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Evaluating the Bearing Capacity of Micropile Groups in Different Soils Using Numerical Methods

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Abstract

This paper evaluates the bearing capacity and failure mechanism of micropile groups in sand and clay. Micropiles are small diameter piles (typically less than 300mm) which are generally used for structural support, underpinning and in-situ earth reinforcement. The goal of this study was comparing the performance of micropile groups in sand and clay. Also, bearing capacity and failure mechanism of the micropile group evaluated and compared to single equivalent concrete pile with a similar cap. For this purpose, bearing capacity diagrams were plotted using finite element based Plaxis 3D Foundation software. Analysis results showed that the micropile group together with the soil within the group developed into a block and had higher bearing capacity in clay rather than loose sand. Also, bearing capacity and failure mechanism of the micropile group in clay was similar to single equivalent concrete pile and the failure theories of piles in the literature.

Keywords: Micropile Group, Finite Element Method, Numerical Modeling, Bearing Capacity, Failure Mechanism.

1. INTRODUCTION

Pile foundations have been used in construction for thousands of years as an economical means of transmitting loads from superstructures to the underlying soil or rock strada. In pile design, piles must be able to sustain axial loads from the structure without failing in bearing capacity or settling so much that structure damage occurs or serviceability of the structure is jeopardized.

Piles with a diameter of less than 300mm are generally referred to as micropiles (Lizzi 1980; FHWA 1997). Modern micropiles were initiated by Dr. F. Lizzi in the 1950s in Italy, where they were called *pali radice* (root piles) in response to the demand for innovative techniques for underpinning historic building and monuments that has sustained damage with time [1]. Micropiles are now widely used for both structural supports in foundations and in-situ earth reinforcement. Micropiles are considered promising foundation elements for improving the bearing capacity or preventing the settlement of existing, deteriorating foundations with minimum disturbance to structures, subsoils, and the environment. The conceptual idea behind this important technological development was to create a type of pile that would be able to carry large loads while causing minimal vibration or disturbance to *in situ* materials at the time of installation. The rigs required to install them are often relatively small. Because of these important advantages, micropiles have been widely used in seismic retrofitting, in the rehabilitation of foundations of structures that are very sensitive and in locations with low headroom and severely restricted access conditions.

In previous model studies on micropile foundations Tsukada et al. [2] have reported the experimental method and results of footings test (FT-Test), micropile test (MP-Test) and micropile-foundation test (MP-FD-Test) in different sand under vertical loads. Miura et al. [3] have analyzed the loading-bearing mechanism, key factors affecting bearing capacity and the network effect of micropile foundations under vertical loads. Different kinds of micropiles have been shown in Figure 1.