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Delay time optimization in blasting operations for mitigating the vibration-effects on final pit walls' stability

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ABSTRACT

Blasting induced vibration is one of the fundamental problems in the open-pit mines and intense vibration can cause critical damage to structures and plants nearby the open-pit mines, especially to the final pit wall's stability. It is very important to study how to control vibration induced by blasting in the mitigation of negative effects of blasting in open-pit mines. This study aims to examine the propagation of blasting induced ground vibrations and find the feasible approaches to reduce the harmful effects of vibrations induced by blasting on the final pit wall's stability. For this purpose, a series of field experiments were conducted in XinQiao Mining Co. Ltd. Sixty-six events and the blasting parameters of these shots were carefully recorded. During the statistical analysis of the collected data, the predictor equation proposed by the United States Bureau of Mines (USBM) was used to establish a relationship between the Peak Particle Velocity (PPV) and the Scaled Distance (SD) factor. The relationship between PPV and SD was determined and proposed to be used in this open-pit mine. Control of maximum charge amount per delay and the selection optimum interval time to reduce the intensity of vibration by waveform interference were applied in practice. Based on the field experiments, we can determine the maximum charge amount per delay and 15 ms delay were proposed to be used in this site, and a decrease in vibration of 24.5% was obtained.
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1. Introduction

Xinqiao Mining Co., Ltd has an open-pit mine with 4 million ton Pyrites production p.a. At present, the final pit walls with about 200 m height have occurred. According to the mining project, the height of the slope will increase to 400 m or above when the open-pit mine will be closed. Pre-splitting blasting has almost not been adopted near the final pit walls during mining in the past, as a result, the slope's surface is not smooth, and the rock mass of the slope adjacent to surface was deteriorated to some extent. The final pit walls have the characteristics of great height, steep, complexity rock properties and low stability. Small landslide of the final pit walls has occurred many times in Xinqiao Mining. Vibrations induced by mining blasting are considered to have the most negative effects on the final pit wall's stability. Control and reducing negative effects of the vibrations induced by blasting on the final pit wall's stability in this open-pit mine is a critical problem, which affects the mining safety and the sustainable development of Xinqiao Mining Co., Ltd. It is very important to measure and control the vibrations induced by blasting with a greater degree of accuracy.

There are a number of documents devoted to study the blasting induced vibrations in open-pit mines, such as Malmagren and Nordlund [1], Dowing and Gilbert [2], Adiguzel [3] and Siskind et al. [4]. In this investigation, many statutory measures have been given to prevent the damaging capabilities of blasting induced vibrations. As we all know, it is well accepted that the Peak Particle Velocity (PPV) is regarded as the most appropriate and accurate indicator of possible damage. PPV is used as a damage criterion but it could not explain its effect on the facilities, which may be situated very far away from the center point of blasting location and even damaged when PPV is very low. So some researchers used spectral analysis to study the vibrations induced by blasting and the results illustrated that low frequency ground vibrations have more damaging capabilities than those of high [5]. Artificial neural networks have been used to predict and control ground vibration in mines but it's accuracy depends on the number of inputs [5–7].

Various countries have their own specifications set on the basis of case study of observed damages and their safety consciousness. Early years, the criteria for estimating the damage

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