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Abstract

Many attempts have been made to predict unconfined compressive strength (UCS) of rocks using back-propagation (BP) artificial neural network (ANN). However, BP-ANN suffers from some disadvantages such as slow rate of learning and getting trapped in local minima. Utilization of particle swarm optimization (PSO) algorithm as a mechanism to improve the performance of ANNs is recently underlined in literature. The objective of this paper is to develop a PSO-based ANN predictive model of UCS. For this reason, a comprehensive experimental program was conducted on 66 granite and limestone sample sets taken from different states in Malaysia. The experimental program consists of direct and indirect estimation of UCS tests. The results of laboratory tests including point load index test ($I_{S(50)}$), Schmidt hammer rebound number (SR_n), p-wave velocity test (V_p) and dry density (DD) test were used as inputs of the network while UCS results were set to be the output. For comparison purposes, the prediction performance of the proposed hybrid model was checked against that of a conventional ANN. Comparison between the coefficients of determination, R^2, obtained through conventional ANN and PSO-based ANN techniques reveal the superiority of the PSO-based ANN model in predicting UCS. In overall, the R^2 for the proposed hybrid predictive model was 0.97 while in case of conventional ANN, the R^2 was found to be 0.71. By performing sensitivity analysis, it was concluded that the effect of DD and SR_n on predicted UCS value is slightly higher compared to other parameters.

Keywords: Unconfined compressive strength, Particle swarm optimization, Artificial neural network, Limestone, Granite.

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