Study and Safety Evaluation on Chamber Blasting of Mined-Out Area in Pao-Maping Mine

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Abstract: A comprehensive study on topographical and geological conditions, current situation of exploration, storage characteristics of the mined-out areas, and the environment condition of the mine in Pao-Maping Mine was carried out. The millisecond controlled blasting technology was utilized to weaken the influence to the surface building and underground facilities induced by the explosion. Additionally, impact caused by shock wave on the critical facilities in the mine was assessed systemically. Simultaneously, the mine ventilation system should be entirely tested and maintained before blasting, to ensure the mine restoration production after the chamber bursting. Besides, safety test should be conducted on the poisonous gas in the mine after the chamber blasting.

Keywords: underground mine; mined-out area; chamber blasting; million-second blasting; mine ventilation; safety assessment

1. Introduction

Blasting vibration wave will affect or endanger the security of building and related facilities, in many occasions; blast vibration is often one of the most important factors which determine the blasting design and construction. The research methods of blasting vibration wave attenuation laws can be divided into: fluctuations in law, numerical method, data fitting method and the method of Sadauskas. In the actual design progress of chamber blasting, the key of the design is to reduce the largest amount of drugs at a single-round in order to prevent the building or structures around the burst source and the important facilities from the bursting. At the same time, to optimize the layout of the chamber, the form of charge and millisecond blasting can prevent the destructive effects of shock waves.

2. Project Overview

Lanping Lead-Zinc is a world famous super-large Pb-Zn deposit and China’s largest Lead-Zinc. The mine area is located in Lanping Bai Pumi Autonomous County of Yunnan Province Jinding town. The geographic coordinate is latitude 26°24’, longitude 99°25’. The distance from the mining area to Dali(Xiaguan) is 250km and there are many highways to Dali. The entire mining area is divided into 7 ore blocks such as Jiaya Hill, Fengzi Hill, Beichang and Paomaping.

Paomaping mine, affiliated with Yunan Jinding Zinc Industry Co., Ltd., is one of the major mines. Since the investment subjects was too much in the initial mining, the mining construction lacked of unified planning. The investors worked each for himself, resulting in the disorderly production of the construction and waste of resources. During this period, a high 54m and 110000m³ in volume mined-out area is formed at the Paomaping block. This mined-out area brings huge security risks to the deep exploitation of more than 600 million tons of geological reserves. The main objectives of the mined-out area chamber blasting are: we adopt tunnel excavation and arrange a strip-shaped chamber beside the mined-out area in order to avalanche certain volume wall rock from the top of the mined-out area to form a buffer layer to ensure the exploitation of the mineral resources under the mined-out area efficient and safety.

3. The Chamber Millisecond Blasting of Paomaping Mined-Out Area

According to the shape and contour of Paomaping mined-out area, surrounding environment and underground conditions, layout strip-shaped chambers along the top of the mined-out area contour line, a total of 12 strip-shaped chambers. The compound floor plan of layout of the strip-shaped chamber blasting in the mined-out area is shown in Figure 1. According to the wall rock of Paomaping mined-out area mechanics testing, computed from the equation of the blasting powder factor and blasting experience, we take blasting powder factor of this chamber blasting K=1.6Kg/m³. During the chamber blasting, because there is a strong folder on the rock at the bottom of the chamber in the mined-out area, we take the largest explosion index. When the underlying charge has been exploded and the middle and upper detonation, the rock mass relative to bottom rock mass is facing more space, so it takes the bottom of charge n = 1.0, middle charge from n = 0.8, the upper charge from n = 0.75. In the design of chamber blasting of Paomaping, the fracture radius of blasting crackers is divided into up fracture radius and down fracture radius. Through the analysis of rele-
vant information, it is almost used in the open-air blasting. We choose the fracture radius for the open-air chamber blasting as the the fracture radius in the design of mined-out area chamber blasting, so the blasting security is high and the statistical data from this blasting is relatively conservative. Its parameters of the chamber blasting in Paomaoping mined-out area are shown in Table 1.

Table 1. The parameter list of chamber Blasting of Mined-out area in Pao-Maping Mine

<table>
<thead>
<tr>
<th>Number of the chamber</th>
<th>Blasting action index</th>
<th>Minimum burden (m)</th>
<th>Explosive specific charge (kg/m$^3$)</th>
<th>Explosive charging density (t/m)</th>
<th>Explosive cavity radius (m)</th>
<th>Fracture radius (m)</th>
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<tr>
<td>B1</td>
<td>1</td>
<td>12</td>
<td>1.6</td>
<td>0.23</td>
<td>2.995</td>
<td>0.95</td>
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<td>12</td>
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<td>0.18</td>
<td>2.354</td>
<td>0.84</td>
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<td>B3</td>
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4 The Security Assessment of Chamber Millisecond Blasting Detonator Network

In order to ensure the reliability and security of detonator network when Paomaping mined-out area chamber blasting, each drug room equipped with one main detonation body, between each host detonation body it used two sets of independent systems of the non-detonator initiation network, between the primary and secondary detonation body and the drug rooms at the same section it used the double strand detonating cord series. The delay time interval of chamber blasting was 110ms, the chamber blasting network diagram is shown in Figure 2.

5 The Vibration Impact Assessment on Surface Structures Resulted from Chamber Blasting

In order to demonstrate the security of chamber blasting in Paomaping ore mined area and to undertake detailed investigations on surface structures, careful study and analysis was carried mainly on the blasting vibration for buildings and structures within 1000 meters away from the explosion source according to the on-site measurement investigation and theoretical analysis, among which the nearest distance from the house to explosion source is only 675 meters. GPS72 was applied to measure the location for buildings and structures above the Paomaping ore.
mined area and to take pictures of these buildings and structures, so as to achieve an accurate understanding of the surface buildings. The measurement process revealed that besides the adit, inclined shaft and buildings and structures near the shaft there are mud, wood and brick houses, transformers, air compressor, hoisters, explosive room, tailings dam and the concentrator and so on. The rest are Yi people living halfway down the hill. As Paomaping ore is surrounded by two small villages and scattered families distributed on hillside, the houses are generally made of earth and wood. In this case, the structure of these houses is very simple and some of the houses even bearing crack. Please refer to Picture 3 for house distribution around the Paomaping ore.

The blasting vibration speed is closely related to mass of explosive as well as the distance. When the blasting propagation velocity in medium of engineering rock mass surrounding exceeds a fixed number, the mine rock would produce displacement and dislocation. According to the analysis and research of the geological data, on-site investigation and blasting experience, the maximum vibration speed of this chamber blasting in Paomaping ore to the houses which are nearest to explosive source is 0.35 cm/s. Only the speed for the houses near shafts (within the scope of the exploitation state) is faster than 0.5 cm/s, while others are all below the speed 0.5 cm/s. Therefore, the chamber blasting in mined area would bring no effects to surface buildings which belong to Yi nationality, and it proves that this chamber blasting is safe.

Figure 3. The house of circumjacent dweller in Pao-Maping Mine

6 The Vibration Impact Assessment on the Main Underground Facilities Resulted from Chamber Blasting

Through field survey and research the main facilities around the outline of Paomaping mined-out area are: hoisters, pumps, air compressors, air pipes, cables and so on. Hoisters, pumps and air compressors should be specially protected when chamber blasting, however these important facilities are basically located in the adit of the important roadways. For the safety assessment of the influence of blasting vibration to the important facilities, the velocity of blasting vibration at important access adit in Paomaping mined-out area when chamber blasting is shown in figure 4.

Figure 4. The velocity of blasting vibration important access adit

From Figure 1 we can know: when Paomaping mined-out area takes chamber blasting, the largest velocity of blasting vibration was at the down adit of 7# second inclined shaft among all of the access adits. It is 27.6 cm/s. Basically, air compressors and hoisters are located in the vicinity of important access adits, according to the relevant blasting criteria we can know: air compressors, pumps and hoisters are safe when chamber blasting.

7 The Effect Analysis of Paomaping Ore Mined-Out Area Chamber Millisecond Blasting

Considering Paomaping Mine mined-out area geological terrain conditions, the exploitation status quo, the mined-out area existing characteristics and the environmental conditions on the surface and underground, taking millisecond blasting for the mined-out area chamber blasting in order to control the damage of vibration-wave and shock-wave to the buildings, structures and key facilities was determined. In order to verify the vibration hazards of the mined-out area chamber blasting and according the actual situation of blasting, 3 IDTS 3850 blasting vibration recorder instruments were respectively emplaced at measuring point 1 near the shaft, point 2 near the inclined shaft and point 3 near the adit receding in the distance. The vibration velocities of each of the measuring point were respectively shown in Figure 5, Figure 6 and Figure 7 below.

From Figure 1, Figure 2, and Figure 3 we can see that when Paomaping chamber blasting, the velocity of blasting vibration near the shaft was bigger than the safety vibration velocity of houses on the surface. But according to the requirements of Paomaping mine, the safety of lives and property of local residents should be taken into consideration in the blasting design. The houses in the...
mine can be ignored and there are traces of destruction is permitted. The main objectives of layout seismic points near Paomaping mine inclined shaft are: to ensure that the vibration velocity of the nearest house from the explosive source is no more than the request in "Blasting Safety Regulations", there are houses of local residents only within the distance from the inclined shaft adit to explosive source. The measuring point near the mouth of adit in Paomaping mine can verify the reasonability of blasting design in depth, and can take simple system regression with the other two measuring points to demonstrate the scope of blasting vibration hazards further.

8 Ventilation Safety Assessment on Chamber Millisecond Blasting

The chamber blasting on mined area would produce substantial toxic and harmful gases, so it is quite difficult to return to safety standards in short time. With the purpose of ensuring the safety of the chamber blasting, detailed inspection and maintenance should be carried on the whole ventilation system. In this case, the ventilation system can be in a safe and high-efficient operation status after the chamber blasting. Before the workers resume the operation under the mine, inspection on toxic and harmful gases at all key locations underground should be conducted by the safety monitoring personnel. Only when every indicator reached the level of safety standard, the underground operation can be fully resumed. Then the mechanical forced ventilation would be in operation in continuous 24 hours after the chamber blasting. The blasting safety technical personnel would be in charge of inspecting the safety standards of the toxic and harmful gases for every point of operation underground from the top step by step. By means of consecutive 8 hours’ inspection, the Paomaping ore can finally be ensured to resume operation safely.

9 Conclusions

1) According to current situation of the exploitation in Paomaping ore, the morphology in mined area and the environment condition surrounding the mined area, the selection of chamber blasting has controlled and reduced the hazard to the buildings and structures on and under the mine brought by blasting vibration.

2) When the chamber blasting was applied to Paomaping ore mined area, the vibration speed of the surface houses is lees than 0.5cm/s, which is within the national safety vibration standards. So it revealed that this chamber blasting made no serious effects to the houses of villagers.

3) The safety assessment on chamber blasting in Paomaping ore mined area, revealed that the buildings and structures would not be damaged by blasting vibration. Only the facilities close to explosion source would be affected by blasting vibration, so it requires strengthening the protection on important equipment underground.

4) After the chamber blasting, in order to ensure the restoration of safe operation underground, mechanical forced ventilation was applied to timely discharge the toxic and harmful gases under the mine produced by chamber blasting.

References

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