Experimental study on the effect of high-precision delay of digital detonator on blasting vibration

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Abstract:

Digital electronic detonators, also known as digital detonators or industrial digital detonators, are detonators that utilize electronic control modules to control the detonation process. Digital detonator technology research and development began in the early 1980s, and in the mid-1980s, digital detonator products began to enter the detonation equipment market. After years of development, digital detonator technology has gradually matured. Compared with ordinary industrial detonators, digital detonators have outstanding advantages such as safety, high precision, traceability, etc., and their application in sandblasting engineering is gradually expanding.

Keywords:

Blasting vibration; digital electronic detonator; high precision delay; image analysis method; blasting blocks

Introduction

On the basis of the national popularization of digital detonators, various high-precision on-site dynamic tests were carried out in the Wagangqiao Iron Mine. The influence law of time lag interval on dynamic vibration was comparatively analyzed, and the distribution characteristics of dynamic fragmentation were analyzed. The study shows that the effect of millisecond time on dynamic vibration in the near zone is greater than that in the far zone, and the closer the measurement point is to the dynamic zone, the greater the effect of millisecond time is. In the neighboring region, the vibration velocity at the measurement point shows a large fluctuation pattern as the millisecond time increases, first increasing, then decreasing, and then increasing. In remote areas, the amplitude of vibration velocity fluctuations decreases significantly. In order to minimize the effect of dynamic vibrations on buildings, different milliseconds should be selected depending on the distance between the building and the dynamic region. The appropriate millisecond time for the near zone is 16 milliseconds and for the far zone is 40 milliseconds.

1. Tests of high-precision delayed field blasting

1.1 Digital detonator workflow

Unlike ordinary industrial detonators, all construction techniques for mining production power have changed significantly after the use of digital detonators, placing higher demands on power operation management, site construction, and power design programs. New procedures have been added to the original construction process, such as digital detonator registration, timing setup, network detection, code download, network startup, and starting line recovery. At the same time, there is an increase in the operation process of the three-code collector and digital initiator, in which the initiator is mainly responsible for communication with the public security control server; the functions of the center are detection, recording, networking, loading, and detonation of electronic detonators. The main workflow of the digital initiator: (1) the initiator registration, reading the digital initiator identity information; (2) network connection: each detonator connected to the explosive zone bus; (3) the site of each detonator time limit adjustment, delay adjustment; (4) network detection: online detection of the state of each detonator; (5) the start-up process: detection, loading and inputting the initiation of start-up code.

1.2 Test plan

Field blasting tests with different differential times were conducted. 6 schemes of milliseconds between holes, 16, 32, 36, 40, 48, and 64 ms, and 8 schemes of milliseconds between rows, 24, 36, 40, 48, 60, 70, 80, and 96 ms. Through the comparative analysis of blasting vibration speed under different schemes, the relationship between high-precision delay and vibration intensity was analyzed, which is a good way to effectively control blasting vibration in mine production and to seek the optimal way to reduce the vibration intensity of the blasts. Hole row interval time. Since blasting vibration has a certain impact on the safety of buildings (structures) around mines, it inevitably produces a certain degree of cumulative damage inside the structure.

2. Test results and analysis

2.1 Burst Vibration Analysis

Blasting vibration monitors were used to test vibrations at different locations. In order to further grasp the characteristics of blasting vibration at different delay intervals, the blasting vibration data were regressed and analyzed using the Sardofsky formula. In order to further compare and analyze the relationship between the blasting vibration speeds of different millisecond times, the change curves of the blasting vibration speeds of different millisecond times were plotted according to the results of the regression formula. millisecond time has a significant effect on the blast vibration, and the closer the measurement point is to the blast zone, the more obvious the effect of millisecond time is. In the proximity range, with the increase of millisecond time, the vibration velocity of the measurement point shows a fluctuation trend of first increasing, then decreasing, and then increasing. The maximum vibration velocity is 36ms/ms and the minimum vibration velocity is 16ms/ms, and the fluctuation of vibration velocity is obviously reduced in the remote area. With the increase of the maximum value of the q section, the vibration velocity of the measurement points increases, but the change rule is milliseconds. When the point spacing is 20ms time 16ms, the vibration velocity of q=250kg and q=150kg is 13.98cm/s and 12.23cm/s respectively, which is 14.31% higher than the vibration velocity of q=250kg. At a distance of 20m and a time of 36m s, the vibration velocities of q=250kg and q=150kg are 65.16cm/s and 48.97cm/s respectively, which are 33.06% higher than the latter, and with the increase of the distance from the measuring point, the blast vibration shows an obvious attenuation pattern. In the range of 60m from the measurement point, the attenuation is maximum. With the increase of the measurement distance, the vibration rate tends to stabilize. In the near zone, the hourly difference has a greater effect on the blast vibration velocity. The analysis shows that the blast vibration is affected by the single charge, hole diameter, distance from the gun center, etc. From the energy point of view, the shock wave only accounts for 3% to 20% of the explosion energy, and the shock wave has the characteristics of high frequency, narrow frequency band, high propagation distance, etc. Due to the damping effect of the drive bearings, the explosion vibration energy is gradually converted into heat, friction energy, etc., with the consumption of vibration wave energy, the explosion vibration velocity with the increase in the distance of the measurement point from the blast zone shows an overall trend of attenuation. In terms of blasting vibration hazards, the closer the building, the stronger the blasting vibration, and the greater the vibration wave energy, is not conducive to the safety of the building. The reverse is also true. Therefore, by adjusting the appropriate millisecond time, a more pronounced damping effect can be obtained in the nearby area, which is very important for the safety of the building. Comparative curves of blast vibration velocities at different distances were plotted. The analysis shows that the overall vibration velocity at the measurement point increases with the increase of the maximum sectional dose. When the maximum sectional load is the same, the measurement point spacing is 20m, the lowest vibration velocity is 16ms, and the lowest vibration velocity is 40ms; with the increase of the point spacing, the vibration velocity is lowest at 40ms and highest at 16ms, and the vibration velocity at 48ms is slightly higher than that at 40ms, and the difference decreases with the increase of the point spacing. From the point of view of building safety, in order to minimize the impact of blast vibration on the building, different response times (milliseconds) are selected according to the distance between the building and the blast area, i.e., 16ms in the near area and 40ms in the far area.

2.2 Blast Crushing Analysis

The degree of crushing is one of the main indicators of the effectiveness of blasting. In order to reduce the subsequent costs of excavators, transportation and crushing, and to control the overall costs of mining operations, it is necessary to appropriately control the degree of crushing at the pick-up point. The labor intensity, time consumption and other defects of manual chip filtering were analyzed. The distribution of demolition blocks in the field test is relatively uniform, the overall distribution is positive, and the highest point is around 100mm, while 50% of the demolition blocks can be controlled within 70mm, and 80% of the demolition blocks can be controlled within 130mm; the level of the demolition pieces is less than 500mm, and the maximum is 464mm, which meets the requirements of the level of the production pieces of the mine, and improves the efficiency of the transportation of the electric shovel. Comprehensive analysis shows that different milliseconds have no significant effect on the degree of cracking.

3. Discussion

(1) In the near blast zone, the vibration velocity of the measurement points increases, then decreases, and then increases again as the millisecond time increases. The effect of the millisecond time on the blasting vibration in the near zone is significantly greater than that in the far zone. The closer the measurement point is to the blasting area, the greater the effect of millisecond time. (2) The closer the blasting area is to the building, the greater the intensity of the blasting vibration, and the greater the vibration wave energy, which is not conducive to the safety of the building. By choosing the appropriate differential time, you can get the best damping effect, and the damping effect is more obvious in the vicinity of the blasting. In order to effectively maintain the safety of the building, it is recommended that different delay intervals be selected according to the distance between the building and the blast area. In the near and far areas, the appropriate millisecond intervals are 16ms and 40ms, respectively. (3) Different high-precision delays have no significant effect on the distribution of blasting blocks, and the overall distribution of blasting blocks is positively asymmetric; 80% of the blasting crushing rate is controlled within 130mm and 500mm, which is conducive to improving the efficiency of on-site shoveling.

Conclusion

In conclusion, from the point of view of field application, some researchers mainly utilize digital detonators to find the appropriate millisecond time to reduce the hazard of blasting vibration, but there is less research on the influence law of delay interval on blasting vibration. Therefore, the influence law of high-precision delay on blasting vibration is analyzed through the comparison test of different delay intervals to guide the blasting risk control in production and to promote the integrated and coordinated development of the mine and the surrounding regional economy.

References:

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