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Numerical Comparison of the Performance of Genetic Algorithm and Particle Swarm Optimization in Excavations

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Abstract

Today, the back analysis methods are known as reliable and effective approaches for estimating the soil strength parameters in the site of project. The back analysis can be performed by genetic algorithm and particle swarm optimization in the form of an optimization process. In this paper, the back analysis is carried out using genetic algorithm and particle swarm optimization in order to determine the soil strength parameters in an excavation project in Tehran city. The process is automatically accomplished by linking between MATLAB and Abaqus software using Python programming language. To assess the results of numerical method, this method is initially compared with the results of numerical studies by Babu and Singh. After the verification of numerical results, the values of the three parameters of elastic modulus, cohesion and friction angle (parameters of the Mohr–Coulomb model) of the soil are determined and optimized for three soil layers of the project site using genetic algorithm and particle swarm optimization. The results optimized by genetic algorithm and particle swarm optimization show a decrease of 72.1% and 62.4% in displacement differences in the results of project monitoring and numerical analysis, respectively. This research shows the better performance of genetic algorithm than particle swarm optimization in minimization of error and faster success in achieving termination conditions.

Keywords: Back Analysis; Soil Strength Parameters; Genetic Algorithm; Particle Swarm Optimization; Python; Excavation.

1. Introduction

Excavation operations increase the probability of occurring problems like collapse of the buildings, large deformations at the ground level and especially unpredicted damages. This importance is due to the concerns related to ground movements around deep excavations. Therefore, precise identification of the soil strength parameters are essential for predicting lateral soil movements. But, there are limitations associated with the results of experimental models and also in-situ tests for determining the soil strength parameters. So, for determination of the soil strength parameters one could take advantage of various the back analysis methods.

The back analysis method was first used by Peck in 1980 to estimate the soil parameters based on project monitoring. Afterwards, the technique was used in geotechnical structures such as rock tunneling, soil structures, identification of soil parameters in laboratory or in situ tests and operational data of excavation systems. Over time, optimization methods including metaheuristic algorithms, such as genetic algorithm (GA) and particle swarm optimization (PSO), were used to accelerate the achievement of ultimate target and increase the accuracy of predictions in the back analysis [1].

In fact, the back analysis methods are based on the measured deformations after construction of the structure and their interpretation. In the back analysis, strength parameters of the soil can be determined by minimizing the difference

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