An analytical solution to reliability assessment of soil shear strength

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Abstract

Soil shear strength is a very important topic in geotechnical problems. Shear strength is dependent on a number of variables and is highly amenable to probabilistic treatment. Probabilistic analysis of shear strength is used as an effective tool to evaluate uncertainty of soil parameters. In this research the jointed distribution random variable method is used for probabilistic analysis and reliability assessment of Mohr-Coulomb shear strength equation. The selected stochastic parameters are internal friction angle, cohesion, and unit weight of soil as well as the depth of which are modeled using truncated normal probability distribution functions. The resultant probability density functions are compared with the Monte Carlo simulation. Comparison of the results indicates superior performance of the proposed approach for assessment of reliability of the shear strength model for unsaturated soils.

Keywords: Reliability assessment, jointly distributed random variables method, Monte Carlo simulation, Soil shear strength

1. INTRODUCTION

Many geotechnical problems such as bearing capacity, lateral earth pressure and slope stability are depended to shear strength of soil. In general, the uncertainty in shear strength determination is divided into three distinctive categories: soil parameters uncertainty, model uncertainty and human uncertainty [1, 13]. Parameter uncertainty is the uncertainty in the input parameters for analysis [5, 7]; model uncertainty is due to the limitation of the theories and models used in performance prediction, while human uncertainty is due to human errors and mistakes [15]. In this research only parameter uncertainty is assessed.

2. METHODS OF PROBABILISTIC ANALYSIS FOR SHEAR STRENGTH

Several probabilistic methods can be used to assess shear strength. These methods can be grouped to three categories: analytical methods, approximate methods and Monte Carlo method [3, 4]. In analytical methods, the probability density functions of input variables are expressed mathematically. They are then integrated analytically into the adopted slope stability analysis model to derive a mathematical expression of the density function of the factor of safety. The Jointly Distributed Random Variables Method (JDRVM) lies in this category [8].

Most of approximate methods are modified version of two methods namely, First Order Second Moment Reliability Method (FOSM) [2, 6, 11].And Point Estimate Method (PEM) [14]. Both approaches require knowledge of the mean and variance of all input variables as well as the performance function that defines shear strength.

Monte Carlo simulation uses randomly generated points to cover the range of the values that enter into a calculation [12]. As many as 10,000 to 100,000 generations points may be required to adequately represent a