Case History

Pa Sak River Improvement Project in Thailand

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Introduction

Climate change has become a serious problem worldwide. The number of reported natural disasters from 2000 to 2019 totaled 7,348, which was 1.7 times larger than the number of reported natural disasters from 1980 to 1999. Meanwhile, 44% of the total disasters from 2000 to 2019 were floods. (United Nations Office for Disaster Risk Reduction, 2020) In 2011, Thailand was devastated by a flood, where the total damage and losses amounted to THB 1.43 trillion (World Bank, 2012). It was reported that the flood was one of the worst floods in the modern Thailand history. To cope with increased precipitation due to climate change, the Thailand government has implemented some flood protection measures. This report introduces a case study of flood protection for the Pa Sak River in Ayutthaya.

Project Overview

The Pa Sak River is located in the northern area of Ayutthaya, as shown Fig. 1. It is extremely important for logistics, which spans from the northern area of Thailand to the industrial area of Ayutthaya. Furthermore, it is connected to the Chao Phraya River, which flows through Bangkok to the sea. Local people use the Pa Sak River for not only transporting industrial materials, but also for daily transportation. This project involves improving the Pa Sak River revetment, which spans 52km. One of the purposes of this project is to prevent flood and excavate the riverbed for larger cargo boats to ensure the appropriate navigation. New revetments such as sheet pile walls can prevent the riverbanks from collapsing when the riverbed is excavated as well as from erosion via flash floodings and waves generated by large cargo boats.

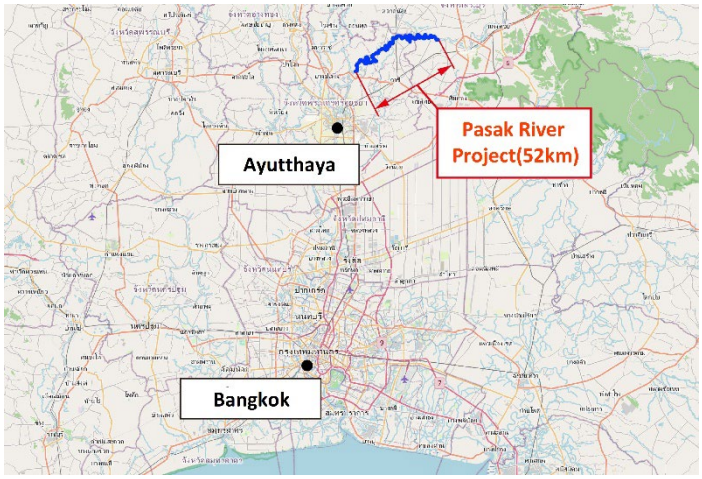


Fig. 1. The map of Pa Sak River Project
ⓒOpenStreetMap contributors
(https://www.openstreetmap.org,
https://opendatacommons.org)

Phase 1 of the project commenced in 2015 and was completed in 2019. In Phase 1, a U-shaped steel sheet pile wall and a concrete wall were utilized as flood protection, as shown in Fig. 2. Currently, Phase 2, which began in 2021, is now in progress and will be completed in 2025.

Fig. 2. U-shaped sheet pile revetment in Phase 1

Structural Type

The project (specifically Part 1 of Phase 2) is the first in Thailand to adopt SILENT PILER^{TM} F301-900 and hat-type steel sheet piles. Hat-type sheet piles were utilized as a revetment and they were used to form a double hat-type sheet pile wall, as shown in Figs. 3 and 4. The hat-type sheet pile offers some advantages, one of which is its width. The width of a hat-type sheet pile is 900 mm, which is 2.25 times greater than that of a U-shaped 400 mm sheet pile. Therefore, the total number of sheet piles to be used can be reduced. In other words, the construction period can be shortened, particularly in soft ground. The other advantage is no consideration of a reduction factor in design stage. The hat-type sheet pile does not require the consideration of a reduction factor as the interlocking position is not located on the center line of the sheet pile wall. Therefore, the total weight of a sheet pile wall is less than that of a U-shaped sheet pile.

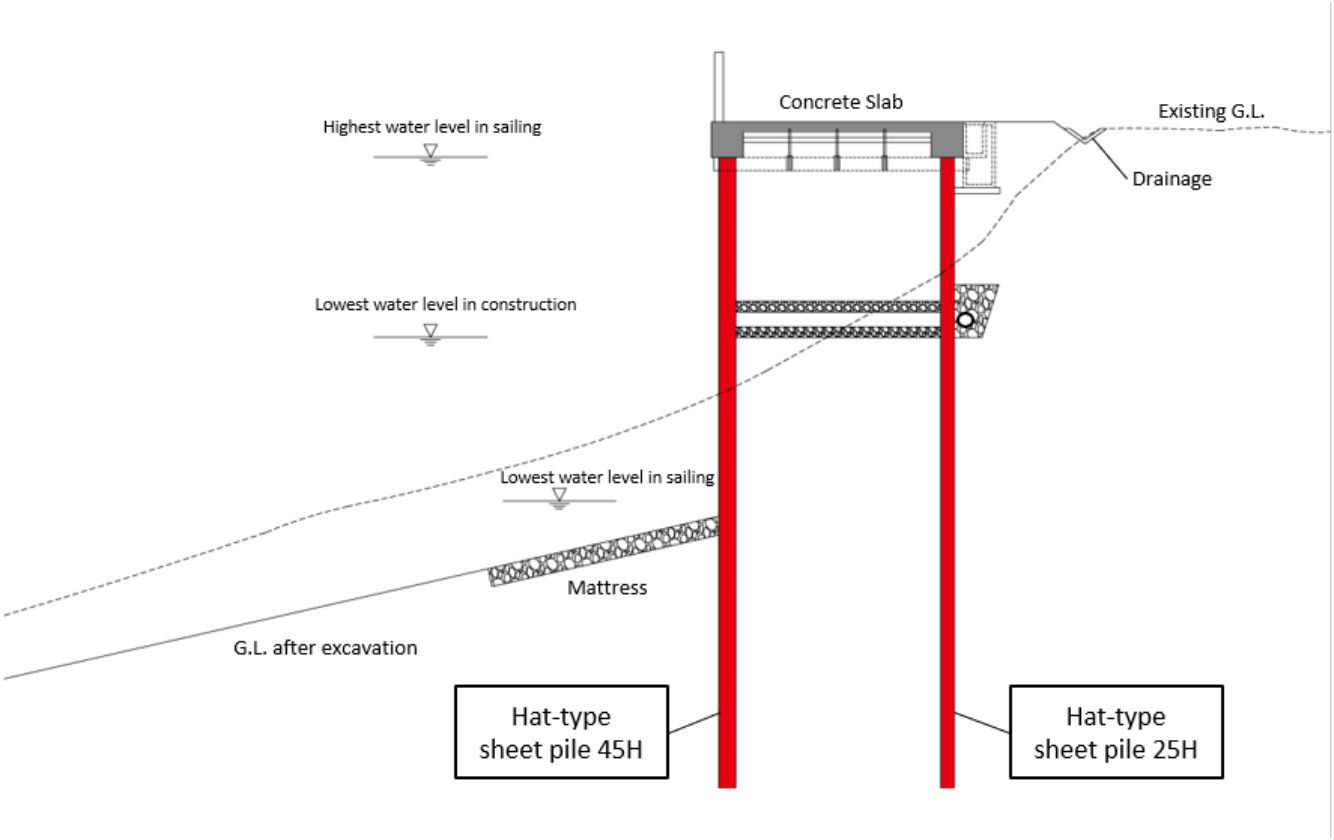


Fig. 3. Cross section of hat-type sheet pile wall

In this project, 45H and 25H hat-type sheet piles were utilized on the riverside and landside respectively. The total number of sheet piles installed at those locations was 4,238. In addition, 2,797 of the 4,238 were installed using SILENT PILER F301-900 to ensure accuracy as they must be placed adjacent to residential areas. After the hat-type sheet piles were installed, excavation was performed to allow large vessels to be operated on the Pa Sak River. To serve the community, the top of the sheet pile was laid with a concrete slab to function as a road for pedestrians. Moreover, stairs on the riverside allowed the locals to use their boats for crossing the river as a means of transportation. The sheet pile wall, which comprises sidewalks and stairs, improves the living environment of the local residents and eliminates the fear of floods.

Fig. 4. Double hat-type sheet pile wall

Press-in Piling Method

As shown in Fig. 5, the SPT N value of this project is approximately 50. Therefore, the press-in with water jetting method (water jetting mode) was adopted. Water jetting is one of the press-in penetration technologies. Press-in with water jetting can reduce the penetration resistance force efficiently. High-pressure water jetting can increase the porewater pressure between soil particles and allow them to easily propagate temporarily. In addition, water that is approaching the ground can reduce the skin friction of the piles and interlock resistance by removing the soil between the interlocks. Consequently, the piles can be installed using the minimum press-in force. Driving assistance such as water jetting is critical for preventing damage to the piles. Figs. 6 and 7 show the main components of the water jetting mode and a photograph of the Pa Sak River project. The main components comprised a press-in machine with JET REEL™, a power unit, a water jet pump, a water tank, a generator, and a water pump.

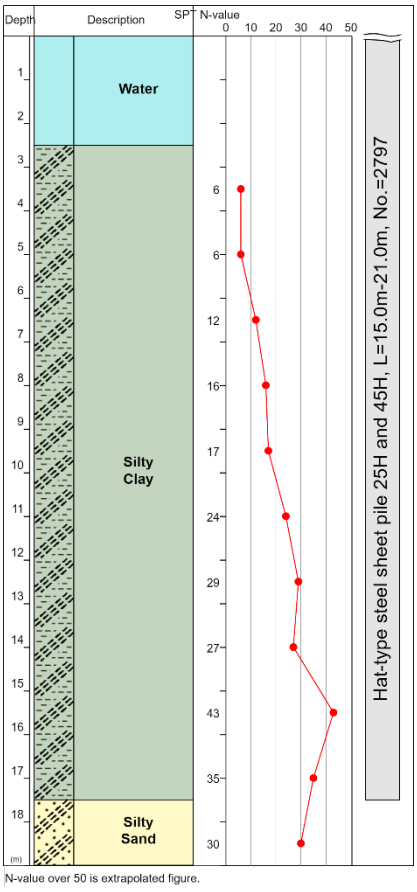


Fig. 5. Borehole data

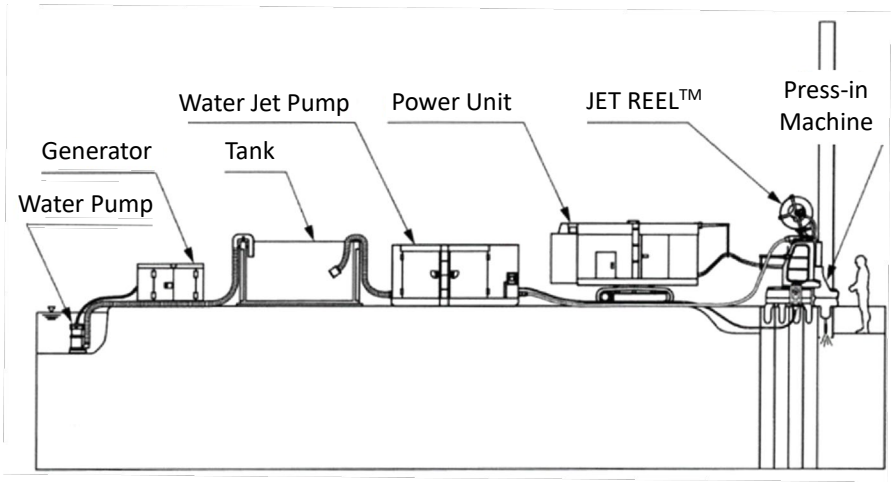


Fig. 6. Main components of water jetting mode

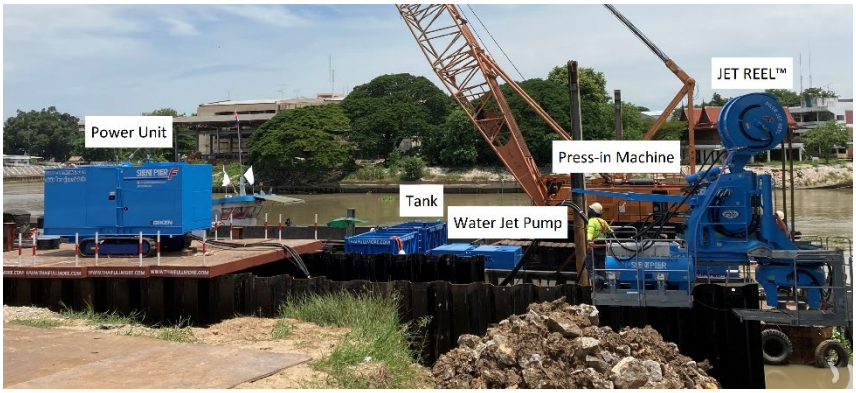


Fig. 7. Photograph of Pa Sak River

(Generator is behind the power unit and water pump is on the riverside)

Fig. 8 shows the details of the equipment, and Fig. 9 shows the press-in with water jetting process. The most significant difference in the standard press-in process is indicated when comparing between Steps 2 and 7, which primarily involve the JET REEL and PILER ECO™ Hose, respectively. The reel is used to wind the hose. The hose is wound up and unreeled automatically by the reel. In Step 2, the jet nozzle is inserted into the JET LOCK™, which is welded on the pile and locked by the pin. In Step 7, after the pile is installed, the hose is extracted by the reel. Therefore, the PILER ECO Hose can be utilized repeatedly.

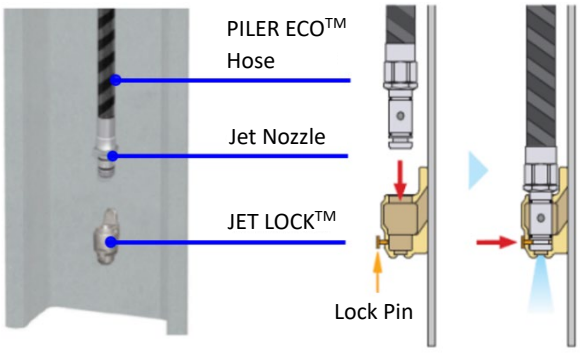
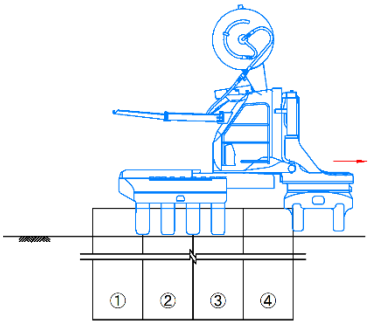
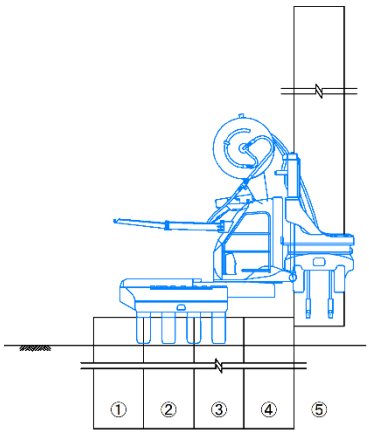


Fig. 8. Water jetting equipment

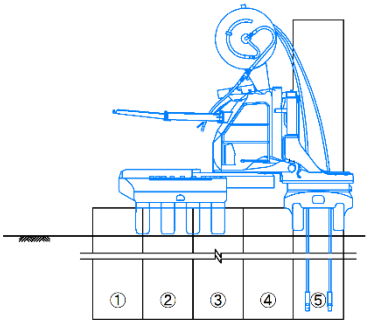
Press-in Procedure (Water Jetting Mode)



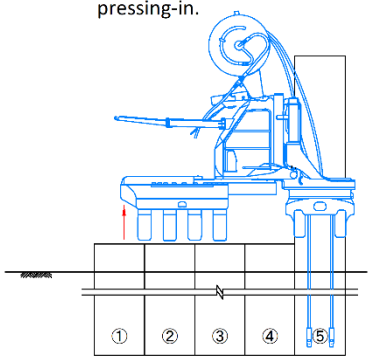
1. Moving the chuck forward for pressing-in next pile.



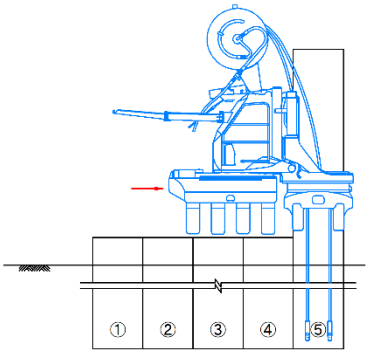
2. Pitch next hat-type sheet pile No.5 and set the PILER ECO™ Hose, then start pressing-in.



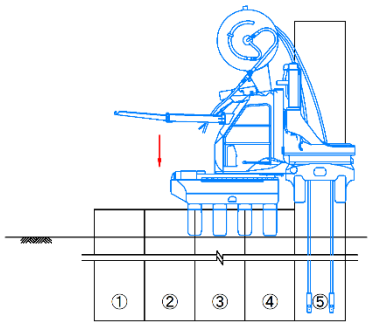
3. Press-in hat-type sheet pile No.5 until it is sufficiency stable.



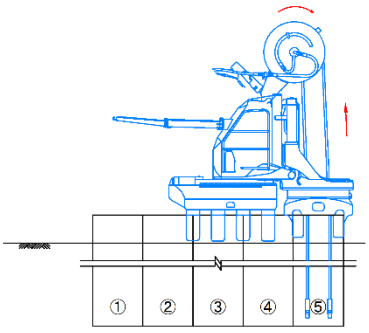
4. Open the clamps and then raise the press-in machine.



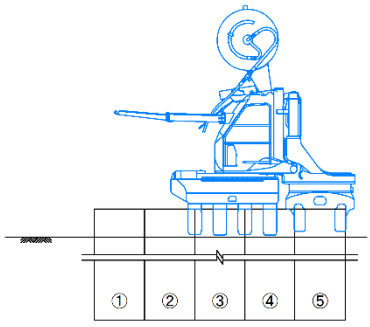
5. Move the saddle forward and change the clamp position.



6. Lower the press-in machine and close the clamps. After self-moving, continue to press-in hat-type sheet pile No.5.



7. After pressing-in hat-type sheet pile No.5 to the specified depth, moving the JET REEL™ forward, then pull out the PILER ECO Hose.



8. Repeat sequences 1-8.

Fig. 9. Construction process

Among the various reasons, the Press-in Method was adopted owing to its environmental friendliness. The press-in machine emits minimal noise and is almost vibration-free. Therefore, it can be applied adjacent to residential areas, as shown in Fig. 10. The other reason is the highly accurate installation afforded by the method. The press-in machine grips the sheet pile near the ground, thus allowing the appropriate amount of press-in force to be transmitted to the pile. Consequently, the alignment and verticality achieved are extremely accurate. In this project, hat-type sheet piles were used as permanent structures. Therefore, the completed shape is critical.

Fig. 10. Construction performed adjacent to buildings

Conclusion

A case study of the Pa Sak River improvement was introduced herein. It is the first project that adopted SILENT PILER F301-900 and the hat-type sheet pile in Thailand, which has demonstrated some advantages. For instance, the Press-in Method adopted, which is low in noise and vibration, can minimize adverse effects to the environment. The hat-type sheet pile, which features a width of 900 mm, affords a shorter construction period. Owing to climate change, natural disasters such as heavy rains, typhoons and hurricanes are expected to increase in the future. In addition, the increasing sea level is a critical issue. In Thailand, both coastal and flood protection must be implemented to ensure the safety of the public. We strongly believe that the Press-in Method can mitigate the above-mentioned issues.

References

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