Case History

Recent Applications of The Press-in Methods in Africa: The Cases of Senegal & Egypt

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Abstract. This paper gives insight into the first two applications of the Press-in methods in Africa, recently experienced in Senegal and Egypt. The Senegal Project is the Dakar port, the second largest port in western Africa behind Abidjan's port. The first objective is to describe the adopted construction method called Gyropress™ Method, and then to compare it with conventional piling work proposed during the preliminary design. This method can accomplish the regeneration and reinforcement work without removing the existing underground structures and installing piles in very stiff ground conditions. A pile wall of length 350 m is built by installed alternated piles of diameters 1000 mm and 318.5 mm. Such an interlock installation method allows for preventing soil particle protrusion. The Gyro Piler™ facilitates the berthing and vessel unloading at the wharf during the construction, with limited vibration and noise, minimum impact on existing infrastructures, and, cost-effectiveness. The second project is the pediatric hospital in Cairo. From among the Press-In alternatives, GIKEN's "Zero Clearance Method" was adopted to ensure both the minimization of dead space between the adjacent structures and the alleviation of construction noise and vibration. In this project, utilized Zero Sheet Piles are 46 no. 7.5 meters and 100 no. 10.5-meter in an area of approximately 30 x 19 square meters. The Zero Piler™ Giken Seko works permitted safe and efficient sheet pile driving. The first two projects have proven the superiority and efficiency of environmentally friendly Press-in Methods in the Middle East and North Africa region.

1. Introduction

Press-in technologies, while being practiced worldwide for two decades due to their effectiveness compared to current foundations and retaining techniques, have not yet attracted the project owners and entrepreneurs in Africa up to 2018. The only way to make possible the execution of Press-in technologies in Africa was to link the JICA funds to help many African countries when coming to the execution of infrastructure projects. In this framework, the first two applications of the Press-in technologies were decided in Africa. The aim of this paper is to report on the first two case histories during which the implementation of IPA technologies took place.

The first project is the renovation of the free platform of the quay wall of Dakar Port (Senegal). The main objective of this project is the renovation of the free platform quay wall of Dakar Port. The second project is the construction of a retaining wall on hard ground condition for the Cairo pediatric hospital. This project will provide helpful support in combatting shortages including specialist doctors, medical equipment, and medical facilities.

2. Free Platform Quay Wall Renovation, Dakar Port (Senegal)

2.1 Overview of Dakar Port

Dakar port, constructed in 1936, is located at the most Western point toward the Atlantic Ocean. This port annually handles around 15,180,000 tons of goods and serves as a transit to inland countries for 14% of its total capacity. The third wharf constructed in 1939 is destined for landlocked countries, 95% is reserved for the Republic of Mali under a bilateral agreement. The transit of goods has increased by 2.5 times from 2010 to 2015 and, then, continued gradually up to 2022. The increase in goods has caused considerable deterioration over the total length of the wharf, which threatened to collapse. Moreover, large vessels are constrained by draught, and puddles of water form on the quay during the rainy season. Thus, the government of Japan, through JICA, provided grant aid of 3.971 billion yen under the ODA program for the rehabilitation of the wharf after a request from the Senegalese authorities in October 2013.

2.2 Third Wharf Description: operations and quay structure

The operated cargo volume in 2010 was 850,000 tons; in 2018, it was expected to attain 1.2 million tons. The planned ship type is Handymax (Bulk Carrier) sized at 35,000 DWT. The existing structure of the wharf consists of a gravity quay type of length equal 350m. This quay is one of three sides of a bay of length 360 m and width of 200 m where the current depth of the seabed is 12.0 m.

2.3 Geotechnical Survey

The geotechnical survey conducted onshore and offshore allowed identifying three layers from the seabed. The first layer is a plastic and hard marl clay of 1 to 3 m thickness. The second layer is a fractured grayish limestone-marl having a moderately low compressive strength from 3 to 12 meters. The third layer is a fractured grayish limestone moderately with low compressive strength up to 17 meters. The unconfined compressive strength of the marl and limestone-marl layers varied from very low to high strength (from 2.6 MPa to 68.8 MPa).

2.4. Design of the platform quay renovation

The existing quay, seriously deteriorated, comprises five gravity blocks resting on the seabed and overlaid by concrete blocks (Fig. 1). The simplest way to renovate the quay consisted to add gravity cellular blocks, filled with added material, and to fill out the space between the existing quay and the new one by backfill material. Such a plan of construction necessitates an enlargement equal to 22m inside the bay from the existing quay. The main concern was that the distance to the opposite quay pier would be narrowed during the operation, reducing maritime safety and convenience. To overcome this inconvenience, the change of quay structure type from gravity to the quay on piles sounded suitable.

Fig. 2 shows the layout of the quay on piles solution. The planned piles, embedded 2 m in the seabed, are distanced 5-6 m from the existing gravity quay wall. For constructing the quay on piles, the Gyropress method was selected. This method of installation is described, in brief, hereafter.

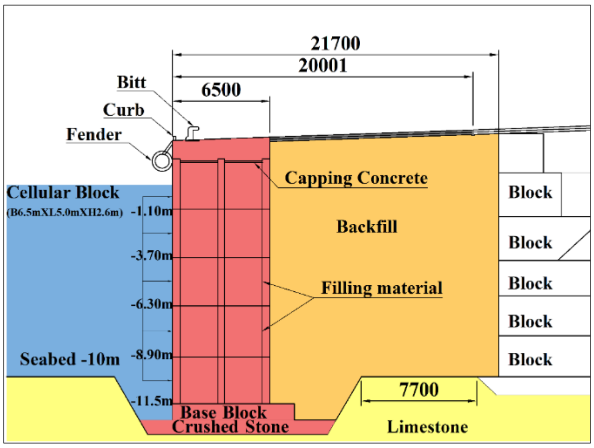

Fig. 1. Initial plan of construction of gravity cellular blocks

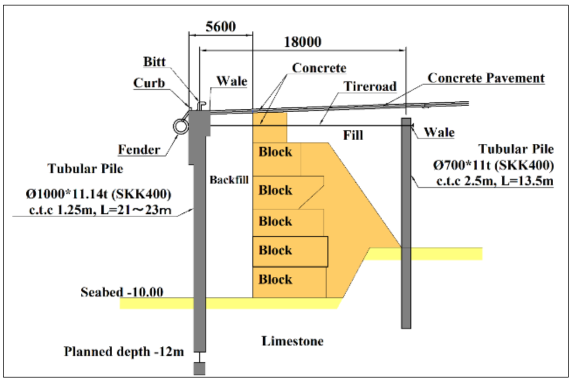

Fig. 2. Quay on piles solution

Table 1 summarizes the reasons for selecting the Gyropress Method for the installation of the quay on piles solution. This latter, confronted with the initially planned gravity wall solution based on four criteria, reveals much suitable. For those reasons, the owner of the project favored the quay on piles solution using the Gyropress method briefly described hereafter.

2.5. The Gyropress Method (rotary press-fitting method)

The Press-in Method, using Gyro Piler™ F401-G1200, installs piles by rotation with the assistance of cutting ring bits attached to the pile toe. This technique was successfully implemented to improve the berths at Nagasaki Port (Japan) from September 2017 to March 2018.

The initial piling represents the first operation to implement the Gyropress Method. This operation comprises three steps, [1]:
1) Insert the steel grid offshore;
2) Put the reaction on the steel grid, and
3) The setup of the Gyro-piler.

Photo 1 illustrates the Gyropress Method of piles installation using special bits to overcome the cutting of hard ground conditions as reinforced concrete.

Table 1. Comparison of the “All casing” and Gyropress methods of installation

	All casing method	Gyropress Method
Overview	Using a workboat such as a guide barge or a pile driving ship, a casing is installed, at first. After placing the steel pipe pile inside, the casing grips it and rotates downward. An excavator removes the crushed stone. It is a current construction method for port piers. Since the work will be carried out offshore by a workboat, the adjacent berths cannot be used during the construction period; a minimum space is required in advance.	Due to the rotary cutting press-fitting, all processes can be performed on the steel tubular pile. For this reason, adjacent berths can be used even during the construction period, hence, there is little economic loss. In addition, it does not affect the water area facilities (berths, routes, etc.) in the port.
Machines	Seven (7) machines: Casing, guide barge, working barge, crawler crane, hoist ship, tugboat, anchorage ship.	Three (3) machines: Gyro Piler, Crawler Crane Power unit.
Workability	Workboats need to be circulated and towed. Since it is a workboat, the process and quality are easily affected by weather and sea conditions. It occupies a wide area by using workboats and mooring lines.	Since everything is done on land or on piles, the work process and quality are not easily affected by weather and sea conditions. No special skills are required because general construction machines are used.
Safety	Due to the large number of work vessels, it is necessary to ensure the safety of vessels moving over the sea.	It does not interfere with the traffic at sea because no work boat is used.
Environment	Due to workboats, represent a concern about the impact on the natural environment and people.	Because it is a vibration-free and noise-free press-fitting method, it has less impact on the surrounding environment.

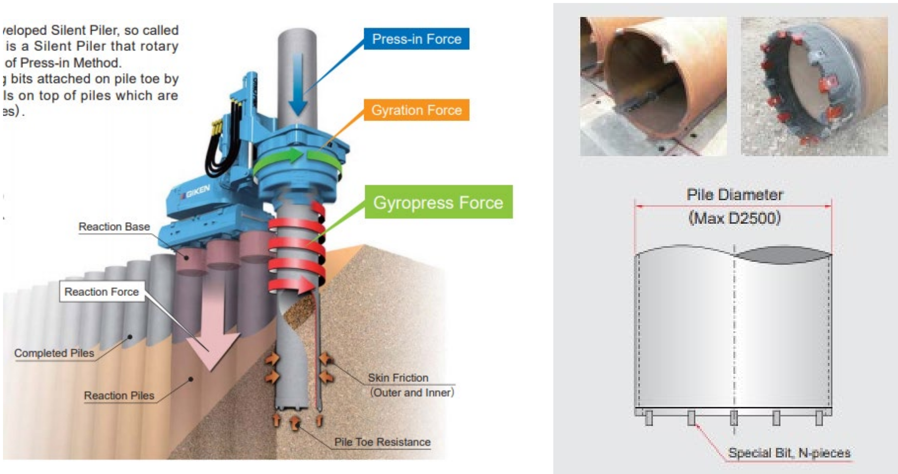

Photo 1. Cutting reinforced concrete overcoming various ground conditions by selected bit arrangements.

Beneficial effects of the Gyropress Method are:

- It was necessary to use a method that would have less impact on the weathered limestone layer.
- The operation at the third wharf should not be stopped as 95% of its capacity is destined for landlocked countries.
- The initial plan was changed from the gravity quay type to a quay on piles to avoid the reduction of the bay width.
- The “All Casing Method” is not recommended, as it requires many working vessels that would interfere with the berthing and vessel unloading at the wharf.
- The Gyropress enables to carry out safe, rapid and environmentally friendly construction method that minimizes the impact on the wharf, without stopping the operation at the port.

3. Construction of Retaining Wall on Hard Ground for the Hospital Facilities in Cairo (Egypt)

The Egypt Project in Cairo one of the largest cities in the Middle East and North Africa, deals with the construction works aiming at the expansion of the facilities at the Cairo University Pediatric Hospital. The hospital was established in 1982 with the support of Japan and is known locally as the “Japanese Hospital”. It has played a central role in providing pediatric healthcare at an affordable cost. However, with aging facilities and limited space; there is a need to enhance the hospital’s capacity by establishing a new infrastructure for which a retaining wall construction, incorporating below-ground excavation was originally planned with traditional construction and piling methods.

The project construction is to build a new pediatric ward in a narrow area surrounded on three sides by existing buildings. The original plan was to use other construction methods, but due to concerns about the impact on the adjacent wall structure, hence the Silent Piler method was adopted.

Potential negative impacts on existing adjacent structures as well as high groundwater levels led to a change in the design, utilizing Giken’s Press-In method of sheet pile installation.

Construction Method

For the Cairo’s Hospital project, the called “Zero Clearance Method” was adopted [2]. This method of installation performed well by using the Zero Piler Machine to construct a continuous steel structure wall at zero meter clearance from an existing structure. The normal Silent Piler requires at least 500 to 600 mm clearance from the existing structure, whereas the method allows zero mm clearance, therefore the maximum construction space can be used. It resulted in the use of the “Zero Clearance Method” of extensive practice, by GIKEN in Japan, operating by the machine called Zero Pile.
The Zero Piler with auguring system enabled piling, near Cairo’s hospital, in hard ground conditions at zero clearance without disturbing the neighborhoods.

4. Conclusions

This paper reported the first two experienced Press-In methods in Africa.

The first case history is the Free Platform Quay Wall Renovation of Dakar Port (Senegal). There were major challenges to overcome in this project. It was necessary to use technology with less impact on the weathered Limestone layer. The operation at the third wharf of Dakar port should not be stopped as 95% of its capacity is destined for landlocked countries. The initial Plan “gravity quay type” also called “The All Casing Method” requires many working vessels that would interfere with the berthing and vessel unloading at the wharf. This quay on piles option turned out unsuitable since it reduces the width of the bay. As a suitable option, the Press-In “Gyropress Method” enabled to carry out safe, rapid, and environmentally friendly construction that minimizes the impact on the wharf, the operation at the port unstopped, and the width of the bay only reduced to 5.6 m.

The second case history is the construction of a retaining wall on hard ground for the New Pediatric Hospital Facilities in Cairo, (Egypt). Piling at zero clearance distance from the existing buildings, the Zero Piler with the auguring system, without disturbing the neighborhoods, was another success of the Giken Press-In technology.

5. References

[1] International Press-In Association (2021). Manuel des structures de soutènement par vérinage. 2ème édition. French IPA Handbook.
[2] Giken Ltd (2014). Construction Revolution: Zero Clearance method.