The Effect of Load Carrying Capacity of Pile-response Under Subsequent Loading for Rotary-Jacking Pile

Nor Syamira Hassan[1] and *Aniza* Ibrahim[1*]

[1]Faculty of Engineering, National Defense University of Malaysia, Sungei Besi Camp, 57000, Kuala Lumpur.

Abstract. Pile jacking process can lead to high bearing capacity, stiff base response but sometimes excessive installation resistance. However, it limited by jack capacity and negative shaft resistance. To overcome some of the above problems and to improve the pile performance, rotary jacking of the pile is used. It can alleviate installation problems and bearing capacity is activated during subsequent loading. Therefore, the objective of this research is to investigate the behavior of pile using this new innovative technique. A 25 mm circular fabricated steel pile was used for the experiments The experiments were done in the laboratory using a large container filled with silica sand, and the rotary and jacking method was tested with few series of cases. Results show that this new method of pile installation is successfully obtained and acceptable. This new method of pile installation is an innovative method to be used for the future in the construction industry.

1 Introduction

The modern technique of pile installation method to improve the footing performance influenced the stiffness and strength of the pile foundation. (Deeks et al 2013).To improve the performance, new design methods are needed. The new method of pile installation is needed to not only to strengthen the foundation system but also to reduce cost, construction time and lessen the environmental impact. Pile jacking technology permits pre-formed displacement piles to be installed without the environmental impact of dynamic methods. With the use of static jacking force, applied using hydraulic rams will evade the noise and ground vibration that experienced using conventional dynamic methods. Other than that, previous research has proved that pile jacking reduces ground-borne vibrations by an order of magnitude compared to traditional percussive and vibro-hammer installation techniques (Rockhill et al 2003). Normally, pile jacking machines with capacities of up to 4 MN are currently used which lead to high bearing capacity, stiff base response and lead to excessive installation resistance occasionally. (White et al 2002, Lehane et al 2003).

Pile driving is one of the important activities for constructing a building. Piles are commonly used as a support and transfer the load from the building. Piles are usually cost

* Corresponding author: aniza@upnm.edu.my

effective foundation solution for building a structure on the soil such as loose and compressible soil especially structures that located in an urban area. Vibrators are usually used for driving the piles into the ground. The pile is subjected to the stress waves of short duration when driving. In fact, the impact driving process can create vibrations, when penetrating the pile into the soil. Knowing that the vibration that creates from the installation of the pile into the ground can lead to the human disturbance and the existing structural damages. The most common problem occurred during installing of the piles is ground vibration. According to Athanasopoulos G.A (2000), ground vibration can be generated by natural causes and also human activities. However, it is not well understood how rotary action can influence the shaft and base resistance of the pile. The pile that needs to be pressed into the ground will have the resistance between the pile and the ground itself. Other than that, testing also needs to be done to check on how the rotary action can give a subsequent response of the pile under working load.

The choosing of pile type is important to build some structure to ensure that the stiffness of the structure itself. The type of pile depends upon a wide variety of factors, including soil type, corrosion, local availability and cost, contractor preference and the load bearing requirement of the foundation. (Adejumo & Boiko, 2012). A new concept technology is introduced to install the pile, which is rotary-jacking technique. The new technique is developing from a common axial jacking method. When penetrating the pile into the ground, the pile is rotated and jacking simultaneously into the ground. The objectives of the research are to measure the settlement soil for the new method of piling.

2 Materials and method

2.1 Materials of the pile

This research used stainless steel piles with 25 mm and 300 diameters and length respectively as in Figure 1.

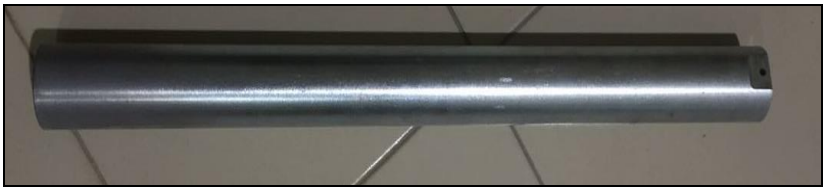

Fig. 1. 25mm diameter stainless steel pile

2.2 Pile driven machine

The custom-made machine is fabricated to simulate pile driven for the new method (Figure 3) and the schematic diagram of the machine is illustrated in Figure 2. The machine is 2.0-meter height and 0.8 meters in diameter. It consists of a large and circular container that containing silica sand. The machine is connected to the switch panel inside the box. Two (2) operated motors are jacking and rotating the motor. The switch panel is made up of three operations which are penetrating, rotating and also vibrating. For penetrating and rotating switch, there are forward and reverse buttons to ease the movement of the pile. The machine that connected to the switch panel also connects with the datalogger which data is transferred to the computer. The Campbell Scientific Datalogger (CR800) is used to

measure the electrical signals and convert the measurement to engineering units. Figure 4 and shows the rotary and jacking motors attached to the machine.

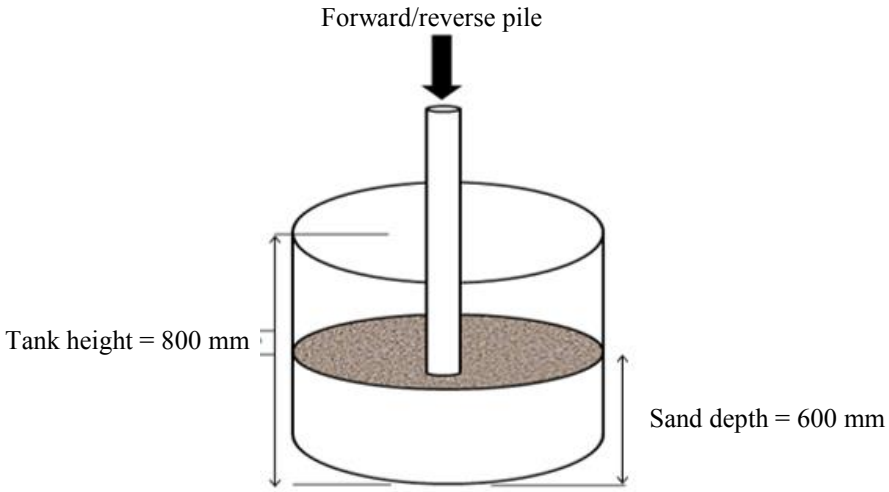

Fig. 2. Schematic diagram of custom made pile driven machine

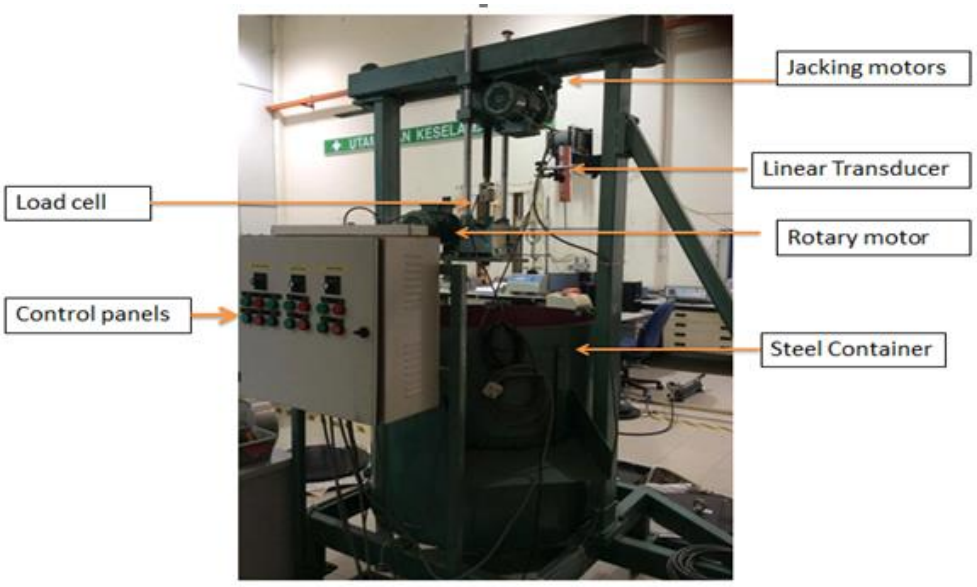

Fig. 3. Custom made pile driven machine

Fig. 4. Rotary and Jacking Motors

2.3 Method

There are two types of experiments conducted for the pile; jacking only and jacking and rotating. Both methods are conducted for a method of installation test and static load test. The summary of the experiments is as listed in Table 1.

For jacking method, it takes about 3 hours for a complete installation process. On the other hand, 1.5 hours are needed for jacking and rotating method to complete.

Table 1. Test for the piles

No.	Material	Method of installation		Static Load Test	
		Jacking Only	Jacking and Rotating	Jacking Only	Jacking and Rotating
1.	The shape of model piles				
	i. 25mm Circular Pile	√	√	√	√

3 Results and discussion

Results show that this new method of pile installation is successfully obtained in the experiments Based on the graphs in Figure 5, it can be shown that load capacity for jacking of 25mm is twice the value of jacking &rotation of 25mm. At the settlement of 150mm for both methods, the load capacity recorded is about 600kN by using Jacking only while the other method recorded about 300kN.

A static load test is carried out by using a weighing block that is 8 kg per block. The maximum load that can be put to the pile are 10 blocks which equivalent to 80 kg at a time. The settlement is increased as the load is increased to the pile. By referring to Figure 6, the result shows that the settlement obtained using jacking and rotating method is smaller compared to jacking the only method. The result shows that at 80 kN of loading, jacking and rotating method produced only 1 mm of settlement compared to 2 mm for jacking the only method.

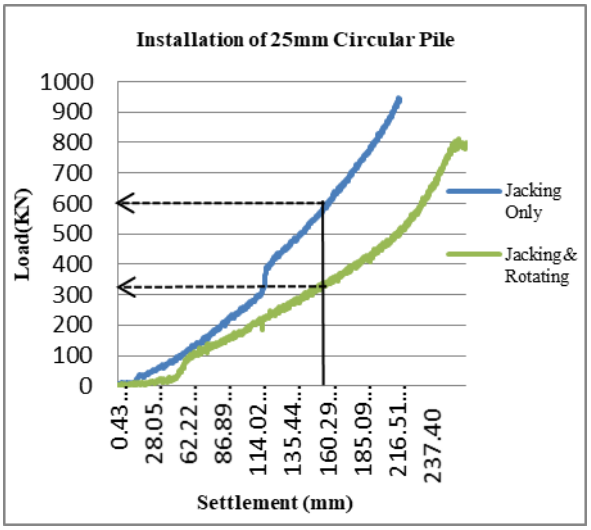

Fig. 5. Installation of Screw pile by jacking method and jacking & rotating method.

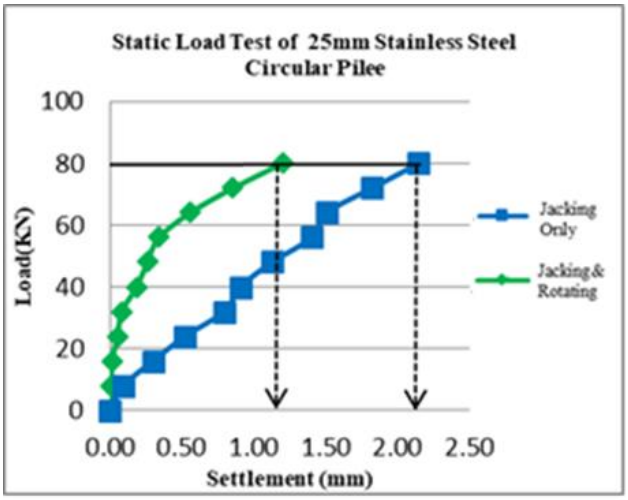

Fig. 6. Static load test by jacking only and jacking & rotating method.

3 Conclusion

Based on the result and analysis of the experiment, it shows that the settlement of the new method of pile driven by jacking and rotating method is improving the method of pile driven for construction. Even the result shows only static load method improves the settlement compare to the previous jacking method; the installation method needs to be improved by reducing the error during laboratory works. However, the static method shows that using the rotary jacking method, pile resistance can be reduced, time reduction of pile

driven into the soil, and less settlement that leads to cost reduction. This new method of pile installation is an innovative method to be used for the future in the construction industry, but more tests should be conducted for verification with varies types of soils.

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