学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Bearing capacity evaluation of various types of foundations subjected to combined load in layered grounds considering nonlinearity of strength against confining pressure
(拘束圧に対する強度非線形性を考慮した、複合荷重を受ける層状地盤上の基礎の支持力評価)

Due to the complexity of the interaction mechanism between soil and foundation, foundation design, is still considered as one of the most difficult tasks in geotechnical engineering. There are many types of foundation, and the bearing capacity of each foundation type is governed both by its structural strength, the supporting soil properties and the forces acting on it. In this thesis, the bearing capacities of three types of foundations are being investigated using an in-house FEM code, namely, the rigid-plastic finite element method. (1) the bearing capacity of strip footing on two-layered c-fai soils, (2) the end bearing capacity of Incompletely End Supported Pile (IESP), (3) the bearing capacity characteristics of spiral pile subjected to combined loads.

(1) In the case of strip footing, the bearing capacity was investigated by considering layer factors. The influences of the following ratios on the bearing capacity factors were investigated: The ratio of the tangent of the angle of friction of the bottom layer to that of the top layer; the ratio of the cohesion of the bottom layer to that of the top layer; the ratio of the unit weight of the bottom layer to that of the top layer, and the ratios of the embedment of the footing and the thickness of the top layer to the footing width. Based on the influences of those ratios, layer factors are determined. Several types of failure mechanics were found and the conditions of occurrence of each failure type are summarized in a chart.

A new approach for estimating the bearing capacity of strip footings on two-layered c-fai soils is proposed. A comparison with available methods in the literature has confirmed the reliability of the proposed method, showing the application limitation of the past research.

(2) In the case of IESP, the end bearing capacity was investigated considering shear strength nonlinearity of soil against confining pressure, and soil-foundation interaction. The effect of the distance between the pile tip and the bottom hard soil layer (d/B) on the end-bearing capacity of IESP was mainly investigated. The influence of ratio (r) of the end bearing capacity of the pile when it reaches the bottom hard layer to the end bearing capacity of the pile when the bottom layer has no influence was also investigated. As a result, the consideration of the shear strength non-linearity leads to accurate estimation of the end bearing capacity, affects the failure patterns and matches previous analytical, experimental and numerical solutions. It is found that the end bearing capacity inversely decreases with the distance d/B and becomes constant around d/B = 3. Based on the results, a formula for estimating the end bearing capacity of IESP is proposed. And comparisons with methods in existing literature have confirmed the reliability of the proposed equation.

(3) In the case of the spiral pile, a series of push-in, pull-out and horizontal loading tests on spiral

piles constructed on soft and viscous ground was conducted, and a method to easily consider the integration effect of surrounding ground by rotational press-fitting is proposed. Subsequently, based on the proposed method, a small-diameter spiral pile is modelled with FEM analysis, various test results were reproduced and parameters to consider the integration effect of the surrounding ground, in numerical analysis, are identified. By the same FEM analysis method, using the identified parameters, the bearing capacity characteristics of the vertical and batter spiral pile for the combined load are obtained. Finally, based on the results, formulas for the bearing capacity envelopes in H-V-M space are proposed and the accuracies of the formulas are verified.