بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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MONA MAGHRABY

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

Mutual Seismic Interaction between Micropiles and surrounding Soil

Thesis
Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Science
IN CIVIL ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
By

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Thesis : Mutual Seismic Interaction between Micropiles and surrounding Soil

Degree : Master of Science in Civil Engineering (Structural Engineering)

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Postgraduate Studies
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STATEMENT

This thesis is submitted to Ain Shams University for the degree of M.Sc. in Civil Engineering.

The work included in this thesis was carried out by the author at the Department of Structural Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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ABSTRACT

Micropiles are small-diameter reinforced grouted piles that are commonly not higher than 30 cm in diameter. Nowadays, micropiles have been used widely in situ reinforcement and for structural support purposes because of their suitability to be used in congested areas and almost in all soil types, and their flexibility in seismic conditions. Micropiles are widely used for slope stabilization, for controlling structural settlement, and in some cases as retaining structures. They are also used for resisting uplift dynamic loads, seismic retrofit mainly in restrictive and low headroom areas, retrofitting historical monuments.

The lack of studies on the prediction of micropiles' seismic response makes it an essential topic to be studied more. This thesis attempts to study the effect of lateral dynamic loads on a structure's response with different foundation type cases. A representative soil model is conducted to represent the soil-structure interaction system under seismic excitation supported with proper boundary conditions in PLAXIS 2D for dynamic analysis based on previous recommendations. The choice of boundary conditions is verified according to the amplification factor's theoretical solution on a model with a simple material and harmonic motion. The behavior of piles is studied and verified from previous results under static and dynamic loading states. A free-field site response analysis of the main soil model is then performed at different structure cases and compared to evaluate the structure's behavior during different earthquakes. An extensive parametric study, considering earthquake magnitude, foundation type, pile diameter, pile length, and the number of piles, has been carried out to investigate the behavior of micropiles. The results of this study showed that the structure's seismic response is highly affected by the

properties of the sub-surface soil layer. The main conclusion of this study showed that underpinning using micropiles is an efficient technique for controlling the seismic response of existing structures.

Keywords: Dynamic soil-structure interaction, micropiles underpinning, seismic excitation, nonlinear analysis, multi-story building, response spectrum.

SUMMARY

Thesis : **Mutual Seismic Interaction between Micropiles and surrounding Soil**

Name : **Noha Ahmed Reda Mohamed El-Shamy**

Degree : Master of Science in civil engineering **(Structural)**.

After a short review of the previous related research studies, this research's main goal is to develop a finite element model that can capture the different aspects of seismic behavior of multi-story building supported with the deep foundation via micropiles. The main target for executing numerical modelling is to show the influence of the surrounding soil on this system and vice versa. Then, FE analyses were used to systematically alter the parameters that affect the seismic response of micropiles. To achieve these goals, PLAXIS 2D models were conducted taking into account the problems that face the dynamic analysis of soil-micropile-structure interaction. These problems include soil non-linearity. So, HS-small strain model was used for soil representation. Also, micropiles' resistance properties and boundary conditions are recorded as the most essential factors in the accuracy of results.

The thesis consists of six chapters

Chapter (1) presents the introduction to this research; it delineates the scope, the main objectives of the conducted research, and the organization of the entire thesis.

Chapter (2) includes a literature review for the previous related research. It mainly describes general trends of the induced deformations and internal forces in piles' sections from lateral seismic excitations. It also reviews some of the most well-known distresses of buildings placed in most vulnerable areas to

earthquakes. The different criteria for assessing soil dynamic behavior are highlighted.

Chapter (3) presents a brief overview of the finite element method that is utilized in the analyses. It shows the used constitutive soil model and parameters of various utilized elements. Equivalence models are executed to verify the used boundary conditions and parameters of the used elements.

Chapter (4) comprises a study of a single micropile behavior under static loading and a study of the effect of micropiles existence on the surroundings, soil, and buildings. The study, also, extended to show the influence of the soil properties on the estimated internal forces of micropiles and the recorded building's deformations. A parametric study for some micropiles parameters, including micropile diameter and length and the number of micropiles under earthquake loading, is also included.

Chapter (5) presents the effect of structure properties -represented in the number of building’s floors- on the estimated internal forces of micropiles and recorded building’s deformations. The connection between micropiles and raft is, also, studied to determine its effect on micropiles and building response.

Chapter (6) presents a general overview and conclusions based on research objectives. This chapter, also, addresses suggestions and recommendations for future studies related to its subject.

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