Study on reduction of blast vibration by changing blasting standard and its prediction method in the open pit mine.

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1. Introduction

Blasting technique has advantages in terms of safety and economy for the mine development. On the other hand, the use of explosives is restricted by law as it may have a severe impact on the surrounding environment owing to factors such as blast vibration, noise, and flyrock. Especially, a blast vibration affects a relatively wide range and has to be paid much attention in the mining operation. Therefore, the control and prediction of blast vibration are very important in order to design an appropriate blasting standard and to minimize its environmental impacts.

This study discusses the measures for reduction of blast vibration by changing blasting standards based on the results of a series of field tests. In addition, the method and simulation model for prediction of blast vibration is also discussed by means of two-dimensional finite element analysis code LS-DYNA.

2. Overview of field tests and numerical simulations

2-1 Field tests

A series of blasting tests under different blasting standards were conducted at Kasuga mine, Kagoshima prefecture. Fig. 1 shows a schematic view of the installation of the accelerometers BM1 to BM3. Three-axial accelerometer was used as an instrument to monitor blast vibration.

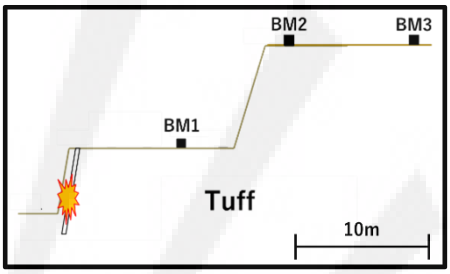

Fig. 1 Layout of accelerometers.

2-2 Numerical simulations

The method and simulation model for prediction of blast vibration was discussed and evaluated in this research. The numerical simulation was conducted by means of two dimensional finite element analysis code LS-DYNA in order to understand the propagation behavior of blast vibration in this mine and predict the blast vibration in the surrounding area. Fig. 2 shows the 2-D simulation model used in this research. Pressure wave induced by blasting around the epicenter can be expressed as the following equation (1) and this equation was applied in this analysis.

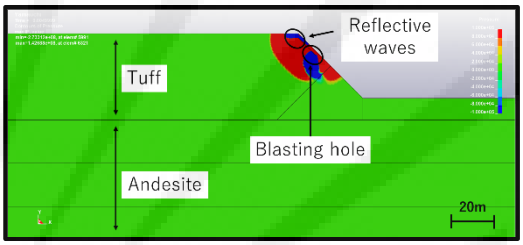

Fig. 2 2-D simulation model.

General formula　$P=P0\ \xi\ \{\exp(-At)-\exp(-Bt)\}$　(1)

where, P: Pressure　P0: Maximum pressure　ξ ,A,B: constant, t: elapsed time after ignition

3. Results and Discussion

PPV(Peak Particle Velocity) and scale distance=R/W1/3 {R: distance from blast hole (m)、W: weight of charging explosive (kg)} were used to evaluate the blast vibration in this study. From the results of a series of field tests, it can be made clear that the burden and the delay time have an obvious impact on the reduction of blast vibration. As shown in Fig.3, the blast vibration can be reduced effectively below the general standard value (PPV<0.002m/s) at the nearest neighbors which is 240m away from the pit as both the burden and the delay time are changed.

Fig. 4 shows the results of numerical simulation and field measurements. As compared both data, it can be concluded that the blast vibration in this mine can be simulated in quantitatively by using this numerical simulation method and model.

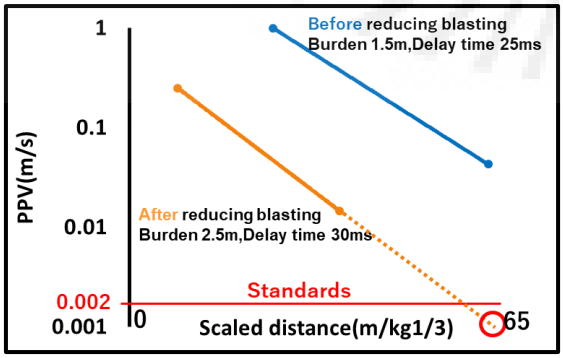

Fig. 3 Results of field tests under blasting designs before and after reducing vibration.

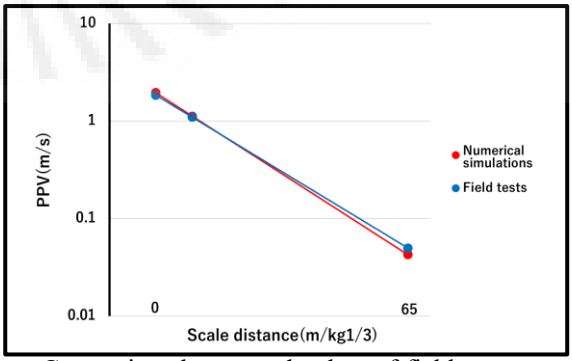

Fig. 4 Comparison between the data of field measurement and the results of numerical analysis.