

## Case-History

# Steel sheet pile earth retaining wall in flood control work (Jinan City, China)

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In recent years, with the progress of global warming, abnormal weather such as intense heat, heavy rain, typhoons and hurricanes have frequently occurred in various countries around the world. China is no exception, and last year, in 2021, they suffered severe flood damage in Henan Province, which is located in the central part of China, with a record heavy rainfall. As awareness of disaster prevention increases, the number of projects where the press-in piling method is adopted is increasing in disaster prevention and mitigation works where disaster countermeasures are urgently needed.

This paper introduces a case of temporary earth retaining work to improve drainage function as part of flood control measures carried out in Jinan City, Shandong Province.

### 1. Project Overview

The main content of the whole project is the new construction of a box culvert. The location of this work is in Jinan City, Shandong Province, China (Fig. 1). Jinan City is located in the western part of Shandong Province and occupies an important position in terms of business and administration as a provincial capital. The Yellow River flows through the city and is vulnerable to floods caused by heavy rains. In 2020, the roads in the construction section of the project were flooded due to a strong typhoon, which caused many inconveniences to the movement and livelihoods of residents in the area, and also caused economic damage in some areas. The Jinan City Government decided to renovate the drainage system to solve the inundation problem in this section.



Fig. 1. The Map of Jinnan City

As shown in Fig. 2, the total length of the entire construction section will be about 1,200 m, and the construction started in January 2021 and will be completed in September 2022. Since there are many residential areas and factories in the construction area, it was necessary to make arrangements for half road closures and detours and so on.



Fig. 2. The map of construction site area

The press-in piling work in this project is the construction of a temporary retaining wall accompanying the new construction of a box culvert. The press-in piling method combined with the water jetting was adopted, and it was constructed with U-shaped steel sheet piles (pile lengths 9m and 12m) using the press-in piling machine F111.

## 2. The Press-in Piling Work

As mentioned above, this site is a densely populated area with houses and factories, and it was required that it would not affect the surrounding economic activities during the construction period as well as vibration and noise should be minimized during the piling work. In addition, preliminary research had revealed that the underground buried utilities and building waste were mixed in the ground. For the above reasons, the press-in piling method was recognized as the most suitable method, and it was decided to adopt it for the project. In addition, since the soil was clay, the construction method combined with the water jetting was adopted.

The challenge for this construction was to pay close attention to the surrounding environment during the construction. As shown in **Fig. 3**, the existing utility poles and high-voltage lines are in close proximity to the steel sheet pile work line at the construction site. When a crane was used to lift the 12m and 9m long steel sheet piles, careful consideration was taken to keep sufficient distance from the high-voltage lines.



Fig. 3. The view from above

**Fig. 4** is a photograph taken during the construction in proximity. As shown in the photo, there were many construction sites close to the existing structures in this case. Since the press-in piling machine is more compact than a general pile driver, it was possible to do the installation work in the minimum space even in a narrow site between an adjacent structure and a steel sheet pile retaining wall. Since the ground vibration and noise during construction were extremely small compared to the conventional construction methods that require impact and vibration, the construction was able to be carried out safely without significantly affecting the surrounding environment.



Fig. 4. Construction in proximity



### 3. Press-in assisted with water jetting method

According to the Handbook<sup>1)</sup>, *Press-in assisted with water jetting method* which was adopted in this project, as shown in **Fig. 5**, is a pressing technique where water jetting is used as a driving assistance. Piles are installed while injecting high-pressure water into the ground from a nozzle that is fitted onto the pile toe to reduce penetration resistance (toe resistance, shaft resistance). *Press-in assisted with water jetting* has the following three advantages.

- ◆ The water pressure generates an increase in pore water pressures associated with a decrease in effective stresses around the toe of the pile, resulting in a decrease in shear resistance of the soil.
- ◆ The upward water flow generated along the interface between the pile and the surrounding soil spreads the effect of reduced effective stresses and reduces shaft friction between the soil and the pile.
- ◆ Prevents the soil clogging inside interlocks, which reduces the frictional resistance between interlocks.

In this work, steel sheet piles to be used for temporary work were used. As mentioned in the previous newsletter (Vol, 6.4), used sheet piles are often used for temporary steel sheet pile retaining walls in China. By using a water jetting together, the press-in/extraction force can be optimized, the damage to the steel sheet pile is minimized, and thus future reuse is possible.

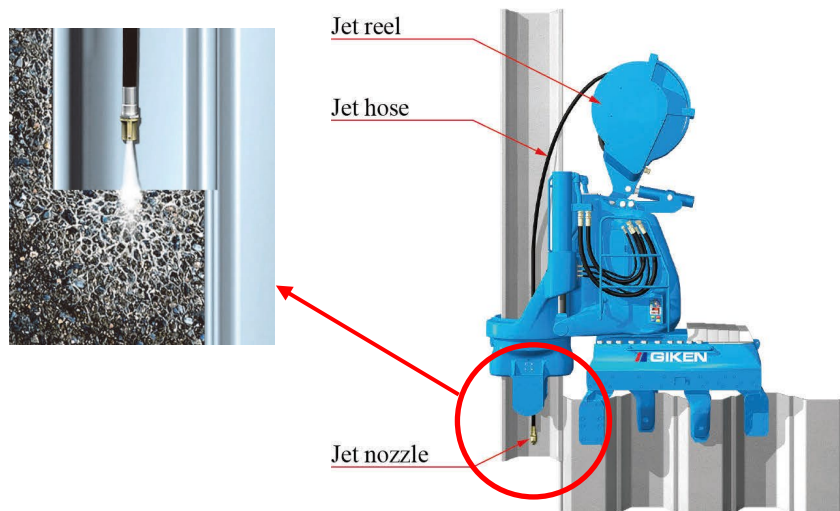


Fig. 5. The image of press-in assisted with water jetting method<sup>1)</sup>

### 4. Summary

In disaster prevention works in urban areas, it is often difficult to secure a large work space, and there are generally many restrictions on construction conditions. By means of the press-in piling method, we were able to reconfirm the usefulness of maintaining the functions of surrounding facilities, minimizing vibration and noise, and performing safe and secure construction at this site. In China, the development of disaster prevention infrastructure is being promoted intensively, and it is expected that the press-in piling method will be more activated in the future.

### References

- 1) International Press-in Association (IPA) (2021) Press-in Retaining Structures: A Handbook Second, Edition, 2021, 200p.