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INVERSE ANALYSIS IN GEOTECHNICS: SOIL PARAMETER IDENTIFICATION BY GENETIC ALGORITHM

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ABSTRACT

Most standard geotechnical in situ tests do not allow the direct identification of the constitutive parameters of the soil layers. The use of the finite element method for the design of geotechnical structures is consequently strongly limited by the rough knowledge of the mechanical properties of soil. This fact leads to set the problematic of inverse analysis in geotechnical engineering: What information concerning the constitutive parameters of the soil is it possible to get from in situ measurement?

This study is dedicated to the identification of parameters of soil constitutive models by inverse analysis. In order to have a suitable identification method able to adapt itself to different kinds of geotechnical structures, we have chosen to use a direct approach to solve the inverse problem [2, 3, 5, 11]. Trial values of the unknown parameters are used as input values in the finite element code PLAXIS to simulate the associated direct problem until the discrepancy between measurements and numerical results is minimized. The problem is then reduced to a parameter optimization and there are no restrictions concerning the soil model or the geometry than for a direct numerical simulation of a geotechnical engineering problem.

Main methods used in literature to solve optimization problems are based on gradient methods [1, 4]. These methods assume the uniqueness of the solution for inverse problems. However, geotechnical studies are often perturbed by modelling errors or in situ measurement. Then, it can not exist one exact solution for an inverse problem but rather than an infinity of approached solutions. The goal of this study is to develop a method of inverse analysis, which permits to identify all these approached solutions. These developments are based on some excavation problems and pressuremeter tests.

To identify the soil parameters from geotechnical studies, the inverse analysis is based on a genetic algorithm optimization process (GA). This method is well known to be robust and efficient to solve complex problems. For geotechnical studies, the authors show that contrary to optimization processes based on gradient methods, genetic algorithm permits to find the best solutions of the problem even with a flat or noisy

error function [7, 9]. Moreover, the study of the genetic algorithm optimization process provides more information than gradient methods on parameter sensitivity and on the existence of mathematical relations between parameters [10]. Furthermore, to describe the set of solutions identified from a genetic algorithm optimization, they introduce a statistical analysis based on Principle Component Analysis (PCA) [6, 8]. This analysis provides a set of solutions for the inverse problem. A principal component analysis on these solutions permits to defined an envelop in which all the parameter values satisfy the inverse problem.

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