Study on Soil Classification Based on Pile Penetration Test Data

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1. Introduction

The Press-in Method is the piling technology which uses a static jacking force and enables piles to be installed without making much noise and vibration or excessively disturbing the ground. Consequently the concept of PPT[1)] arises, to expect piles to be utilized as a tool for grasping the ground conditions by monitoring the jacking force during their installation and extraction. This research aims to develop a methodology to provide the soil classification based on PPT data.

2. Experimental Methodology

8 test cases (Table-1.) were carried out using the ϕ318.5mm steel tubular pile and the hydraulic piling machinery. ‘v’ is the installation velocity, ‘D’ is the diameter of the pile or penetrating rod, and ‘c’ refers to the coefficient of consolidation. Profiles of the test site and test pile are shown in Figure-1. and Figure-2.

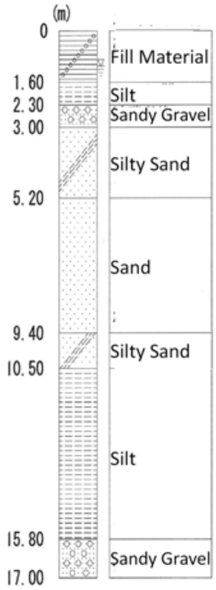

Figure-1.

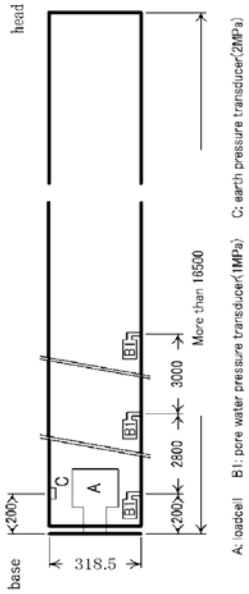

Figure-2.

3. Data Analysis

One analysis method to provide the soil classification based on CPT data was developed by Robertson[2)]. The soil classification chart for the CPT data is two dimensional; one axis represents the normalized cone resistance and the other the normalized friction ratio. In this paper, the PPT soil classification chart is proposed by defining normalized base resistance Q_b^* and normalized shaft resistance ratio F_s^* as below.

$$Q_b^*=(q_b-\sigma_{v0})/\sigma_{v0}'$$

$$F_s^*=\{f_s/(q_b-\sigma_{v0})\}\times 100\ (\%)$$

Here,

σ_{v0}; horizontal total stress before installation,

σ_{v0}'; horizontal effective stress before installation,

q_b; base resistance during installation,

f_s; shaft resistance during installation.

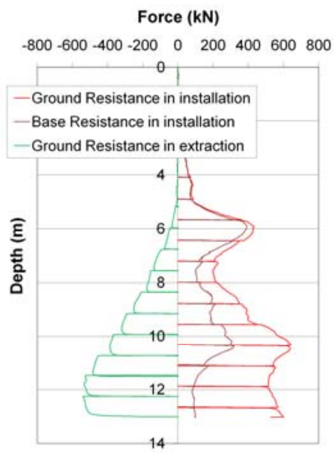

Figure-3.

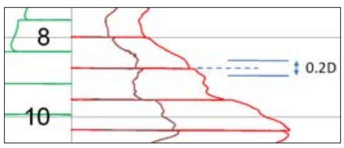

Figure-4.

Table-1.

	Number of test cases	v (mm/s)	vD/c	depth (m)
‘High Speed’	3	30	9555/c	13.0
‘Middle Speed’	2	12	3822/c	
‘Low Speed’	3	2	637/c	
CPT in general	-	20	714/c	-

The PPT data (Figure-3.) involves at regular intervals the depth where the resistances show a sharp drop. This is due to the pauses required to open, raise, and close the ‘chuck’ (the mechanical region for holding piles). The data measured in 0.2D (mm) around these depths (Figure-4.) are excluded so that the influence of the pauses is eliminated in the soil classification chart.

Keywords: Press-in, Pile Penetration Test, soil classification
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4. Results

Figure-5. shows the soil classification charts using PPT data acquired by the above-mentioned analysis. The soil classification of each plot in the charts, expressed by its shape and color, is based on the site profile given in Figure-1. On the other hand, the domains in the chart, numbered from 1 to 9, represent the soil classification in Robertson's soil classification chart. The PPT data in 'Low Speed', which has a similar vD/c value (which is supposed to dominate the drainage condition during installation[3]) compared with CPT[4] as confirmed in Table-1., show some agreement in soil classification. The 'sand' data of PPT (i.e. the plots which are classified as 'sand' according to the site profile in Figure-1.) can be found in the domain 6 which represents 'clean sand to silty sand'. The 'silty sand' data of PPT are found mainly in the domain 5 which is defined as 'silty sand to sandy silt'. Half of the 'silt' data are included in domain 5 and the rest are identified in domain 4 ('clayey silt to silty clay'). This result in 'silt' data could be more reliable than the site profile, for the layer between 10.5 (m) and 15.8 (m), which is classified as 'silt' in the site profile, was observed to contain several thin sandy layers[5]. The other two charts in the case of 'Middle Speed' and 'High Speed' show the tendency that the plots are shifted towards bottom right, which certifies that the drainage condition shifts towards undrained condition due to the increase of installation speed.

5. Summary

PPT data were confirmed to indicate a similar tendency on the proposed PPT soil classification chart, compared with the CPT data on Robertson's soil classification chart. More tests should be conducted in different sites with piles of different diameters and by different installation speed, to improve the precision and assure the reliability of PPT soil classification chart.

REFERENCES

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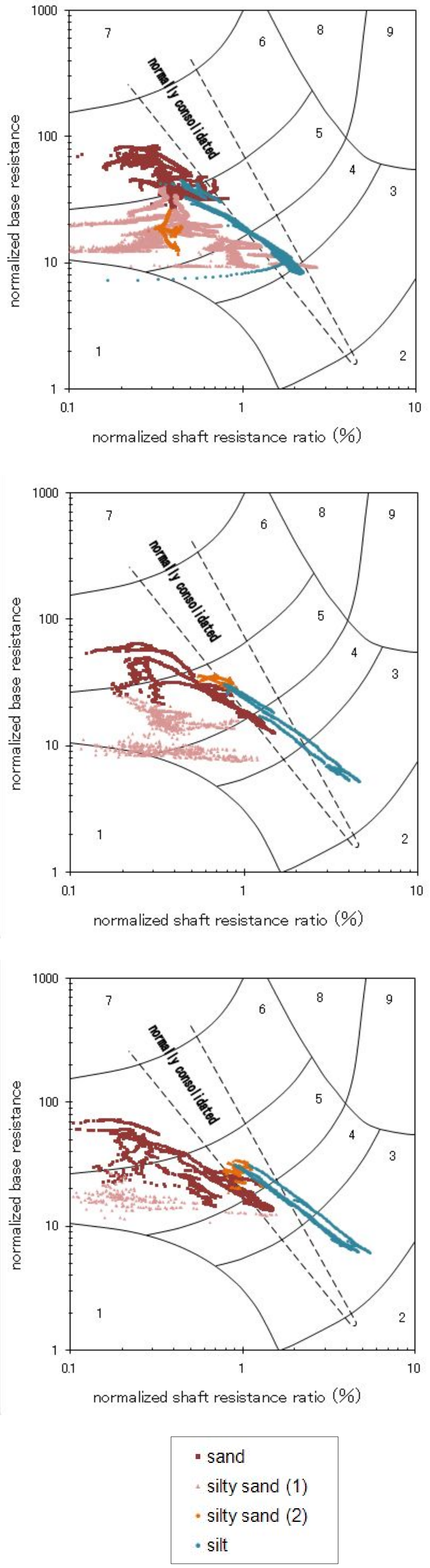

(a) Low Speed

(b) Middle Speed

(c) High Speed

Figure-5. PPT soil classification chart