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Improving Florida's Drainage Channels with Pressed-in Sheet Piles

Takefumi Takuma
Giken LTD., c/o Giken America Corp.
Shigeru Kambe
Blue Iron Foundations and Shoring LLC

INTRODUCTION

Drainage is becoming a more pressing matter, especially in low-lying urban areas in many parts of the world due to the steadily rising sea level. For example, major streets of the City of Jacksonville Beach, which is located on the Atlantic coast of northeastern Florida, have been inundated often enough to need a comprehensive upgrade. The agency in charge of Florida's state highways (Florida Department of Transportation) is improving State Road A1A (3rd Street), which runs through the city from north to south, and its drainage system in the northern part of the city. The entire city was originally built on a large sandbar and marshes and therefore, the area's drainage has been heavily relying on a system of drainage channels. The State Road A1A (3rd Street) Drainage Project is to widen and to improve a part of the existing drainage channel in the densely populated residential neighborhood of the city.

PROJECT'S SCOPE OF WORK AND SELECTION OF PRESSED-IN SHEET PILE WALLS

The channel improvement involves the following work items.

- Tree and vegetation clearing and removal
- Steel sheet pile installation
- Dewatering
- Excavation and removal of roots, stumps, debris, and soil
- Placement of bedding stone and rip raps
- Placement of concrete capping on top of the new sheet piles walls
- New fencing and sod placement after regrading
- Replacement of 5 roadway bridges

See Fig. 1 for the typical conditions of the channel prior to construction. The project is being worked on in Phases 1 through 7 including 5A and 5B to minimize the road closures and their associated detours. The work area is very narrow between rows of houses, limiting the size of new structures and the space available for construction activities. Therefore, the self-standing vertical steel sheet pile walls were selected for the drainage improvement for the majority of the locations. The project's plan specified "Non-vibratory Press-in Method Required" for most of the sheet pile installation because the drainage channel runs directly behind densely built homes and a high school campus where piling related noise and vibration would be minimized with press-in piling (White et al. 2002). Some sections have a sheet pile wall just on one side while the other sections have them on both sides as Fig. 2 depicts. The project is designed by the Jacksonville, Florida office of Parsons Transportation Group.

Fig. 1. Typical Conditions of the Drainage Channel before Construction

SOIL CONDITIONS AND SHEET PILE LENGTHS

The project's typical soil conditions are predominantly fine sand with N-values varing between 3 and around 30 to 35. There are stiffer sand layers at some locations with N-values up to 47 at the depths of 7.6 to 8.5m, which are at near the pile tip elevations. The goundwater level is about 0.9 to 1.5m below the grade. The design sheet pile lengths are between 6.1 and 13.1m. Fig. 3 shows the vertical location of the project's longest sheet pile in the corresponding soil conditions.

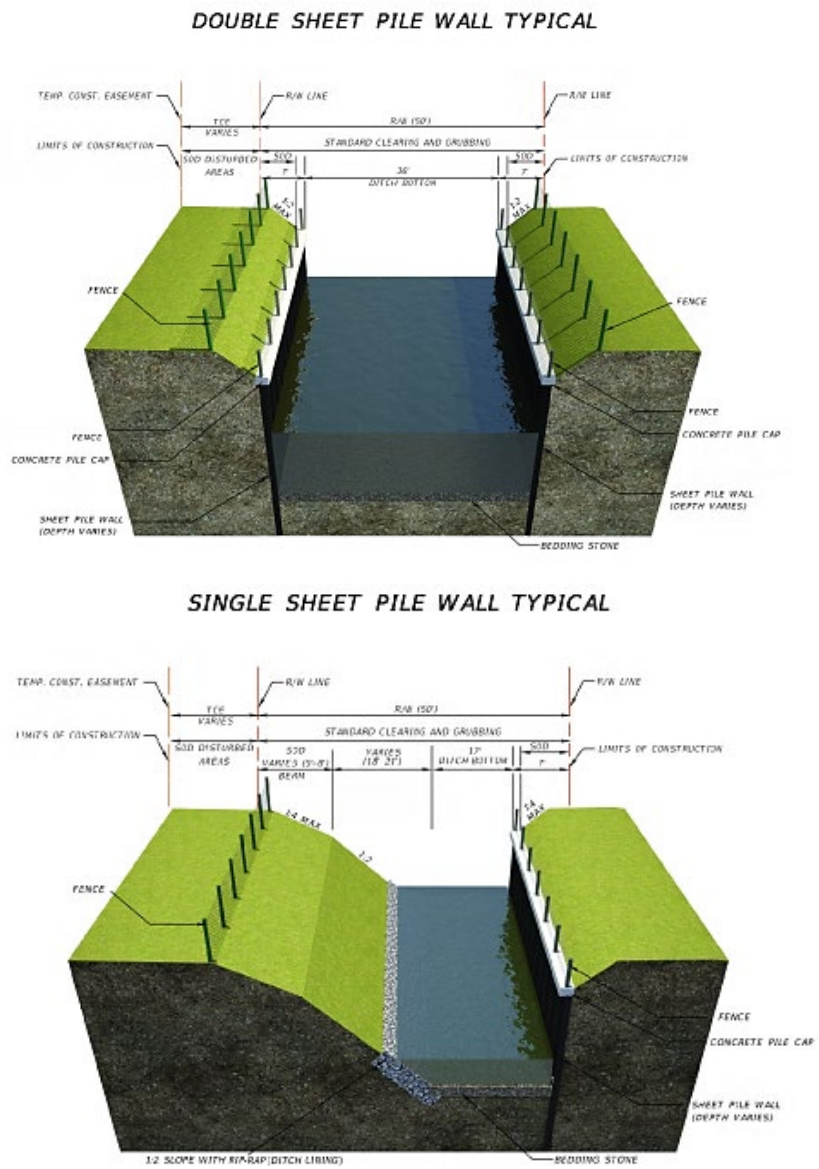

Fig. 2. Typical Single and Double Sheet Pile Wall Configurations (Source: http://nflroads.com/ProjectFiles/5057/Sheet_Pile.pdf)

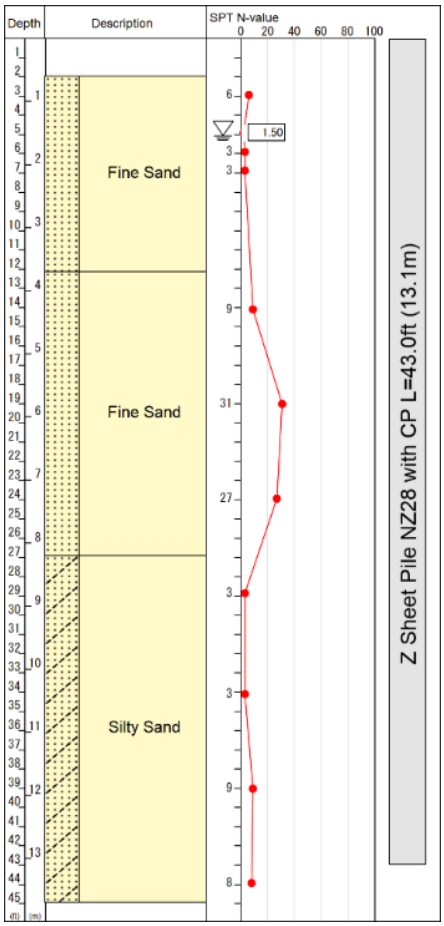

Fig. 3. Typical Soil Conditions and Vertical Location of Sheet Pile

SHEET PILE WALL INSTALLATION

Although the soil's N-values were above 35 at certain locations, the piling subcontractor (Blue Iron Foundations and Shoring LLC) was able to complete all the piling work without use of a water jetting or auger attachment, which would be essential for sheet pile installation in denser granular or other types of hard soil (Roesner et al. 2006 and Takuma et al. 2018). The press-in piling quantity was approximately 23,100m^2 (2,458m of wall length) with NZ19, NZ26, NZ28 sheet piles and NZ28 with plates welded on its flanges. Fig. 4 shows the section of a coupled NZ28 sheet piles with welded plates as an example. All the surface of the sheet piles was treated with a zinc primer plus a tar-epoxy coating on the exposed area on the water's side for corrosion protection.

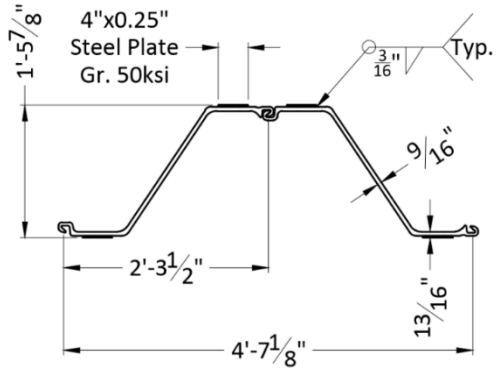

Fig. 4. Section of NZ28 Sheet Piles with Steel Plates (Source: Nucor Skyline)

Fig. 5 shows a Giken ECO1400S press-in piling machine installing a pair of sheet piles in a very narrow work area. The piling contractor utilized a movable working deck which straddled between finished

sheet pile walls on both shores for keeping the piling machine's power unit safe and dry. Fig. 6 shows two sets of piling machines side by side; one extracting the old sheet pile wall with the other simultaneously installing a new wall where the channel's unsupported slope was kept minimal to avoid a potential collapse of residential properties behind it. The fact that two sets of press-in piling machines could work in tight working space was also essential for the section behind the high school, which needed the piling work finished during its summer break with two machines working simultaneously.

Fig. 5. Press-in Piling of Sheet Piles

Fig. 6. Extraction of Old Sheet Piles (Left) and Installation of New Ones (Right)

Once sheet piles were installed, capping concrete and fencing were placed on top as shown in Fig. 7. The sheet pile walls' top elevations were designed to meet the existing grade, therefore, the capping concrete's top surface also undulates over the longitudinal distance according to the surrounding grade. The press-in piling work was started in July 2018 and safely completed in late May 2020 with an 8-month break due to the work of the general contractor (The de Moya Group Inc.).

Fig. 7. New Sheet Pile Walls with Capping Concrete

CONCLUSIONS

Pressed-in sheet piles can make highly reliable and space saving drainage channel improvements safer even in densely populated areas with very confined working space as exemplified by the case study project. There appear to be more of these types of channel and levee improvement projects in line not only in coastal Florida but also in low-lying communities in the rest of the world; possibly due to climate change and oncoming sea level rise.

ACKNOWLEDGMENTS

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