaction of nearby residents, and to meet the requirements of blasting construction.

2 Principle of blasting technology for deck charge

Deck charge is divided into multiple sections of the column charge, by air, water, rock slag and other separation. According to the principle of resonance detonation of detonation energy, it is a method of rational allocation of energy.

2.1 The principle of deck charge blasting

When use continuous column charge structure in the blasting, the charge surface and the rock are in direct

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contact. Compressive stress waves of explosive detonation and quasi-static gas pressure are directly on the rock, usually there would be forming crushing zone in around the wall. In the case of the explosion of 5000-10000MPa produced by the ultra-high pressure, the crushing zone rock not only produces serious crushing damage, consume a lot energy, and its temperature also suddenly increased, resulting in further loss of explosive energy.By the mine blasting Standard, the generation of crushed areas marks the waste of energy from explosives.

Deck charge technology can effectively improve the energy utilization of explosives. Former Soviet Union Melnikow N V et al. have studied this technique in theory. Their research shows that due to the presence of the air layer, it causes the secondary and subsequent series of load waves during the explosive process and at the same time cause further damage to the fractured rock mass caused by the previous pressure wave. Although the use of air-spaced charge, the average pressure acting on the borehole is lower than the continuous column charge method, it can be broken by the subsequent action of the loaded wave. The use of air gap charge method, through the intermediate medium to change the contact between the charge and the walls of the hole, can reduce the initial pressure of the stress wave and detonation gases products in the hole wall. So that the surroundings do not produce particularly obvious powder-like rock particles. Meanwhile the action time of the initial pressure extended (as shown in Figure 2), and obtain a greater blasting impulse (burst pressure and burst pressure action time product). In the of case of reducing the amount of explosive, it can improve the energy efficiency of explosives and achieve the purpose of broken rock.

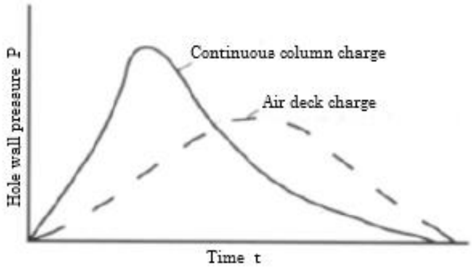

Fig.2. Hole wall pressure and action time

2.2 Deck ratio determination

During the explosion, the energy of the explosive is stored in the cavity, forming a plurality of loads, extending the time of stress acting on rocks, thereby reducing the energy of the broken hole and increasing the energy delivered to the surrounding medium. Therefore, we should make full use of the advantages of air separation blasting structure. Firstly, the reasonable air compartment ratio R_a must be determined.

$$R_a=L_a/(L_a+L_c) \qquad (1)$$

Where: L_a - charge length cm;

L_c - deck length cm;

R_a - deck ratio;

In engineering practice, the determination of the proportion of the air layer often depends on the empirical data, but the value is changing relatively large. Melnikow N V thought that taking 11% to 35% of the volume of the chamber is better. Moxon N T thought that taking 15% to 35% of the volume of the chamber is better. Some domestic scholars believe that the blasting can achieve better results when the proportion of the air layer is 30% to 40% of the volume of the chamber. Zhu Hongbing and others analysis on the air layer ratio through the shock wave theory and think that the upper limit of the appropriate proportion of the air layer is 30% to 42%.

2.3 Blasting vibration effect of deck charge

Blasting vibration is one of the effects of engineering blasting operations, which can not be eliminated. Enterprises would as much as possible avoid blasting vibration hazards in the construction process. Due to the presence of the air layer, the initial pressure on the hole wall is reduced. The initial pressure is from the stress wave and the detonation gas product generated during the blasting, Which can play the role of energy buffer, further reduce the vibration generated by the blasting, meet the requirements of blasting construction. So the in deck charge blasting technology has been widely used in the project.

3 Blasting scheme and parameter design of deck charge

Through the analysis of the principle of deck charge, combined with the actual situation of Huaneng open pit mine, the ore body rock fracture is very developed. It is easy to produce the foundation when the air gap is at the end of hole. Meanwhile it is easy to produce large and explosive decomposition when the air gap is at the upper part of hole. So here the exploration of the central air separation charge blasting is the main one. The middle air gap charge blasting used Orica high-precision non-electric detonator and hole-by-hole detonation technology. The interval time between of the holes is 25ms.The interval time between the rows is 65ms. Hole extension time is 400ms. There are some measurement points for blasting vibration monitoring in the vicinity of the mining area near the residential. The blasting parameters for the open pit are set as follows.

3.1 Borehole diameter and borehole length

The bench height is 9m. There are vertical blasting and plum blossom hole in the blasting area.The hole spacing is 5m and the row span is 4m. Borehole length is 10m.The excess drilling is 1m and borehole diameter is 110mm. There are ammonium oil explosives and down-the-hole drill. The above parameters are consistent with the blasting parameters of the original blasting scheme, which is the continuous column charge.

3.2 Charge and tamping

The axial air separation charge technology is that each hole set two kits. The first pack is placed at the bottom of the hole and the second pack is placed on the top of the hole. The explosive will be separated from the center of the hole by the barrier made by PVC pipe. And then the hole will be tamped with rock slag. Charge structure is shown in Figure 3 and the parameters are as follows:

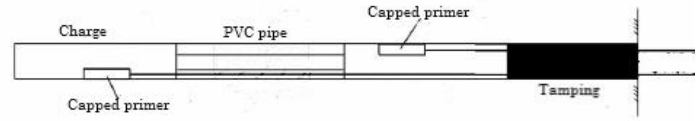

Fig.3. Charge structure diagram

The tamping length is about 2.8m. The spacer is placed in the middle of the blasting hole and the length of the air separator is 2.3m. The upper dose is 15kg and the charge length is 2.45m. The bottom dose is 15kg and the charge length is about 2.45m. The total length of the pillar and air interval was 7.2m and the total length of the pill was 4.9m. The deck ratio Ra was 32% and the maximum dose of single hole was 45 kg;

4 Analysis of blasting effect on site

The blasting effect improved significantly in accordance with the above blasting parameters using the deck charge technology in Hua Neng open pit mine, as shown in Figure 4.

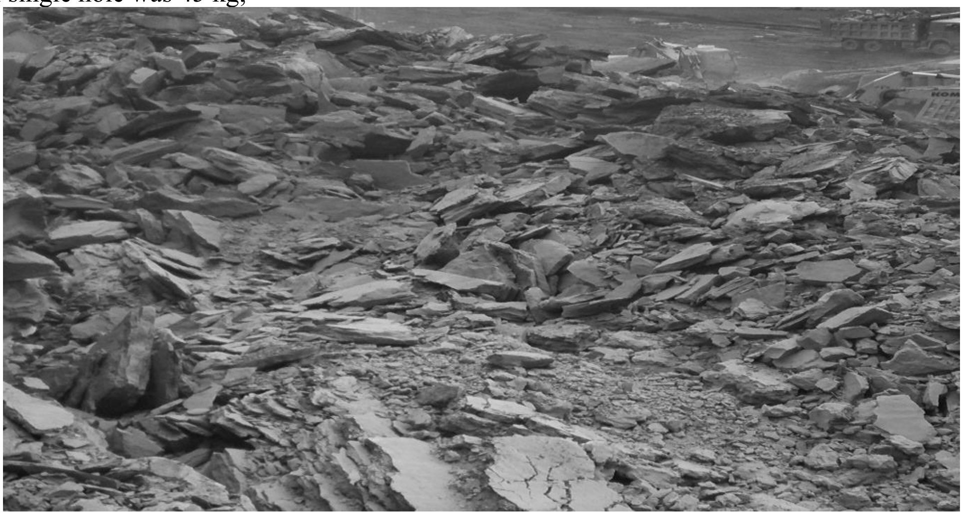

Fig.4. On-site blasting effect

By comparing the blasting effect of the continuous column charge before and the blasting effect of the axial air separation charge scheme, and the analysis and calculation, the following blasting effect comparison table is obtained.

Table1 Comparison of blasting effects

Program	large chunks rate /%	Second broken number	Bootleg rate /%	Explosive factor kg/m^3	Resident floor vibration speed cm/s	Number of resident complaints
Former	23.71	4	4%	0.34	0.40	8
Improved	14.95	1	3%	0.23	0.21	0

From Table 1 shows, the use of deck charge technology could ensure that the rock blasting crush effectively. Rock blasting loose could meet the basic requirements of excavator loading. There are few particularly large chunks. And excavator loading efficiency could maintain the normal level. At the same time, we can see that the effect of air gap charge technology for reducing the chunk rate is more obvious, but the bootleg rate is basically consistent with the previous continuous column charge program. Through the blasting effect analysis, the explosive factor of air deck charge is about 0.23Kg/m^3, and the explosive factor of continuous column charge is 0.34 Kg/m^3. It can be seen the air gap charge technology could reduce the explosive consumption in the premise of ensuring the blasting effect, and reduced by about 32.35%. It can save the cost of explosives and improve the usage efficiency of explosive energy. The air gap charge has a good vibration reduction effect, and vibration speed decreased by 47.5%. The vibration within the scope of the Residents is not very strong, and the residents can basically accept it. The number of complaints is reduced from 8 person to no one, and the program improved got a good effect.

5 Conclusion

Through the analysis of the blasting effect of the axial air separation charge scheme, the following conclusions are drawn:

(1) Air deck charge blasting method can significantly reduce the chunk rate and ensure the normal efficiency of the excavator loading compared to continuous column charge blasting method.

(2) Deck charge blasting can effectively reduce the consumption of explosives, save explosives costs, and

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improve the usage efficiency of explosive energy.

(3) The axial air separation charge has a good effect of reducing the blasting vibration, which can effectively solve the problem that the blasting vibration requirement is relatively high in the actual project.

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