A COMPARISON BETWEEN STATIC LOAD TEST AND HIGH STRAIN DYNAMIC TEST ON BORED PILES

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ABSTRACT

Piles are both statically and dynamically tested to obtain the capacity and to verify design. Both the test will provide results that may vary base on the method applied in conducting the test. It is therefore, necessary to compare the results of a static load test with dynamic load test. Many comparison studies are conducted worldwide, but most of it is for displacement pile. Therefore, the results of the test are compared for replacement piles. The piles are tested statically prior to dynamic test. The test results shows that a good agreement have achieved between both the test with plus minus 2mm at working load in terms of settlement. Comparatively the settlement predicted in dynamic load test is smaller compared to static load test. In terms of total capacity, the Davisson's method gives the lowest value compared to other methods. The Davisson's method is used to compare the results because it is more conservative. The comparison shows that the piles are within 20% relative to the capacity obtained through Davisson's method. Since the static test was conducted prior to dynamic test, the capacity obtained from dynamic test is higher due to the pile undergone elastic compression during static load test and also due to soil setup. The shaft distribution show that large shaft distribution obtained on long piles. They are comparable with the dynamic test taking into account the time factor.

ABSTRAK

Cerucuk biasanya diuji secara static dan dinamik untuk menentukan beban tanggungan dan juga untuk mengesahkan rekabentuk. Kedua-dua ujian akan menghasilkan keputusan yang berlainan berdasarkan kaedah yang digunakan untuk melaksanakan ujian. Oleh demikian, ia adalah penting untuk memperoleh suatu hubungan diantara ujian static dan ujian dinamik beban cerucuk. Banyak kajian yang dijalankan di merata dunia, tetapi kajian-kajian ini tertumpu pada 'driven pile'. Oleh yang demikian, kajian ini adalah tertumpu terhadap 'bored pile'. Cerucuk-cerucuk ini diuji secara static terdahulu sebelum menjalankan ujian dinamik. Keputusan adalah memuaskan bagi bebanan kerja dengan ±2mm. Secara ringkas boleh dikatakan bahawa keputusan yang diperolehi pada bebanan ujian adalah lebih rendah bagi ujian dinamik berbanding ujian statik. Dari sudut bebanan muktamad pula, kaedah Davisson memberi nilai yang paling minima berbanding kaedah-kaedah yang lain. Nilai ini adalah pada had yang rendah, oleh itu ia digunakan bagi tujuan kajian. Keputusan menggunakan kaedah ini memberikan keputusan bahawa nilai ujian dinamik adalah dalam 20% nilai yang diperoleh. Ini adalah kerana ujian static dijalankan dahulu sebelum ujian dinamik dan ini mengakibatan cerucuk mengalami terikan mampatan dan jugan masa perantaran mengakibatkan tanah pulih semula keadaan asalnya. Dari segi bebanan sisi cerucuk, didapati bebanan sisi menguasai nisbah yang lebih banyak bagi cerucuk panjang. Keputusannya dapat dipersamakan dengan ujian dinamik jika masa perantaraan diambil kira.

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A	-	Cross section Area of the pile
c	-	Wavespeed
E	-	Modulus of Elasticity of the pile material or strain gauge reading
F_m	-	Force measured
F_c	-	Force calculated
j_c	-	Empirical correlation factor (Case method damping factor)
L	-	Distance along the pile between two telltale anchor plates
ΔL	-	Difference in movement between two telltale rods
Q	-	Quake
Q_{ra}	-	Load in the pile midway between two anchor plates or load in the pile at the location of the strain gauge

R_{shaft}	-	Shaft Resistance
R_{toe}	-	Toe Resistance
R_u	-	Ultimate resistance in the soil ‘springs’
Δt	-	Travel time
v_m	-	Velocity measured
Z	-	Pile impedance
P	-	Mass density

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CHAPTER 1

INTRODUCTION

1.1 Background

Foundation is an essential part of a structure because it transmit load from the structure to the soil below it. The foundation can be classified into shallow foundation and deep foundation. Shallow foundations such as individual footings, combined footings, and raft foundation are used when the supporting soil is found at shallow depth. While, deep foundations such as caissons and piles are required when the depth of supporting soil is significant or building is placed on soft compressible soil. Deep foundation is also required if construction is subjected to horizontal load or moment.

Piles are mainly classified into two categories; displacement piles and replacement piles. Displacement piles consist of reinforced piles, pre-stressed piles, steel-H piles, whereas replacement piles consist of bored piles, and cast in-place-piles. All these piles are designated to a particular situation or site based on location and type of structure, ground condition and durability.

Piles are designed based on the load that is transferred from the structure to the piles; thus the type, size and length of piles are determined accordingly. However, load test should be conducted to verify the design capacity. Piles that are not properly designed, would pose danger to the structure. Inadequate load or large settlement would cause severe damage to the structure and its occupants.

There are several alternatives to load test, i.e.: maintained load test (MLT), high strain dynamic test (PDA), statnamic test and Osterberg Cell load testing. All the mentioned tests are rigorously being carried out in Malaysia. These tests would provide the engineer with the load and the corresponding settlement. It actually enables the engineer in decision making as to resume work or to make changes to the selected design criteria. Of the four, the most viable and the most common as being practiced in the industry are the Static Load Test and the High Strain Dynamic Testing.

Maintained load test or static load test is commonly known in construction industry. It uses hydraulic jacking system against a kentledge or against a beam restraint by anchor piles. The load is measured by the reading of pressure gauge on the hydraulic jack. At present the load is measured directly by a load cell interposed between the pile head and jack or between the jack and platform to get an accurate and reliable measurement. This test is also known as conventional test. It requires proper setup, manpower, machinery and longer duration to maintain the load.

High strain dynamic test or dynamic pile testing is conducted using two to four sets of sensors known as accelerometer and transducer attached to the pile. The basis for this testing is wave mechanics. The test requires sensors, pile driving analyzer and the pile driving system. On every impact of the driving system/ram, the sensors capture the impact force and velocity. The captured signals of strain and acceleration were conditioned and possessed by the pile driving analyzer to produce plots of force and velocity versus time. The ability to accurately predict static capacity for dynamic pile testing has resulted in many studies and has been the focus

of dynamic pile tests on many project sites. Standard practice requires performing signal matching on the data to more accurately determine capacity from the dynamic tests. CAPWAP (Case Pile Wave Analysis Program) analysis is the most used program to evaluation capacity from high strain dynamic testing data. Previous studies have demonstrated generally good correlation of CAPWAP signal matching results on dynamically re-striked tests with that of static load tests.

Since, the usage of static load test and high strain dynamic test is rapid and almost conducted in every site, comparisons between the two tests for bored pile is attempted in this project paper.

1.2 Problem Statement

There are many studies conducted on the comparison between high strain dynamic testing and CAPWAP analysis, and static load test in Malaysia, but most of it was made for the displacement piles. I, in this project study however, will focus on replacement piles (bored piles). Comparison is made between the static load test results and the CAPWAP signal matching result on dynamic re-strike test. Furthermore, an attempt is made to compare the results obtained from the maintain load test and the high strain dynamic test and CAPWAP analysis.

1.3 Objectives

The objective of conducting this study is to compare the results obtained in static load tests with that of high strain dynamic tests and CAPWAP analysis in terms of:

1) The load transfer mechanism through pile;
2) The load and the corresponding settlement of the pile; and
3) The total bearing capacity of the pile.

1.4 Scope

In this project paper special attention is provided to the bored piles. The bored piles are vertically tested with both static load test and high strain dynamic test.

The data for this paper is obtained from real time projects conducted in construction industry. In this case, the piles are fully instrumented for measurements of stress and displacement. Static load test are conducted prior to the dynamic test. The static load test is conducted using kentledge with load cell, whereas; the dynamic test is conducted using a drop hammer.

The subject of this study is not the accuracy, but relative comparison between static load test and high strain dynamic test to evaluate the capacity and load transfer mechanisms within the piles.

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