A New Constitutive Model for Prediction of Saturated Sand Behavior Using Artificial Neural Network

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Abstract
The soil constitutive relation is one of the important issues in soil mechanics[1]. In the current geotechnical approach, the relationship between stresses and strains is represented by a series of mathematical equations to describe the soil behavior based on a set of fundamental parameters[2]. The main problem with this parametric approximation is the high mathematical complexity involved especially when nonlinear effects have to be included and also when different types of soils are considered. In this paper by using test data from triaxial shear test of saturated sand, including void ratio, axial strain, deviatoric stress, confining pressure and mean effective stress, an Artificial Neural Network(ANN) is trained and tested. Finally, the results of the networks are employed to simulate the behavior of saturated sand and to compare the stress path curves obtained from test data with those of ANN results.
Keywords: Artificial Neural Network, constitutive model, triaxial test, saturated sand.

Introduction

A constitutive law represents a mathematical model that describes our ideas about the behavior of some material[3]. In other words, a constitutive law simulates, with the aid of mathematical tools, some physical behavior that was mentally conceptualized. During the past decades, increasing interest has been focused in the development of a satisfactory formulation for the stress–strain relationships of engineering soils that incorporates a concise statement of nonlinearity, inelasticity and stress dependency based on a set of assumptions and proposed failure criteria. In spite of considerable complexities of these constitutive models, and due to an inadequate understanding of the mechanisms and all factors involved, it is impossible to capture the complete material response along all complex stress paths and densities[4]. Many different constitutive laws, founded on different concepts, have been offered to the scientific community; and every proponent frequently proclaims the superiority of his law over the others. Since Hooke's times, the methodology used for developing these constitutive models has kept essentially the same step sequence: (a) the material is tested and its behavior is observed; (b) a mathematical model is postulated to explain