Advances in Engineering Research, volume 163
7th International Conference on Energy, Environment and Sustainable Development (ICEESD 2018)

Analysis of Ultrasonic Testing in Engineering Blasting

Xie Huagang[1, a] Wu Lingli[1,b] Xu Chao[1,c] Zhu Yuya[1,d] Wang Shanmin[1,e]

1.Tongling University, Tongling 244061, Anhui Province, China

[a]email:xiehg2005@126.com, [b]email: 181531464@qq.com, [c]email: 37790451@qq.com, [d]email: 1036965210 @qq.com [e]email: 1328003103 @qq.com

Keywords: Ultrasonic flaw detection; engineering blasting; rock damage; numerical simulation

Abstract: Ultrasonic flaw detection is widely used in engineering blasting, especially the non-destructive testing of rock blasting damage, and it has a good detection effect. By analyzing parameters proposed by ultrasonic flaw detection, the amount of rock damage can be obtained, and Then complete the corresponding test work.

Introduction

With the extensive application of blasting technology, the study of rock blasting damage has become a core problem in the blasting field. In particular, the influence and damage of blasting vibration on the mine slope has been highly valued by scholars at home and abroad. For example, in the latest international "Blasting Safety Regulations", blasting vibration safety permitting standards have newly added allowable standards for the permanent influence of blasting vibration on high slopes. Fei Honglu and Zhao Yupu passed the sound velocity test of the rock mass at the same location before and after the blasting and the regular observation of the peak velocity of the blasting vibration velocity, and used the sound velocity test results to obtain the damage coefficient of the rock mass, so that under the condition of multiple blasting cumulative damage, the blasting was obtained. The velocity of vibration shows an exponential decay with the change of sound velocity in rock mass[1]。It is believed that there is a crack in the rock body before blasting and it is treated as an initial damage to the rock mass. Other weak structural planes serve as potential damages, then the damage variable is defined and the rock damage evolution equation is established. Starting from this theory, we can see that the process of slope failure is actually the process of damage accumulation. The damage of rock mass is due to the damage variable exceeding the limit[2]. Using the combination of ground penetrating radar and ultrasonic waves, blasting damage detection was performed on different charge structures of concrete models. The results show that the ground penetrating radar is feasible for the blasting damage location of concrete. Combined with ultrasonic technology, the blasting damage can be quantitatively evaluated. The concrete blasting damage mainly occurs at the initial damage (defect) of the concrete, that is, the concrete blasting. The damage is mainly the result of the "injury" of the initial damage (defects); the damage area of the GPR section shows a good correspondence with the reduction of the acoustic velocity before and after the blasting[3].

Application of damage in the mine

The safe mining of mine pillars and the treatment of goafs are directly related to the sustainable development of mines and the safety of personnel. Based on the geology of iron-zinc polymetallic mines in Xilinhaote, Xilinhaote, Inner Mongolia Xingye Group, ultrasonic testing technology was used to rock masses. Based on the theory of blasting damage, the cumulative growth law of surrounding rock damage in the sub-segment mining roadway under the action of multiple blasting is systematically studied. The cumulative damage of surrounding rock blasting and the recovery of the ore pillar and the stability of the goaf area are studied[4]. In the blasting excavation of rock slopes, the use of pre-splitting blasting can effectively reduce the occurrence of slope overcutting and rock fall, and can make the slope more smooth, beautiful and stable. However, in pre-splitting blasting, safety accidents are very easy to occur, and the blasting performance is also different according to the corresponding requirements. In view of this problem, the damage of slope rock mass by presplit blasting was experimentally studied[5]. The field test method was used to test the near-field blasting of rock roadway. With the advancing of the tunneling working face, the propagation attenuation law of blasting vibration along the side wall of the roadway was obtained. The damage law of the roadway sidewall was studied by ultrasonic testing technology. The study revealed the cumulative damage law of rock mass under blasting vibration. The study found that: In the blasting near area 15m blasting vibration attenuation slow, followed by a sharp decay process, advance to 25m when the driving surface, blasting vibration attenuation to about 1cm/s. By comparison, it is found that the slash method is more suitable for the damage test of the roadway sidewall, and the damage degree increases sharply when the working surface is advanced to 10~20m. Comprehensive analysis of the blasting vibration and acoustic measurements shows that: Under the periodic blasting vibration load, the micro-cracks perpendicular to the test hole are preferentially developed. The attenuation of the blasting vibration is the external manifestation of the internal damage development of the rock mass[6].

Research and analysis of ultrasound damage

Rock blasting damage has always been one of the hotspots and difficulties that many scholars are concerned about. For the blasting damage of surrounding rock directly or indirectly affects the safety and stability of the project, it is necessary to study the blasting damage determination of rock mass. Scientific understanding of rock blasting damage can effectively reduce support costs and reduce accident rates. At present, bulk acoustic wave testing technology has been widely used at home and abroad, and it is also one of the reliable means for engineering geological survey and geotechnical engineering mechanics research. Although the development of acoustic wave testing technology has been nearly 40 years old, the research on the correlation between acoustic wave velocity and rock mechanics characteristics is still at a stage of development. Predecessors have done a lot of work in researching acoustic wave test technology and got a lot of achievements[7]。

The impact of blasting on the basic quality index BQ of the rock mass was analyzed theoretically. Several blasting methods to reduce the damage are introduced. At the same time, the damage effects of different blasting methods on rocks are analyzed by calculating parameters such as the basic quality index of rock mass, rock integrity index, and the impact of blasting on rock mass integrity. Satisfactory results[8]。 Blasting excavation will cause the destruction or loosening of surrounding rock in a certain range, which will lead to a decline in the carrying capacity of the surrounding rock. In combination with engineering practice, acoustic sounding technology is used to test the drilling core and the field piled test block. Combined with the field test results, the broken looseness range is determined and verified by each other to prove that the sound wave detection technology is reliable[9] .

Application of Ultrasonic Damage in Sputum

Luo Xiang[10] through the non-blocking explosion test of rock specimens of different resistance lines, using acoustic wave testing and CT imaging technology, studied the damage law of rocks under the impact of the impact of the load. The test results show that the radial blast impact damage of rock is attenuated around the blasthole, and the decay rate decreases nonlinearly with the distance from the rock to the center of the blast point. The rock damage is reduced rapidly within 3 times the borehole's distance from the center of the blasthole, 3 Aperture damage is reduced slowly; borehole axial damage tends to decrease as the distance from the center of the charge to the charge increases. At the beginning, the gradient is larger, then the gradient tends to be gentle as the distance increases; the distance from the different resistance lines detonates. There are differences between blast impact damage in the axial and radial directions of blast holes in rock specimens. Based on the analysis of existing rock blasting damage models and rock damage and fracture theories, Yang Xiaolin[11] et al. used the Taylor method to calculate the effective elastic modulus to establish a new rock blasting damage model, and proposed that the rock under the action of the blast stress wave. The damage fracture criterion, based on the DYNA2D program as the basic framework and the decoupling method under small damage conditions, was used to numerically simulate the damage history of marble under tamping and unpacking conditions.

Conclusion

With the extensive application of blasting technology, the study of rock blasting damage has become a core problem in the blasting field. In particular, the influence and damage of blasting vibration on the mine slope has been highly valued by scholars at home and abroad. The extensive application of ultrasonic flaw detection in engineering blasting has solved a series of engineering problems in practical engineering applications.

Acknowledgements

This work was financially supported by the 2017 Anhui Provincial Outstanding Young Talent Support Program(gxyq2017080); 2017 Anhui Provincial College of Natural Science Research Key (Major) Project (KJ2017A473); 2016 Anhui provincial quality project (2016ckjh214) ; 2016Provincial College Students Innovation and Entrepreneurship Training Program (201610383069); 2016 Provincial College Students Innovation and Entrepreneurship Training Program Project (201610383074); 2017 National College Students Innovation and Entrepreneurship Training program Project (201710383027); 2017 National College Students Innovation and Entrepreneurship Training Project (201710383028); Tongling College School Quality Project (2016xj045), (2016xj010)

References

[1] TIAN Ji-long . Study on Accumulative Damage Effect and Stability of Blasting Vibration on Open Slope [D] . Fuxin: Liaoning Technical University , 2013 .

[2] WANG Guo-xin . Study on Damage Assessment and Structural Effect of Rock Blasting [D] . Fuxin: Liaoning Technical University , 2012 .

[3] XU Li-li, PU Chuan-jin, XIAO Zheng-xue, et al. Experimental Study on Blasting Damage Combining Ground Penetrating Radar and Ultrasonic Wave [J]. Metal Mine, 2013(05): 14-17+30.
[4] FEI Hong-lu, YANG Wei-feng, YANG Zhi-an, et al. Study on Damage Laws of Surrounding Rocks of Mining Roadway in Metal Mines Under Repeated Blasting [J]. blasting, 2012(04): 38-41+94.
[5] XU Xue-yuan, MENG Xiang-zheng, LUO Guo-qing, et al. Experimental Study on Damage of Slope Rock Mass by Presplit Blasting [J]. Guangdong Science &Technology, 2013(02): 82-83.
[6] YANG Guo-liang, YANG Ren-shu, CHE Yu-long. Cumulative damage effect of surrounding rock under cyclic blasting vibration [J]. Journal of China Coal Society, 2013(S1): 25-29.
[7] Deng Yingxiang. Study on Damage Evolution Characteristics of Engineering Rock Mass under Cyclic Blasting Loading[D]. Ganzhou: Jiangxi University of Science and Technology, 2013 .
[8] ZHANG Zhi-cheng, XIAO Zheng-xue, PU Chuan-jin, et al. Study on Damage Effects and Damage Control of Rock Blasting [J]. China Tungsten Industry, 2006(06): 18-22.
[9] JIANG Zeng-guo, FANG Ze-fa, LIU Jing-xiu. Sound Wave Detection Technology of Blasting Excavation Effect [J]. Mining and Metallurgical Engineering, 1997(02): 18-20.
[10] Luo Xiang. The damage law of rock under blast impact and its influence on blasting effect [D]. Mianyang: Southwest University of Science and Technology, 2015.
[11] YANG Xiao-lin, WANG Shu-ren. Rock Blasting Damage and Numerical Simulation [J]. Journal of China Coal Society, 2000(01): 21-25.