Study on Dispersion of Jacking Force Measured through Press-in Process

Press-in, Jacking force, Dispersion

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1. Introduction

The Press-in Method is the piling technology to install various types of piles by a static jacking force. Since this piling method enables the piles to be installed without excessively disturbing the ground, the jacking force monitored during installation and extraction of piles provides information such as the condition of the pile being pressed-in, or the conditions of the ground where the pile is being pressed-in. On the other hand, the jacking force tends to show some dispersion even in the cases where the piles are installed on the same condition. This dispersion is supposed to be due to several reasons such as the inconsistency of the ground conditions or the difference in skills of the operators of the press-in piling machinery. This paper aims to gather the data of jacking force measured in the several tests of the past, and to show the mean value of maximum jacking force and coefficient of variation in several groups of test results to summarize the tendency.

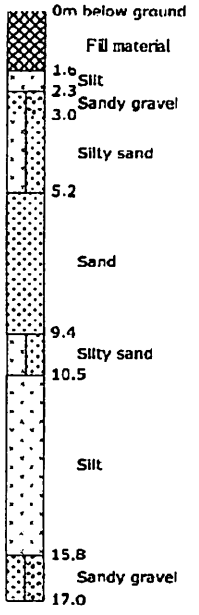

Figure-1. Site Profile

2. Methodology

Different types of steel sheet piles and tubular piles have been installed in the same test site. The site profile is shown in Figure-1. All the tests were conducted using the hydraulic press-in piling machinery. The measured items were jacking force and embedment of the pile. The measured 'maximum jacking force' and calculated 'average jacking force' of each installation are classified into several groups by the pile type and length, to provide the mean values of them in each group. These mean values, along with the coefficient of variation, of 'maximum jacking force' and 'average jacking force' in each group are shown as the result of this research. The 'average jacking force' is defined as below (Figure-2.).

$$J_{ave.} = E / L$$

$$E = \int J(x)dx \approx \sum (x_i - x_{i-1}) \cdot J_i$$

$$i = 1, 2, 3, \cdots, n$$

Here,

$J_{ave.}$; average jacking force (kN)
E; total installation energy (kJ)
L; embedment depth (m)
J, J(x); jacking force (kN)
x, x_i; depth (m)
i; natural number

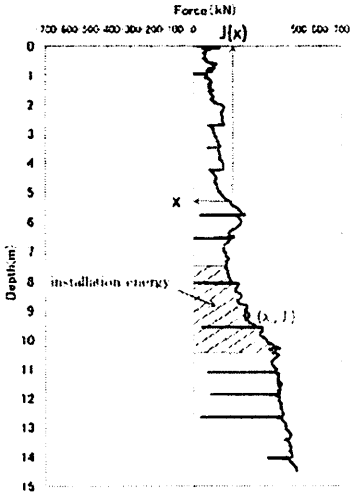

Figure-2.

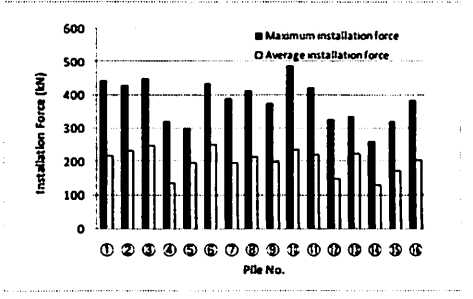

Figure-3.

Table-1.

Jacking Force	Maximum	Average
Mean Value	378.2 (kN)	200.3 (kN)
Standard Deviation	62.3	36.0
Coefficient of Variation	16.5 (%)	18.0 (%)

3. Terminology

'400P', '600P', '900P', '1400P' refers to the steel sheet piles with the section width of 400 (mm), 600 (mm), 900 (mm), 1400 (mm) respectively.
'ϕ 318.5' refers to the steel tubular pile with the diameter of 318.5 (mm).
'Monotonic installation' refers to the installation where the downward displacement continues.
'Installation by surging' refers to the installation with repetitive downward and upward displacement.
Installation 'without interlock' means that the pile is installed, not being interlocked with any other pile.
Installation 'with interlock' means that the pile is installed, interlocked with another pile.

4. Results

4.1 Monotonic installation

Figure-3. shows the maximum jacking force and average jacking force of 16 400P piles which were installed strictly on the same conditions (shown in Figure-5. as the test group of 0711). Along with the information in Table-1., the maximum and average jacking force shows some dispersion even if the installation conditions were controlled the same.

Figure-4. is the correlation diagram of maximum jacking force and average jacking force of all the tests of monotonic installation. Strong positive correlation is identified between them. This suggests that the mean value or coefficient of variation show a similar tendency, both in maximum jacking force and average jacking force. This is why the results of all the test groups shown in Figure-5. are focused only on maximum jacking force.

From the results in Figure-5., coefficient of variation varies from 10 (%) to 25 (%) in general in the test groups of installation without interlock. Maximum jacking force tends to increase in proportion to the pile width. Comparing two 0511 test groups, the maximum jacking force is about 1.35 times larger in the case of installation with interlock than the case without interlock.

4.2 Installation by surging

Maximum jacking force and average jacking force show positive correlation in Figure-6. From Figure-7, it is concluded likewise that the coefficient of variation varies up to 25 (%) in the test groups of installation without interlock, while the groups of installation with interlock shows more than 25 (%) of coefficient of variation in general. Comparing two 0710_1400P_11.5m test groups, the maximum jacking force is about 1.47 times larger in the case of installation with interlock. On the other hand, from two 0710_1400P_8.5m test groups, the maximum jacking force is not influenced by the interlock. This implies that the influence of interlock on maximum jacking force appears below a certain depth (around 10 (m)).

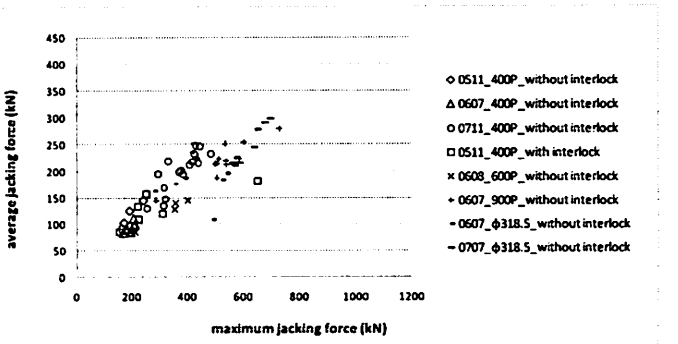

Figure-4.

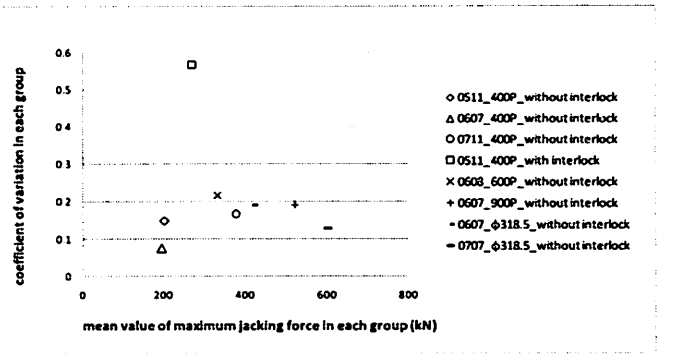

Figure-5.

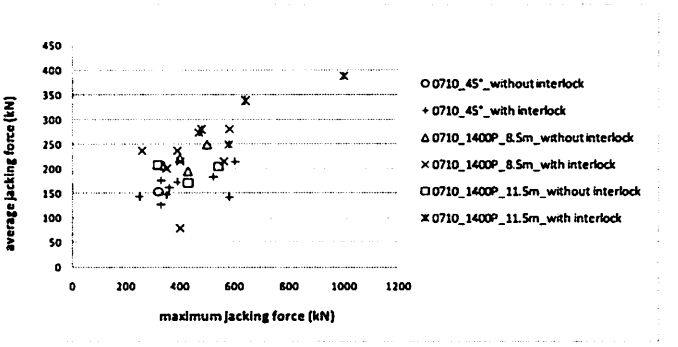

Figure-6

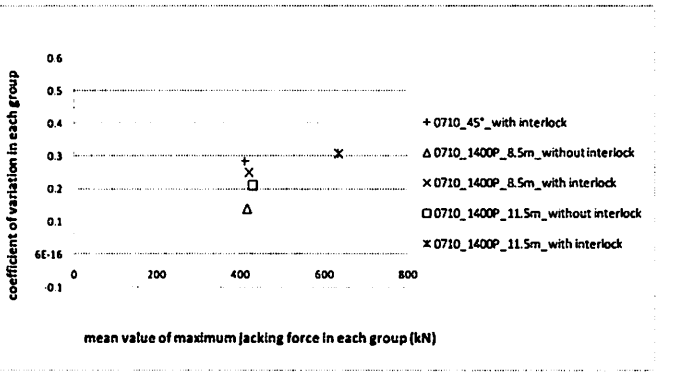

Figure-7.

5. Summary

1) Maximum jacking force and average jacking force showed a positive correlation. The correlation was stronger in the cases of monotonic installation than in the cases of installation by surging.

2) Both in monotonic installation and installation by surging, the coefficient of variation varied from 10 (%) up to 25 (%) in the cases of installation without interlock.

3) The influence of interlock on maximum jacking force appeared below a certain embedment depth (around 10 (m)). The maximum jacking force during the installation with interlock was 1.35-1.47 times larger than that during the installation without interlock.