Artificial Neural Network (ANN) Model for Shear Strength of Soil Prediction

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Abstract. Geotechnical structures, design of embankment, earth and rock fill dam, tunnels, and slope stability require further attention in determining the shear strength of soil and other parameters that govern the result. The shear strength of soil commonly obtained by conducting laboratory testing such as Unconfined Compression Strength (UCS) Test and Unconsolidated Undrained (UU) Test. However, random errors and systematic errors can occur during experimental works and caused the findings imprecise. Besides, the laboratory test also consuming a lot of time and some of them are quite costly. Therefore, soft computational tools are developed to improve the accuracy of the results and time effectively when compared to conventional method. In this study, Artificial Neural Network (ANN) was employed to develop a predictive model to correlate the moisture content (MC), liquid limit (LL), plastic limit (PL), and liquidity index (LI) of cohesive soil with the undrained shear strength of soil. A total of 10 databases was developed by using MATLAB 7.0 - matrix laboratory with 318 of UCS tests and 451 of UU tests which are collected from the verified site investigation (SI) report, respectively. All the SI reports collected were conducted in Sarawak, Malaysia. The datasets were split into ratio of 3:1:1 which is 60:20:20 (training: validation: testing) with one hidden layer and eight hidden neurons. The input parameter of Liquidity index (LI) has shown the highest R-value (regression coefficient) which are 0.926 and 0.904 for UCS and UU model, respectively. In addition, the predictive models were tested and compare with the predicted and observed cohesion obtained from the collected experimental results. In summary, the ANN has the feasibility to be used as a predictive tool in estimating the shear strength of the soil.

Introduction

Soil is the uncemented aggregate with the mixture of minerals and solid particles consists of air and water between the solid particles. The engineering properties and behaviour of soils are various, and complex, which depend on the type of soil, physical properties and chemical properties. The study of soil and engineering properties of soil is a crucial factor in showing the behaviour of soil according to Khater et al., [1]. Soil shear strength of the utmost significance engineering property in designing the geotechnical structures, including deep foundations, retaining structures, road embankment, earth and rock fill dam, tunnels and slope stability. This study focused on significant of using soft computing techniques in indicating the geotechnical design parameter; soil cohesion in estimating the shear strength of soil. The Artificial Neural Network (ANN) technique known as an artificial intelligence (AI) programmed mathematical tools works same as the human brain function is used and presented in this current study. It had been widely applied by many researchers for estimation, forecasting, pattern recognition, computation and designs in several fields with consistent and high accuracy results. In this study, the collected test results from Site Investigation (SI) report are used for the ANN model. The ANN model data are analysed and the results were compared with the laboratory tests data which are Unconfined Compression Strength (UCS) Test and Unconsolidated Undrained (UU) Test. This soft computing technique used to minimize the need for elaborate, shorter time consuming and cost effective when compared to laboratory and field test data.