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Numerical Evaluation of Behavior of Excavations Stabilized by Cast-in-place Concrete Pile

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Abstract

One of the effective methods which is nowadays very common in deep excavation of urban areas is the stabilization of cut slopes using the cast-in-place concrete piles. The aim of this study is the evaluation of behavior of vertical cut slopes which are stabilized using the method of cast-in-place concrete piles. The layered soils with different geotechnical parameters have been modeled and analyzed using the finite element method. The effects of different parameters such as cohesion, the percent humidity of the soil as well as the geometrical shape of concrete piles on the horizontal and vertical displacements of cut slopes are also investigated.

Keywords: Cast-in-place concrete piles, excavation, retaining structures, finite element method.

1. INTRODUCTION

Fast rate of urban development on one hand, and lack of urban space in metropolises on the other hand, have forced engineers to implement many of their projects through excavation in sites with vertical or near-vertical cut slopes. Given the importance of the stabilization of vertical slopes in urban constructions, many research works have been devoted in this field.

Tabrayi et al. [1] evaluated the behavior of vertical cut slopes stabilized by tieback systems using 2D and 3D finite element modeling. The research of this reference is founded on the case study of stabilized tieback systems of Mashhad's Financial Tower. Zou et al. [2] presented an effective new interface element for modeling the interaction between nail and soil. Note that the soil nailing method is widely used as a reinforcing technique to retain excavations and vertical slopes in many countries and regions. Zou and Yen [3] introduced a simple mathematical formulation to model the slippage between nail and its surrounding soil. They considered a few key factors which are soil dilation, bending of the soil nail, vertical pressure, and non-linear subgrade reaction stiffness. They validated their suggested model by comparing their results with those of other researchers. Chen et al. [4] studied the stability of cut slopes in large scale using 3D finite element method. In order to improve the safety factor associated with the shear strength reduction finite element method, they suggested a new strategy. In this reference, a generalized bisection search algorithm is proposed to reduce the possibility of encountering non-convergence. Alcasane et al. [5] studied the effect of different slip surface search techniques on the factors of safety obtained using the limit equilibrium (LE) slope stability methods. They also compared the results obtained from the finite element method, the linear grid method, the rectangular grid method, and the Monte-Carlo searching techniques with each other. Choudhury and Chatterjee [6] proposed a simplified two-degree of freedom mass-spring-dashpot dynamic model for the estimation of the active earth pressure at the back of the retaining walls under seismic conditions. They presented results in terms of displacement, velocity and acceleration-time history are for some typical cases. Golchoubi and Barkhordari [7] studied the sensitivity of basic parameters of nailed soil slopes using finite element method. In this research, the effect of different parameters of nailing, such as