Interpretation of construction management data recorded during installation of cutoff sheet pile wall in coastal waste reclamation facilities

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ABSTRACT

Vertical hydraulic barrier in a coastal waste reclamation facility takes an important role to separate the waste from the sea environment. Steel companies and marine constructors have developed new technologies to meet the technical standard issued in 1998 as ministry ordinances in Japan. Although performance confirmation for joints of the vertical hydraulic barrier, mostly cutoff sheet pile wall, is important, it is impossible to confirm all of their joints. Therefore, it is useful if the performance can be confirmed through construction management data recorded during sheet pile installation. Objective of this study aims to propose a practical method to assure impervious performance of the joints. Development and proposal of the quality control method to ensure the impervious performance was attempted based on a previous study to find a correlation between performance confirmation for sampled joints and their construction management data. To identify sheet piles overloaded during installation, cross-sectional image of those data drawn along the sheet pile wall is useful in the quality control.

Keywords: waste reclamation facility, impervious wall, hydraulic barrier, cutoff sheet pile, quality control

1 INTRODUCTION

Spatial variability of soil properties is very important in practical engineering; however, it is very difficult to identify and describe spatial variability from ground investigation, because interval of boring or CPT investigation is generally as long as in order of several tens of meters. In the present study, we examine a case study to use spatial variability of soil properties obtained as construction management data recorded in a construction of vertical hydraulic barrier with cutoff sheet piles in a coastal waste reclamation facility.

The aim of this study is to develop a quality control method in a construction of hydraulic barrier of waste reclamation facilities for municipal solid wastes and/or industrial wastes in shallow sea along dense populated coastal cities. Although performance confirmation for joints of impervious wall, mostly consisting of cutoff sheet piles, is important, it is impossible to confirm all of the numerous joints of the sheet piles. Therefore, it is useful if the performance confirmation can be replaced by quality control through construction management.

2 BACKGROUND AND METHODOLOGY

Hydraulic barrier of the seawall around coastal waste reclamation facility, in most cases, is constructed as a cutoff sheet pile wall (Watabe et al., 2010). Several useful cutoff technologies for vertical hydraulic barrier have been proposed and their impervious performance in the real field has been examined in the previous studies (Watabe et al., 2007). To confirm impervious performance of a joint of a sheet pile wall in real construction; a useful method is conducting a leakage test using a pocket cell attached behind of the joint; however, it is impossible to check all the numerous joints in the sheet pile wall. Actually, in many cases, they do not confirm the impermeability of the cutoff sheet pile, and they also do not report construction management data, because their main concern is only the final figure without regard to the installation process. To solve this problem, the aim of this study is to propose the quality control method in construction of hydraulic barrier of waste disposal facilities.

A series of construction management data gathered in sheet pile installation were examined to find correlation between those data and impervious performance (Watabe et al., 2012). It was concluded that the cross-sectional image of the data drawn along the sheet pile wall, which reflects the spatial variability of soil properties, is useful for the quality control to
identify the joints of sheet piles overloaded during their installation.

3 PROPOSAL OF QUALITY CONTROL METHOD

The waste reclamation facility studied in this study (Fig. 1) was constructed for dumping of coal ash wasted from a coal-fired power plant. The studied regions are indicated as arrays A, B, and C on the map. The cutoff sheet piles used in this facility was specially developed for a coastal waste reclamation facility (Oka et al., 2004). Their joint-sockets have a small pocket for filling up with impervious material, e.g. swelling type rubber below the water level and silicone resin above the water level (Fig. 2).

Typical cross-sectional drawings of the seawall with cutoff sheet pile wall on the arrays A, B, and C are shown in Fig. 3.

To confirm the health of the swelling rubber during and after installation, covered electric wire was attached along the swelling rubber preinstalled in the pocket and its insulating resistance was monitored during the installation of the sheet-pile with vibratory hammer. According to some preliminary field tests, it can be said that the rubber is not damaged if the insulating resistance shows high value, i.e. electric wire is not damaged. Those previous field tests concluded that the rubber is not damaged if any significant irregular operation has not been given during the sheet pile installation; in addition, the covered wire is broken prior to damage of the rubber. These conclusions suggest that the insulating resistance is a useful index in the quality control on the safe side.
In some sheet piles, insulating resistance suddenly decreased to almost zero during installation, but those were observed for the preceding sheet piles. Because the swelling rubbers are installed in both sockets of the preceding and succeeding sheet piles, the possibility that the both rubbers are simultaneously damaged is almost zero when the pile installations are smoothly conducted.

Based on these studies, cross-sectional image of construction management data drawn along the sheet pile wall by aligning the depth profiles of driving speed and power electric current value of vibratory hammer are thought to be useful. In addition, depth information of sheet pile tip when the insulating resistance was lost is useful in the quality control.

Along the arrays A, B, and C, cross-sectional images of construction management data: (a) driving speed and (b) current value are shown in Figs. 4, 5, and 6, respectively. In Fig. 4(a), the driving speed was significantly decreased when the sheet pile tip reaches the deeper portion; however, in Figs. 5(a) and 6(a), the driving speed was almost constant at whole of the depth. On the contrary, in all the figures showing the depth profiles of current value (Figs. 4(b), 5(b), and 6(b)), the current was significantly increased at the deeper portion below the sandy fill layer (Bs), particularly in Fig. 6(b).
(a) Driving speed of the sheet piles (unit: m/min)

(b) Current value of the vibratory hammer (unit: A)

Fig. 4. Cross-sectional image (view from the sea) of construction management data in Section A.

Fig. 5. Cross-sectional image (view from the sea) of construction management data in Section B
In these figures, construction management data reflects the variation of soil stratigraphy, which was obtained by boring investigation preliminary conducted. Therefore, the cross-sectional image of construction management data drawn along the sheet-pile wall can be used to identify which depth is the discontinuity plane of the soil layers, i.e. to interpolate between the boring logs. In addition, the depths of sheet pile tip when the swelling type rubber indicated a symptom of damage are shown as triangles (Δ) in the figure. The cross-sectional image with the depth where something happened may be useful to identify which swelling rubber was possibly damaged corresponding to a sort of irregular operation. Visualized construction management data along the sheet pile wall, which is reflecting the spatial variability of soil properties, is useful to evaluate the health of cut-off sheet pile wall. Also, this information can be effectively used to make a maintenance management plan. The idea using construction management data recorded during the installation of sheet piles to evaluate the spatial variability of soil properties is consistent with the idea using penetration resistance of the mandrel during the installation of PVD in dredged soil deposits to find the spatial distribution of segregated partial sandy layers (Watabe et al., 2014).

The work progress of civil structures including cutoff sheet piles has been controlled focusing on the completed structure following a specification without regard to the construction management data; however, the technology proposed in this study aims to reflect the construction management data to the quality control. This proposal is generally not favorable for constructors, because it forces to burden additional responsibility on them. This study, however, has been conducted as a collaborative research project between a client of the work, steel maker, marine constructor, and national research institute; and the results are expected to be used for quality improvement in cut-off sheet pile wall.

5 SUMMARY

In the present study, we examined a case study to use spatial variability of soil properties obtained as construction management data in the construction of hydraulic barrier with cutoff sheet piles for the coastal waste reclamation facility. A series of construction management data gathered in cut-off sheet-pile driving were examined to find correlativity between those observed data and impervious performance. Useful quality control method using these data was proposed to ensure the impervious performance. To identify sheet piles overloaded during installation, cross-sectional image of those data drawn along the sheet pile wall reflects spatial variability of soil properties and is useful in the quality control.
REFERENCES


