Prediction of Rock Fragmentation Due to Blasting in Sarcheshmeh Copper Mine Using Artificial Neural Networks

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ABSTRACT

The main objective in production blasting is to achieve a proper fragmentation. In this paper, rock fragmentation the Sarcheshmeh copper mine has been predicted by developing a model using artificial neural network. To construct the model, parameters such as burden to spacing ratio, hole-diameter, stemming, total charge-per-delay and point load index have been considered as input parameters. A model with architecture 9-8-5-1 trained by back propagation method was found to be optimum. To compare performance of the neural network, statistical method was also applied. Determination coefficient (R^2) and root mean square error (RMSE) were calculated for both the models, which show absolute superiority of neural network over traditional statistical method.

Keywords: Blasting; Fragmentation; artificial neural networks; Sarcheshmeh copper mine.

INTRODUCTION

Fragment size distribution due to blasting is very important in efficiency of whole process of the mining operation. Competence of all the subsystems (e.g. loading, hauling and crushing) is dependent on the fragmentation quality (Mackenzie 1966). Optimum size distribution can optimize the overall mine/plant economics (Michaux and Djordjevic 2005; Hustrulid 1999; Kanchibotla 2001; Morin and Francesco 2006).

As many factors are involved in fragmentation quality, from which some are out of reach of blast designer, solution seems to be not so easy. Pertinent parameters can broadly be categorized as rock mass properties; blast geometry and explosive properties (Thornton et al. 2002).

Empirical techniques are mainly established on the basis of experimental information considering only some of the relevant parameters resulted in inaccuracy of the models. These methods with very high accuracy are strongly recommended for solving complicated problems. Many applications of newly developed methods of Artificial Intelligence (AI) based techniques have been observed in the previous investigations.

High capability and performance of Artificial Neural Networks (ANN), a subdivision of AI, in solving problems from different branches of science and technology has made the technique to be applied by many researchers. It can be used as a proper substitute for auto-correlation, regression, trigonometric and other statistical analysis. A model was developed by Maulenkamp and Grima (1999) to predict uniaxial compressive strength. Point load testing was evaluated using ANNs by Yang and Zhang (1997). This technique was applied for tunnel stability analysis and selection of supporting system by Cai and Zhao (1997). Strength of some schistose rocks was estimated by Singh et al. (2001). Khandelwal and Singh (2002) studied stability of waste dump slopes. Maity and Saha (2004) assessed damage in structures because of variation of static parameters. Singh et al. (2004) investigated anisotropic and P-wave velocity in some type of rocks. ANN method was applied by Dysart and Pulli (1990), Finnie (1999) and Musil and Plensiger (1996) for determining different type of events such as earthquake, mining blasts, chemical explosions using seismological data. Similar investigation was performed by Rudajev and Ciz (1999). Monjezi et al. (2006) predicted the ratio of muck pile before and after the blast, fly rock and total explosive used in the blasting operation. Khandelwal and Singh (2005) predicted the air over pressure using neural network and compared findings with USBM predictor. Monjezi and Dehghani (2008) used ANN method to attenuate back break in the blasting operation of an iron ore mine.

In the present study a new model using artificial neural network has been developed to predict fragmentation in Sarcheshmeh Copper mine of Iran.