MİNİMİZATİON OF OVER BREAK DUE TO EXPLODİNG İN TUNNELS USİNG İNTELLİGENT METHODS

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Abstract: In the executive process of a tunneling project, overbreak phenomenon is always one of the most important issues. Nowadays, according to the progress of industry and having new technologies introduced to tunneling industry and their gradual acceptance, traditional methods (drilling and blasting) are replaced by the new methods .Although, the overbreak issue has been largely controlled by project implementers, but it has never been completely eliminated from tunnelling projects. In this research, prediction and optimization of overbreak was discussed using intelligent networks. Best model was selected based on scoring, then it was used for optimization. The R^2 and RMSE values of the selected model were 0.921, 0.4820, 0.923 and 0.4277 for training and testing, respectively. The artificial bee colony (ABC) algorithm, which is one of the new optimization algorithms, was used to optimize these parameters of the blasing pattern. Due to the fact that over break is one of the main problems in tunneling, this reduction can have an important role in the quality and stability of the tunnel. After creating several optimization models and modifying its weights, the optimum amount for the overbreak was 1.63 m^2, which is 47% less than the lowest value achieved during execution process (3.055 m^2). The optimal pattern can be obtained with the least possible amount of overbreak.

Keywords: Tunnel, Overbreak, Artificial neural networks, Artificial bee colony.

INTRODUCTION

In traditional drilling (drilling and blasting operation), overbreak is always one of the most important issues in the execution stages of a tunneling project. The factors affecting overbreak can be categorized into three groups of rock mass properties, explosive properties, and geometric characteristics of the blasting pattern (Mandal and Singh 2009).So far, several researches have been focused on overbreak in mine fields (Maerz, Ibarra, and Franklin 1996; Ibarra, Maerz, and Franklin 1996; Mandal and Singh 2009). Few studies have been conducted on the prediction of overbreak in the tunneling projects. Jang and Topal (2013), predicted overbreak value of a tunnel in South Korea using the neural network. In this work, they used a 49 dataset containing 6 inputs; RMR, rock strength, rock quality index, gap spacing, and groundwater levels. Shaorui et al. (2013) implemented a neural network model for predicting overbreak values in a tunneling project in Chine. According to the research, neural networks can be used to predict overbreak in tunnels and estimate this phenomenon with an appropriate approximation.

In the present study, the value of overbreak was predicted in tunneling projects excavated by drilling and blasting method, using neural networks. After the creation of different models, a scoring system was used to select the best model. Then, the artificial bee colony algorithm was utilized to obtain optimal values of blasting pattern in order to reduce the amount of overbreak. According to the results, suitable patterns can be used to reduce the overbreak in the tunnels.

METHOD

In this research, prediction and optimization of overbreak was discussed using intelligent networks. Best model was selected based on scoring, then the selected model was used for optimization. R square (R^2) and root mean square error (RMSE) were the criteria used for selecting

the best artificial neural network (ANN) model. The artificial bee colony (ABC) algorithm was used to optimize blasting pattern parameters.

DISCUSSION

In this research, the best network (No. 7) was selected and then the ABC algorithm was used to minimize the tunneling overbreak. Given that the amount of RMR varies from 30 to 39, most of the samples were taken with aRMR value of about 36, and the optimization for this part of tunnel was obtained from the rock mass of the tunnel pathway. As it was metioned earlier, the search continues to find the minimum amount of overbreak. Several models of ABC algorithms were implemented with different bees. Fig 1 shows the implementation of an algorithm for minimizing the amount of overbreak.

The optimized parameters after implementation of the ABC algorithmare shown in Table 1. According to the ABC algorithm, the optimized parameter for overbreak in tunnels executed by drilling and blast method, was 1.63 m^2. As mentioned in dataset, the minimum value for drilling was about 5.055 m^2, which was reduced by 47 percent using the optimum ABC optimization algorithm, compared to the initial state. Also, the number of delays, the periphery burden, the end row burden, the periphery spacing, the end row spacing, special charge, advanced length, and overbreak found to be 4, 0.921 (m), 1.796 (m), 1.695 (m), 1.242 (m), 1.235 (kg/m^3), and 1.927 (m^2), respectively. Cost function of this case is illustrated in Fig 1 and the optimized values for the blasting pattern are given in Table 1.
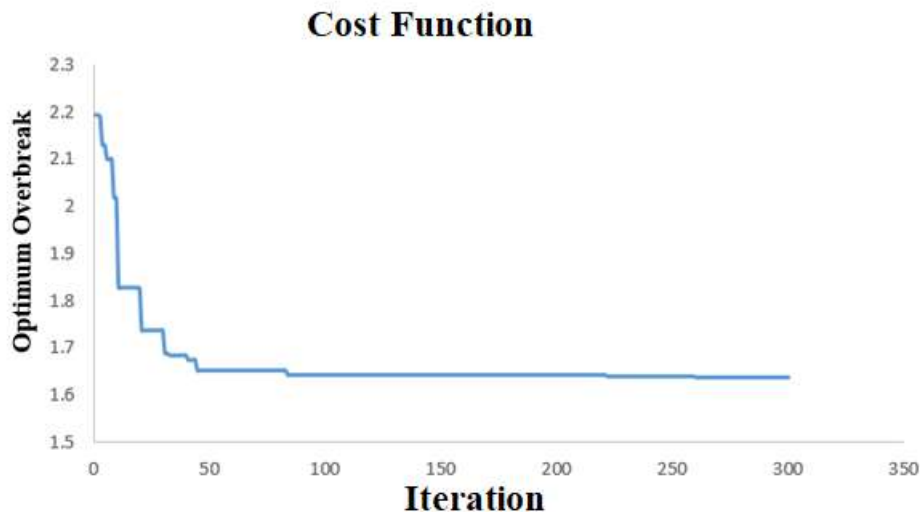

Fig. 1. Minimizing the overbreak valus of tunnel section

Table1.Blasting pattern with optimized values

Parameter	Optimal values
Number of delay	4
Periphery burden (m)	0.921
End row burden(m)	1.796
Periphery spacing (m)	1.695
End row spacing (m)	1.242
Special charge (kg/m^3)	1.235
Advanced length (m)	3.927
Overbreak (m)	1.63

CONCLUSIONS

In this research, the prediction and optimization of overbreak was considered using intelligent methods. Considering that mostly the drilling and blasting method is used for tunnelling in Iran, it is important to recognize the important parameters for predicting overbreak. In the current study, nine input parameters were used to construct the neural network using the Levenberg-Macawat Learning Algorithm. The best model was selected based on the scoring, and then used for optimization. R-square (R^2) and the root mean square error (RMSE) values of the selected model for training and testing were equal to 0.921, 0.4828, and 0.923 and 0.4277, respectively. Sensitivity analysis on data showed that RMR has the maximum and the number of delays has the minimum impact on overbreak. The artificial bee colony (ABC) algorithm was used to optimize these parameters of the blasting pattern. After creating several optimization models and modifying its weights, the optimum amount for the overbreak was 1.63 m^2, which is 47% less than the lowest value achieved during execution process (3.055 m^2). The optimal pattern can be obtained with the least possible amount of overbreak. This optimization method can be used in other mining and civil engineering projects to ensure economical and safe drilling patterns.

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