

# Chapter 56

## Artificial Intelligent Approaches for Prediction of Longitudinal Wave Velocity in Rocks

**A. K. Verma**  
*Indian School of Mines, India*

**T. N. Singh**  
*Indian Institute of Technology, India*

**Sachin Maheshwar**  
*Indian School of Mines, India*

### ABSTRACT

*Intelligent techniques are quickly gaining importance in the field of geophysics, mining and geology. In this chapter the significance of intelligent techniques like ANN and ANFIS for prediction of longitudinal wave velocity and its advantages over other conventional methods of computing have been discussed. Longitudinal wave measurement is an indicator of peak particle velocity during blasting in a mine and it is a significant factor to be predicted to minimize the damage caused by ground vibrations. Wave velocity measurements have wide applications in the different fields of geophysics, mining and geology. In this chapter, ANN and ANFIS models are designed to predict the longitudinal wave velocity of different rocks and correlation have been developed with fracture properties. The fracture roughness coefficient and physico-mechanical properties are taken as input parameters and longitudinal wave velocity as output parameters. The mean absolute percentage error for the Longitudinal wave velocity predicted by Adaptive Neuro Fuzzy Inference System has been found to be the least.*

### 1. INTRODUCTION

Use of seismic techniques in geological engineering is increasing day by day to assess long-term strength of rock structure. The dynamic behavior of rocks are largely characterized and determined by various techniques. Attempt are made to examine rockbolt enforcement, blasting efficiency of rock by the seismic velocity measurement, estimation of fracture zone developed around the underground opening, deter-

DOI: 10.4018/978-1-5225-1908-9.ch056

mination of degree of rock weathering and characterization of fractured rock mass (Price et.al.,1970; Young et.al.,1985; Hudson et.al.,1980; Karpuz and Pasamehmetoglu, 1997; Boadu, 1997).

Several studies have been done to study the relation between the rock properties and longitudinal wave velocity and tried to establish relation to the static rock properties. Rock type, density, hardness, porosity, strength properties, temperature, grain size and shape, confining pressure, etc. are the most significant factors influencing the Longitudinal-wave velocity. Rocks have undergone throughout their past to a broad variety of diagnostic processes which influence their petro physical and longitudinal wave properties. Apart from these, fracture properties (roughness, filling material, dip, strike, etc.) also influence the compressive wave velocity in rock. The relation of the seismic velocities in rocks of the western region of the central Asia to density and other physical parameters is discussed by Yudborovsky and Vilenskaya (1962). Aveline et al. (1964) have found lower velocity in weathered granite, as compared to fresh one. Berezkin and Mikhaylov (1964) have revealed linear correlation between density and elastic wave velocities in rocks of the central and eastern region of the Russian platform. Measurement of wave velocities in rocks as well as in many other materials is available in the literature (Goodman, 1989; Kern, 1990). Prediction of peak particle velocity, an indicator of Longitudinal-wave helps in designing structures near blasting region of surface mines and other applications related to blasting. Long-term stability of rock structures can only be achieved when longitudinal wave velocity of the rock mass is fully known. Earthquake advance warning is possible by detecting the non-destructive Longitudinal-wave that travel more quickly through the Earth's crust than do the destructive secondary and Rayleigh waves. Determination of Longitudinal-wave enables the development of earthquake resistant buildings.

Due to the fast development of soft computing tools, it is now possible to solve number of complex problems with greater degree of accuracy and authenticity. The soft computing tools like artificial neural network, fuzzy logic, genetic algorithm, etc. have potential to provide rapid, precise and accurate prediction of ground vibration over well-known predictors (Verma 2009, Sinha et al., 2010, Singh et.al, 2004a, b). ANN approached by many researcher to predict the ground vibration using various parameters and comparing the result from the available predictors justify the superiority of soft computing (Singh and Verma, 2005, Khandelwal and Singh 2006).

For the prediction of maximum dry density (MDD) and unconfined compressive strength (UCS) of cement stabilized soil, two artificial intelligence techniques were described (S. K. Das, P Samui, A K Sabat, 2011) First technique uses various artificial neural network (ANN) models such as Bayesian regularization method (BRNN), Levenberg-Marquardt algorithm (LMNN) and differential evolution algorithm (DENN). The second technique uses the support vector machine (SVM) that is firmly based on the theory of statistical learning theory, uses regression technique.

Several studies have been done for the successful application of artificial neural networks are generalization of the model to validation data set, training algorithm of the network and "Black box" system due to insufficient explanations to the weight vectors. The performances of three different type of artificial neural networks; Bayesian regularization neural network, differential evolution neural network and Levenberg-Marquardt neural network techniques are compared to predict the compaction characteristic and specific gravity of highly heterogeneous material, fly ash based on its chemical composition. Different statistical performance criteria are used to compare the performance of above neural network models (S. K. Das, A.K. Sabat).

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