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Research and analysis of uncoupled charge blasting

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Abstract: The research status from coupling blasting theory, experimental study on decoupling charge blasting, decoupling charge blasting field application research status, the decoupling charge blasting in the hole wall pressure increases, higher utilization of explosive energy, to enhance the ability of rock breaking, reducing explosive consumption, so as to achieve safe and efficiency consumption.

Introduction

Decoupling charge can reduce the peak value of blasting initial pressure and make full use of explosive energy. In order to overcome the problems of large consumption, over crushing of rock and easy to produce large blocks and bottom, many open-pit mines are often exploded by decouple charge blasting[1].The decoupling charge blasting technology is also studied and the corresponding application, such as in the trench application, in the open hole blasting application in tunneling and mining in the application of presplit blasting in slope excavation, but also made the ideal blasting effect[2-4] ; As in ore mining to maximize the bulk of precious metals, such as bauxite rate, improve the blasting fragmentation and achieve higher economic benefits of Shandong metallurgical company and University of Science and Technology Beijing and other units [5]。 For example, the laboratory model test and field test in Anhui University Of Science And Technology were applied to study the application of water coupling charge blasting in well digging and smooth blasting.The conclusion is that the utilization ratio of the hole is increased and the peripheral forming is improved[6].

Study on the theory of uncoupled charge

Based on the blasting characteristics of the decoupling charge structure, Wang Wei and others[7] have studied theoretically the parameters of the shock wave in the rock at the same distance from the blasting source under the action of coupling and decoupling charge blasting. Conclusion: the formation of A. blasting explosive shock wave pressure exceeds the ultimate compressive strength

of rock over dozens of times, so the rock surrounding a charge shatter area; B. and blasting compared to uncouple can reduce the initial pressure of shock wave of blasting hole wall rock, but can increase the hole wall the rock pressure of the shock wave. The reasonable coupling coefficient, the formation of crush zone, greatly reduce the energy dissipation; C. water is generally considered as nonlinear elastic medium, so water medium become explosive detonation products and rock elastic buffer layer between the increase of energy transfer, prolong the acting time of shock wave, increase the scope of explosion. Yan Shilong and others[8] according to the detonation dynamics and elastic wave theory, analysis calculation of water coupled radius zone and cracked zone crushing blasting hole in surrounding rock, and analysis software effect of decouple coefficient of rock damage range numerical simulation examples and ANSYS/LS DYNA engineering calculation. Luo Yungun and others[9] according to the similitude law of blast and the equations of shock wave in water of bore water coupling blasting hole wall pressure, and the dynamic of rock under explosion load stress field is studied, which theoretically calculated the bore water blasting crack zone radius, crush zone radius and smooth blasting or other controlled blasting forming the best uncoupling coefficient; and through the engineering practice of the theory is verified.

Experimental study on Blasting of uncoupled charge

Han Xinping and others [1] using KUS model, the ANSYS/LS-DYNA of oil shale were analyzed by numerical simulation, obtained the rock blasting effect is better, more uniform block. Based on the dynamic simulation software AUTODYN, Guo Haoran and others[10] have simulated the elliptical bipolar linear concentrator column (EBLSC). Two dimensional face symmetric method is used to calculate the decoupling charge condition of granite rock mass and air interlayer. The influence of EBLSC structure and decoupling coefficient on smooth blasting effect is studied, and effective volume work model is established to evaluate blasting effect. The results show that the hole line direction and the vertical direction of the specific impulse is similar to that of the deviation is less than 10%, so the total energy along the circumferential distribution, but the hole line was penetrating cracks, and the crushing ring thickness and cavity expansion to a much lesser extent, shows that the charge structure can significantly improve the rate of the blasting effect and use of explosive energy, with the increase of coupling coefficient, loss of volume work on the direction of the connection hole decreases first and then increases, there is a maximum effective power. With the curve fitting, the optimal uncoupling coefficient is about 3.62. Guan Shaohua and others[11] in order to study the crack propagation rule of eccentric decouple charge structure, the explosive test of charge structure with different charge decoupling coefficients (1, 1.29, 1.57, 1.71, 1.86, 2, 2.28) was conducted in PMMA plate. The experimental results show that when the eccentric decoupling charge is applied, the radius of the micro crack area around the blasting hole is uneven. With the increase of the decoupling coefficient of the charge, the radius difference of the microcrack zone on the coupling side and the uncoupling side is gradually increasing. The coupling coefficient is 1.71, the longest side coupling main crack length, crack length, crack length reached the maximum average; coupled side with the longest side coupling main crack length difference, the main difference between the length of the main crack and crack the total average length difference reaches maximum. The study has a certain reference value for improving and optimizing the eccentricity uncoupled charge structure and reducing the blasting damage and damage to the surrounding rock. Yang Guoliang and others[12] used dynamic strain test and high speed photography system to study the mechanism of directional fracture blasting of air spaced charge in slit tube. Using 4 charge structure, the study found that: when the coupling coefficient is 1.5, the hole on both sides of the measuring point of strain ratio is 2.1, the duration of pressure reached 9 μs,

directional fracture effect. Through high speed photography, it is found that the propagation velocity of the crack is not a constant. The velocity of the crack is oscillatory, and its formation mechanism is analyzed. Based on the model experiment, the field test of underground tunnel and open slope engineering blasting is carried out by using the decoupling charge coefficient 1.5 and 1.66, respectively, and good results are achieved. Wuhan Institute of rock and soil mechanics, Chen Jingxi[13] study of stress wave in rock fracture analysis of related factors: A. air coupling condition of the peak stress is bigger than the water coupling condition; B. air under condition of coupling stress peak rise time is shorter than the water coupling condition; C. coupling under the condition of the duration of air force peak than water coupling condition is short, and basically belongs to the pulse signal. It is concluded that the time of the increase of the stress peak affects the length of the crack propagation. It is easy to produce a few short cracks when the peak load increases rapidly. On the contrary, it produces less and longer crack size, and wall integrity.

Field application of uncoupled charge blasting

Han Xinping and others[1] carried out field blasting tests in Fushun east open pit mine by coupling charge and decoupling charge. It was concluded that the block rate decreased by 6%, the tailings rate decreased by 7% and the average block size decreased by 80mm, and no residual phenomenon was observed. Xiang Ming and others[14] standard gauge railway in Kenya, Mombasa, Nairobi (hereinafter referred to as the Mongolian railway) full line slope smooth blasting by decoupling charge blasting, the amount of super, underexcavation way of slope reduced, cutting slope of the smooth degree of improvement, guarantee the slope stability; compared with ordinary blasting reduce the number of blasting excavation, blasting, blasting cost reduction, improve safety. Li Xinping and others[15] in order to study the reduction of blasting excavation on the reserve of rock damage, using numerical simulation method, the influence of different charge structures on blasting effect, found that compared to single center cartridage and eccentric double roll, roll eccentric single pre crack forming effect of charge structure and the best，the explosion load of the borehole wall in the reserve side is small, in the excavation area on one side is larger, can reduce the blasting excavation on rock damage will also reserve more energy in the excavation blasting of rock mass.Yan Dayang and others[16] in Anqian iron mine slope ocean governance early formation is not smooth blasting and stability, to the daily production security hidden trouble. In order to ensure the stability of the mining field fixed slope, to uncouple presplit blasting test in the field, to be considered from the aspects of blasting parameters, charge structure, initiation, initiation network, on the slope treatment and achieved good results, for the future to help provide guidance by blasting. Xu Gang and others[17] in Lu Ning coal seam No. 2 for hard roof of blasting, the blasting blasting parameters directly affect the hard roof weakening effect in blasting parameters, effects of coupling coefficient of radius of broken zone and cracked zone size. When the decoupling coefficient is too large, the initial pressure of the hole wall is too small, which will affect the blasting effect. If the coupling coefficient is too small, the energy of the explosive will be lost in the crushing area, which can not form a larger fissure area, and also affect the blasting effect. Therefore, it is necessary to study the reasonable uncoupling coefficient in depth.

Conclusions

Although the research on decoupling charge blasting has made some achievements at home and abroad in recent years, it has been widely applied in engineering applications, and has been

affirmed by researchers. However, because of its complex mechanism of explosion, there are still many problems worth studying. The following are the conclusions drawn from the current results of the uncoupled charge blasting and the future research directions.

1. The decoupling charge explosion increases the pressure around the hole wall, increases the utilization rate of explosive energy, enhances the ability of rock breaking and reduces the consumption of explosive, so as to achieve the goal of safety increasing efficiency and reducing consumption.

2.In numerical simulation, meshless method has obvious advantages over finite element in mesh distortion and mesh migration. It is more conducive to simulate the explosion process of decouple charge blasting. At present, there are few researches on numerical simulation in this field, and further research is needed.

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