DETERMINATION OF UNIT SKIN FRICTION FOR PILE IN SAND

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"I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of the degree of Master of Engineering (Civil-Geotechnics)"

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requirements for the award degree of
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Dedicated to my parents whose passion, motivation proved vital in fulfilling the partial requirements of the project,

and

My wonderwall who has been a great source of inspiration.

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ABSTRACT

The unit skin friction is difficult to assess. The method of installation of the pile and the pile material, as such, assume considerable significance as shall be seen hereafter. The choice of the unit skin friction formula depends on the soil type and the pile type. The consistency of unit skin friction value is depends on the unit weight of sand. Different types of sand will produce different values of unit skin friction. In this paper, a program of field and load testing tests for 2 bored piles with diameter varying from 600 mm to 750 mm constructed in Malaysian sand was conducted to measure the axial response of bored piles. The predicted unit skin friction were obtained from semi-empirical method suggested by Meyerhoff (1976), Reese and Wright (1977), and Tan et al. (1998). The measured unit skin friction value was estimated from back analysis of data obtained from pile load test. The results then were evaluated and compared. Based on the result obtained, the predicted unit skin friction of bored piles in dense sand will be higher than loose sand due to the roughness of the material itself. The measured unit skin friction obtained from back analysis of pile load test also provides the nearest value of unit skin friction to the predicted unit skin friction as suggested by Tan et al. (1998). It shows that the value can be considerably used for construction of bored piles in sand in Malaysia.

ABSTRAK

Unit geseran kulit adalah sukar untuk dinilai. Kaedah pemasangan cerucuk dan bahan cerucuk adalah antara faktor yang diperlukan untuk menilai unit geseran kulit. Formula unit geseran kulit bergantung kepada jenis tanah dan jenis cerucuk. Nilai unit geseran kulit juga bergantung kepada berat unit pasir. Jenis pasir yang berbeza akan menghasilkan nilai unit geseran kulit yang berbeza. Dalam kertas kerja ini, program ujian lapangan dan ujian beban cerucuk untuk 2 cerucuk tuang situ dengan diameter yang berbeza-beza dari 600 mm ke 750 mm dibina di pasir Malaysia telah dijalankan untuk mengukur tindak balas paksi cerucuk tuang situ. Cerucuk tuang situ tersebut akan diuji menggunakan ujian beban untuk mengesahkan integriti dan prestasi cerucuk tuang situ. Untuk ujian lapangan, unit geseran kulit akan ditentukan secara kaedah empirikal yang dicadangkan oleh Meyerhoff (1976), Reese dan Wright (1977), dan Tan et al. (1998). Bagi ujian beban cerucuk, nilai unit geseran kulit dianggarkan daripada hasil analisis yang diperolehi daripada ujian beban cerucuk. Hasil keputusan akan dinilai dan dibandingkan dengan unit geseran kulit yang diramalkan. Berdasarkan keputusan yang diperolehi, unit geseran kulit yang diramalkan daripada cerucuk tuang situ di dalam pasir padat akan memberi nilai yang lebih tinggi berbanding pasir longgar akibat daripada kekasaran bahan itu sendiri. Unit geseran kulit yang diperolehi daripada ujian beban cerucuk juga memberi nilai yang terdekat dengan unit geseran kulit yang dicadangkan oleh Tan et al. (1998). Ini menunjukkan bahawa nilai unit geseran itu boleh digunakan untuk pembinaan cerucuk tuang situ di dalam pasir di Malaysia.

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LIST OF SYMBOLS

Q_{ag}	-	Allowable geotechnical capacity
Q_{su}	-	Ultimate shaft capacity
Q_{bu}	-	Ultimate base capacity
f_{su}	-	Unit shaft resistance for each layer
f_{bu}	-	Unit base resistance for the bearing layer
A_s	-	Pile shaft area
A_b	-	Pile base area
F_s	-	Partial Factor of Safety for Shaft Resistance
F_b	-	Partial Factor of Safety for Base Resistance
F_g	-	Global Factor of Safety for Total Resistance
K_{su}	-	Ultimate unit shaft resistance of soil
K_{bu}	-	Ultimate unit bearing resistance of soil
α	-	Adhesion factor
s_u	-	Undrained shear strength
K_{se}	-	Effective stress shaft resistance factor
σ_v	-	Vertical effective stress
ϕ'	-	Effective angle of friction (degree) of soils
N_c	-	Bearing capacity factor
N_γ	-	Bearing capacity factor
N_q	-	Bearing capacity factor
B	-	Pile diameter
D	-	Depth of pile base
β	-	Shaft resistance factor for coarse grained soils

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CHAPTER 1

INTRODUCTION

1.1 Background

A pile maybe classified roughly as friction or end bearing, according to the manner in which they develop support. Bored piles transfer the applied loads to the ground via skin friction of pile shaft and end bearing of pile toe. When a pile is driven into soil of fairly uniform consistency and the tip is not seated in a hard layer, the load-carrying capacity of the pile is developed by skin friction. The load is transferred to the adjoining soil by friction between the pile and the surrounding soil. The load is transferred downward and laterally to the soil. Point bearing piles become very long and uneconomical to be used when no layer of rock is present depth at site. Thus, friction pile is used in this type of subsoil. The piles are driven through the softer material to specified depths.

In most cases, the axial compression loads from superstructures are designed to be transferred by bored piles to the soil layer. Bored piles cause some amount of disturbance very near the pile shaft when installed in a sandy profile. Normally, a drilled pier base can be found on the medium dense sand with a competent stratum located at a substantially greater depth. Due to the high degree of roughness of concrete between the soil particles at the borehole wall and the cement, the interlocking of the shaft with the soil cause shearing to take place within the soil immediately adjacent to the pile. Therefore, the unit skin friction is controlled fully by the shear strength of the sand.

Due to uncertainties associated with pile design that may affect safety and economy of a project, pile load tests are usually conducted to verify the design assumptions and load carrying capacity of the piles. Static load tests (SLT) are among the reliable testing method to ensure the satisfactory pile performance with particular reference to the capacity, settlement and structural integrity. Usually, 1 to 2% of the total number of piles is selected for load test. During the test, static load were applied and maintained using a hydraulic jack and were measured with a load cell.

It is a common practice in Malaysia for the pile to be loaded up to twice of the working load, which is regarded as the Test Load of the pile. On most occasions, the results of this test do not show a distinct plunging ultimate load, therefore the results need interpretation to estimate pile capacity or ultimate load.

1.2 Problem Statement

A few methods have been proposed for predicting the unit skin friction of bored piles in sand. Of these different methods, semi-empirical relations have been used most widely. It is very subjective to determine the unit skin friction as it depends on one’s past experience and judgment to determine the soil characteristics at specific site condition. The unit skin friction is difficult to assess. This is because the magnitude of unit skin friction depends on the intimacy of contact between the soil and pile surface, the magnitude of the stress acting normal to the pile surface and the friction/adhesion parameters that characterize the pile-soil interface.

1.3 Objective of the Study

The aim of this study is to identify the most appropriate interpretation methods to estimate the unit skin friction for bored piles specifically sand in Malaysia. The objective of the study comprises of the following:

a) To determine the unit skin friction for bored piles in sand.
b) To collect data and analyse the unit skin friction for bored piles in sand.
c) To compare the relation of measured unit skin friction obtained from pile load test data with predicted unit skin friction from previous study.

1.4 Scope of the Study

The scope of study covers the positive skin friction on piles rather than negative skin friction. It covers some literature review on the relevant subject, data collections of Standard Penetration Test (SPT) results, preliminary site investigations reports, and bored piling records. The study also focus on the analysis of unit skin friction for the replacement piles, which is bored piles. Only the skin friction capacity of bored piles which were constructed in sand has been considered in this study. The analysis used for determining unit skin friction is by using semi-empirical equations.

1.5 Significance of the Study

The significance of this study is to ensure the correlations by previous study adopted for design of unit skin friction are satisfactory and in order to be implemented in Malaysia. This study will also provide better understanding towards the skin friction capacity in the design stage of bored piles constructed in sand.

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