Research Article Impact Factor: 4.226 ISSN: 2319-507X
Dhatrak A. I., IJPRET, 2015; Volume 3 (9): 280-286 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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EFFECT OF EXCAVTION INDUCED SOIL MOVEMNT ON AJACENT PILE STRUCTURE IN LAYERED SOIL

DR. DHATRAK. A. I[1], KULKARNI S. D.[2]

1. Associate Professor, Department of Civil Engineering, Government College of Engineering, Amravati, Maharashtra, India
2. PG Student, Department of Civil Engineering, Government College of Engineering, Amravati, Maharashtra, India

Accepted Date: 05/03/2015; Published Date: 01/05/2015

Abstract: - In dense urban environments where land is scarce and buildings are closely spaced, deep excavation for basement construction and other underground facilities like cut- cover tunnels are unavoidable. As these excavations are usually carried out close to existing buildings, a major concern is to prevent or minimize damage to adjacent building and underground utilities. As many high rise buildings are supported on pile foundation, there is concern that lateral ground movement resulting from the soil excavation, may adversely affect the nearby pile foundation systems. The lateral load imposed by the soil movements impose the bending moment and deflections in the pile, which may lead to structural distress and failure. This paper aims at investigating the effect of excavation induced movements on the lateral deflection and bending moments on pile situated near the excavation in sand and clay. For this purpose a comparative study of excavation effect on pile in sand and clay are studied. Several experimental studies have also been conducted to explore the effect of various parameters like diameter of pile, length of pile, distance of pile from excavation, excavation depth to pile length ratio, stiffness of wall, and stiffness of pile on the deflection and bending moment of pile and deflection and bending moment of wall supported to the excavation. The common results from the literature included significant effect of the increase in distance of pile from excavation and depth of excavation on the deflection and bending moment of pile

Keywords: Pile, Side supported Excavation, Deflection

PAPER-QR CODE

Corresponding Author: DR. DHATRAK. A. I

Access Online On:

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How to Cite This Article:

Dhatrak A. I., IJPRET, 2015; Volume 3 (9): 280-286

INTRODUCTION

In dense urban environments where land is scarce and buildings are closely spaced, deep excavation for basement construction and other underground facilities like cut- cover tunnels are unavoidable. As these excavations are usually carried out close to existing buildings, a major concern is to prevent or minimize damage to adjacent building and underground utilities. As many high rise buildings are supported on pile foundation, there is concern that lateral ground movement resulting from the soil excavation, may adversely affect the nearby pile foundation systems. The lateral load imposed by the soil movements impose the bending moment and deflections in the pile, which may lead to structural distress and failure.

In deep excavation soil supported wall get deflected by the moment induced due to soil movement. Several researches have used numerical modeling and centrifuge test modeling to evaluate the performance of pile adjacent to the side supported excavation. They established that for piles in sand, the induced pile bending moment and deflection increase with increase in excavation depth. As clay rather than sand is the predominant subsurface material in many cities, the analysis of pile response in clay near the excavation is carried out by using centrifuge model test and results in reduction in pile response with increasing the distance of pile from excavation.

LITERATURE REVIEW

The literature shows limited but sufficient work has been done on plastic waste mixed in soils in the recent past, with a number of researchers adopting various approaches for studying the behavior of plastic waste reinforced soil. Several experimental studies have also been conducted to explore the effect of various parameters on the shear strength and compressibility characteristics of soils with randomly distributed plastic waste strips/chips in soil. The common results from the literature included the increase in shear strength, unconfined compressive strength and tensile strength of the soil. These papers have provided a basis for understanding the behavior of randomly oriented plastic waste chips in soil. Some of related works are discussed below,

H.G.Polous and L.T.Chen (1997) represented the study of finite element method and the boundary element method for pile response due to excavation induced lateral soil movements, with specific attention being focused on braced excavation in clay layers as shown in fig 2.1. They vary the parameters like undrained shear strength, wall siffness,strut siffness,strut spacing (s) and pile diameter (d) to investigate the pile response. They conclude that pile response increases with increasing undrained shear strength due to an increased ultimate lateral soil

pressure and decreases with stiffer excavation support conditions and struts stiffness (k) and smaller strut spacing because such support conditions result in smaller soil movements.

C.F.Leung, Y.K.Chow and R.F.Sen (2000) carried out a centrifuge model tests on unstrutted deep excavation in dense sand and its influence on an adjacent single pile foundation. The method takes into consideration the depth of excavation, length of pile, distance of pile from wall and the soil properties as shown in fig 2.2. The test result revealed that the induced maximum bending moment and deflection on the pile decreased with exponentially with increasing distance between the pile and the wall.

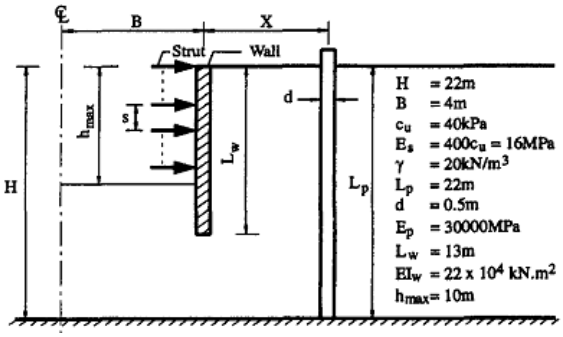

Fig 2.1: Finite Element model with strutting system

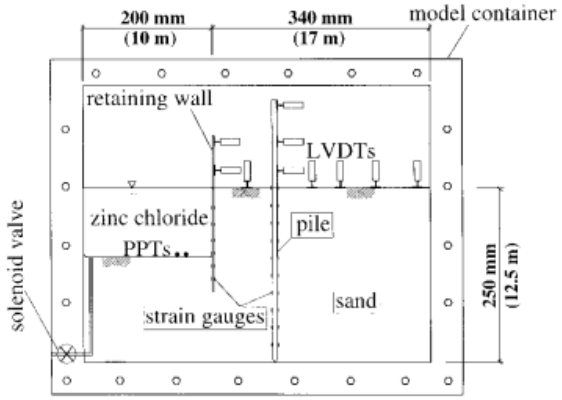

Fig 2.2:Centrifuge Model Setup for Sand

A.T.C.Goh, K.S.Wong, C.I.Teh and D.Wen (2003) presented the results of an actual full scale instrumented study that was carried out to examine the behavior of existing pile due to the nearby excavation activities resulting from a 16 m deep cut and cover tunnel. The excavation is supported by struts spaced at 9m horizontally. The pile was located 3m behind a 0.8 m thick diaphragm wall. Excavation to the formation level that was 16 m below the ground surface

resulted in maximum lateral pile movement of 28mm (Inclinometer). A simplified numerical procedure based on finite element method (BCPILE) was used to analyze the pile response.

D.E.L Ong,C.E. Leung and Y.K.Chow(2006) carried out a series of centrifuge model test to investigate the behavior of single pile subjected to excavation induced soil moment behind a stable retaining wall and the excavation up to the wall colapse.They carried out the test by varying the distance between the pile and excavation in clays. The results reveal that a pile located within 3m behind the wall where the soil experience large shear strain due to stress relief as a result of excavation, the induced pile bending moment and deflection reach their maximum value. The numerical model is used to back-analyze centrifuge test data which gives reasonably good prediction.

D.E.L.Ong, C.F.Leung and Y.K.Chow (2006) was carried out a series of centrifuge model test to investigate the behavior of pile group of various sizes and configuration behind the retaining wall in very soft clayas shown in fig 2.3. With a 1.2 m excavation in front of the wall which simulate initial stage of excavation prior to strutting the test results reveal that the induced bending moment on an individual pile in a free-head pile group is always smaller than that on a corresponding single pile located at the same distance behind the wall. A finite element program developed at the National University of Singapore is employed to back-analyze the centrifuge test data.

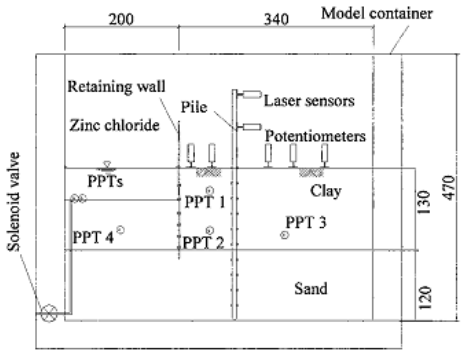

Fig 2.3:Centrifuge Model Setup for Clay

Elkady T. (2013) investigate the effect of excavation induced moments on the lateral deflection and bending moments of pile situated within the influence zone of a cantilever side-supported excavation in sand as shown in fig 2.4. A series of nonlinear finite element analysis were perform(ABAQUS) to assess the effect of excavation depth, distance of pile from side supported excavation , pile stiffness and wall stiffness. Results indicate that distance of pile from

excavation and excavation depth have a significant effect on the lateral deformation and bending moment on pile; while side support stiffness has a less makeable effect.

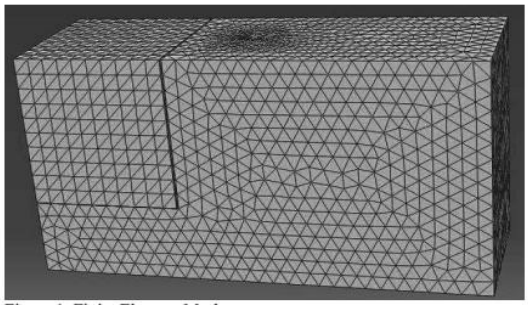

Fig 2.4:Finite Element model of excavtion near pile in sand

Kulkarni.S.R (2014) presents a study of deep basement excavation for 33 stored high rises Tower in Bengaluru. Contiguous bored piles are provided as earth retention system with anchorage at three levels. A Finite element software (Plaxis 2D) was used to evaluate the bending moment of wall and settlement of ground. Result indicates that as the depth of excavation increase moment on wall also increase.

MATERIALS AND METHOD

Generally in deep excavation soil profile consist of number of layers of soil having different geotechnical properties. The previous study deals with the investigation of pile response in particularly clay and soil. Practically at site it is difficult to find out full sand layer or clay layer. The earlier studies are therefore extended to investigate the behavior of single pile due to excavation induced soil movement in layered soil. The parametric study should be carried out with Finite element software (MIDAS3D). The analysis have been performed to assess the effect of diameter of pile, length of pile, distance of pile from excavtion, excation depth to pile length ratio on the adjacent pile in two layers of soil either weak over strong or vice a versa.

The bending moment and deflection of the pile changes as depth of excavation increases and the distance pile from excavation increases. To find the bending moment and deflection of piles various parameter are to be studied. This study may come out with solution so that the effect of excavation near to pile foundation can be used while deep excavation is carried out near pile foundation. The result obtained from the finite element analysis of effect of excavation induced soil movement to the adjacent pile will be studied and on that basis conclusion will be drawn.

CONCLUSIONS

Several experimental studies and analytical studies have also been conducted to explore the effect of various parameters on the deflection and bending moment on pile near excavation. The common results from the literature included the increase in bending moment and deflection with decrease in distance between pile and excavation. Based on the experimental investigations following are some of the conclusions obtained by various research work.

i) The pile response increases with increasing untrained shear strength due to an increased ultimate lateral soil pressure and decreases with stiffer excavation support conditions and struts stiffness and smaller strut spacing because such support conditions result in smaller soil movements..

ii) The induced maximum bending moment and deflection on the pile decreased with exponentially increasing distance between the pile and the wall.

iii) Pile response is significant as the depth of excavation increases.

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