PERFORMANCE OF HORIZONTAL SOIL HOOK SYSTEM IN SAND

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Sir,

CLASSIFICATION OF THESIS AS RESTRICTED

PERFORMANCE OF HORIZONTAL SOIL HOOK SYSTEM IN SAND

Hamed Niroumand

Please be informed that the above mentioned thesis entitled " PERFORMANCE OF HORIZONTAL SOIL HOOK SYSTEM IN SAND " be classified as RESTRICTED for a period of three (3) years from the date of this letter. The reasons for this classification are

(i) This system is a new method and invention,

(ii)

(iii)

Thank you.

Sincerely yours,

Pp DKlArarKm

Departfent Ceal Eeg

Faylf Eeg

Uisi Teg Maly

Dedication

To my wife & my parents

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ABSTRACT

Structures like buried pipelines, transmission towers and earth structures subjected to considerable vertical or horizontal pullout forces are usually supported by anchors. The anchors are helical or plate systems which require excavation and grout in their applications. During the last fifty years, many researchers focused on pullout capacity of anchors. Comparison between experimental and theoretical analyses has been performed to validate the ultimate pullout load of anchors. The aim of this research is to obtain breakout factor and ultimate pullout capacity load of Soil Hook System (SHS) and compares it with previous finding by different researchers. SHS is a new anchor system base on the state of the art of plate anchors that does not require grout and excavation in their applications. The experiments were conducted in a chamber box. Two sizes of SHS with the length 297 and 159 mm were used. For the 159 mm long SHS, an embedment ratio between 1 and 7 were employed. For the SHS of length 297mm the embedment ratio used were between 1 to 4. Both SHS were tested in loose and dense sand. Dry sand with unit weight of $\gamma_d = 14.90\ \mathrm{kN/m^3}$ and $\gamma_d = 16.95\ \mathrm{kN/m^3}$were used for loose and dense sand packing respectively. The results of a comprehensive theoretical analysis on the behavior of SHS were presented. These include hook size, ultimate pullout capacity; pull out load, and breakout factor. It was found that the pullout load capacity and breakout of SHS was similar to the works done by the previous researchers in plate anchors. The results show that the failure mechanism pattern around the SHS at shallow and deep levels were similar to the rupture surface pattern from previous researchers. This research has solved the problem of the installation of anchors into sand with SHS without the need to grout or excavate.

ABSTRAK

Struktur seperti rangkaian paip tertanam, menara talian dan struktur bumi yang dikenakan daya tarikan menegak atau mendatar kebiasaan nya disokong oleh penambat. Penambat sistem heliks atau plat memerlukan penggalian dan turapan didalam penggunaannya. Sepanjang lima puluh tahun, para penyelidik hanya menumpukan pada keupayaan tarik keluar penambat. Perbandingan antara analisis eksperimen dan teori telah dilakukan untuk menilai semula beban penarikan keluar muktamad penambat. Tujuan utama penyelidikan ini adalah untuk mendapatkan nilai faktor putus dan keupayaan tarikan keluar muktamad sistem cangkuk dan membandingkannya dengan penyelidikan sebelumnya oleh penyelidik dari seluruh dunia. Sistem cangkuk tanah merupakan sistem penambat baru kerana seni reka bentuk pada penambat yang tidak memerlukan penggalian dan turapan dalam penggunaannya. Ujikaji dijalankan di dalam kotak kebuk yang memuatkan dua saiz sistem cangkuk dengan panjang 297 dan 159 mm. Untuk sistem cangkuk tanah bagi, panjang 159 mm, tanah nisbah kedalaman yang digunakan adalah antara 1 dan 7. Sistem cangkuk tanah bagi panjang 297mm nisbah kedalaman yang digunakan adalah antara 1 hingga 4. Kedua-dua sistem cangkuk ditanam dalam pasir longgar dan padat. Pasir kering dengan berat unit $\gamma_d = 14.90\,\mathrm{kN/m^3}$ dan $\gamma_d = 16.95\,\mathrm{kN/m^3}$ digunakan untuk pasir longgar dan padat. Keputusan analisis teori yang menyeluruh tentang ciri-ciri sistem tanah cangkuk dihuraikan. Ini termasuk dimensi cangkuk, keupayaan tarik keluar muktamad, beban tarik keluar dan faktor putus. Dapat dilihat bahawa keupayaan beban tarik keluar dan putus bagi sistem cangkuk adalah sama dengan hasil ujikaji oleh penyelidik sebelumnya dalam penambat plat. Keputusan kajian menunjukkan bahawa pola mekanisma kegagalan di sekitar cangkuk tanah pada paras cetek dan dalam adalah sama dengan pola pecah permukaan oleh para penyelidik yang lepas. Penyelidikan ini telah menyelesaikan masalah pemasangan penambat didalam tanah pasir dengan sistem cangkuk tanah tanpa perlu penggalian dan turapan.

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A	:	Area of Anchor Plate
B	:	Length of Anchor Plate/ Soil Hook System (SHS)
C_u	:	Coefficient of Uniformity
D	:	Width of Anchor Plate / Soil Hook System (SHS)
D_{10}	:	Effective Grain Size
D_{50}	:	Uniformity of Sand
e	:	Void Ratio
G_s	:	Specify Gravity
H	:	Depth of Soil
$K_\circ$	:	Earth Pressure Coefficient at Rest
L	:	Depth of Soil above Anchor Plate/ Soil Hook System (SHS)
L/D	:	Embedment Ratio
n	:	Porosity
P	:	Pullout Load
P_u	:	Ultimate Pullout Load
t	:	Time
γ	:	Unit Weight of Soil
?	:	Soil Friction Angle
N_q	:	Breakout Factor
γ_d	:	Dry Unit Weight of Soil
M	:	Mass of Soil
V	:	Volume of Soil
S_f	:	Shape Factor
H_{cr}	:	Critical Embedment Ratio
W	:	Effective Weight of Soil
P_s	:	Shearing Resistance

P_t	:	Force Below of Area
K_u	:	Nominal Pullout Coefficient of Earth Pressure on a Convex Cylindrical
n_r	:	Relative Porosity
I_d	:	Density Index

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Structures such as transmission towers, tunnels, sea walls, buried pipelines, retaining walls and others are subjected to considerable pullout forces. In such cases, an economic design solution may be obtained through the use of tension members. These elements, which are related to anchors, are generally fixed to the structure and embedded in the ground to effective depth so that they can resist uplifting forces.

1.2 Statement of Problem

Most of the anchoring system in this country is a grout base anchoring .The installation may take several days. Soil Hook System (SHS) is a new anchoring with innovative state of the art plate which can be installed in sand without having to grout it. It is expected from this system to increase the speed of construction and cost effective.

1.3 Objectives of Research

The main aim of this research is to investigate the behavior of ultimate pullout capacity of Soil Hook System (SHS) in dry loose and dense sand. In order to achieve the aim of study, five objectives have been identified:

i. To investigate the ultimate pullout capacity of two size Soil Hook System (SHS) in loose and dense sand,

ii. To make new empirical formula based on the result of Soil Hook System (SHS) in sand , due to real tests in soil laboratory,

iii. To compare the break-out factor in Soil Hook System (SHS) with previous works by different researches.

iv. To design rigid of Soil Hook System (SHS) in CATIA , that it is a mechanical software,

1.4 Scope of Study

In this study special attention is provided to Soil Hook System (SHS) that is investigated with only horizontal pullout load test in dry Kota Tinggi sand. The data for this study will be obtained from test data in geotechnical laboratory in University Technology Malaysia.

1.5 Thesis Outline

Reviews of previous researchers' activities are discussed in Chapter Two including the analytical procedures. This chapter is a review based on the Introduction to the Topic of plate anchors because Soil Hook System (SHS) is a type of art special in plate anchors.

Field test and two model laboratory tests will be used to research the performance of horizontal Soil Hook System (SHS) subjected to pullout loading. Field studies in plate anchors, reported by last researchers, will be discussed in Chapter Two.

Review of the theories and numerical analysis in plate anchors from previous researchers will be discussed in Chapter Two, including the analytical procedures. Analyses, beginning from Meyerhof and Adams (1968) until the most recent analysis such as Kuzer and Kumar (2009), are also reviewed.

Research methodology will be discussed in Chapter Three. The Soil Hook Systems (SHS) tests were performed to study the pullout test in loose and dense sand around the Soil Hook System (SHS) in chamber box , that the up mentioned system will rotate after the beginning of pullout loading. Raining methods and vibration method were employed in chamber box to obtain loose and dense packing sand respectively.

Chapter Four contains the interpretation of the experimental results. The variations of model ultimate capacity, P_u with the embedment ratio L/D and N_q breakout factor in dry loose sand and dense sand are analyzed. Dry sand was originated from Malaysia sand quarry area, generally having grain sizes between 0.205 to 2.36 mm. It was used as an embedment medium in small and big model in the wood box. Due to the difficulties in preparing the similar sand sizes, a wide range of size between 0.07 to 5.01 mm was used as the embedment of small and big model sizes of Soil Hook System (SHS) in wood box. It was assumed that no prominence effect on the stress value will be encountered between these two arrangements. Soil Hook System (SHS) was fabricated blade, joint and their rods that they used as a new anchor in special shape, with a length 290 and 145 mm, width 100 and 50 mm, which it can be taken into sand and after putting into balance embedment the rotation begins.

Chapter Five contains the interpretation of the theoretical analysis results. The new empirical formula of model ultimate capacity, P_u with the embedment ratio L/D and N_q breakout factor in dry loose sand and dense sand were compared to previous theories in anchor plates. The proposed results will be compared with previous works such as Murray, Meyerhof and Dickin.

Chapter Six outlines the main conclusions of this research and suggestions for future work.

1.6 Expected Finding

The expected findings of this research have been identified:

i. Performance of pullout test of Soil Hook System (SHS) in loose and dense sand

The system is expected that the Soil Hook System (SHS) drives into sand consisted of loose sand and dense sand, with no excavation of the waterfront property, thus no holes, no digging, no grouting, no expensive restoration is required.

ii. Compare of Result in laboratory with previous works

The Compare of result in laboratory and previous works by last researchers will be conducted with anchor plate results without grouting and development scheme in loose and dense sand.

iii. Conclusion

This study is successful if it can achieve the research study objectives.

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