1. Introduction

Although these roles of sewage system will never change, its capacity must be increased because of the recent climate change; partly because of the recent global warming, localized heavy rains with more than 50 mm/hr occur frequently. There are flood disasters caused by the highly localized downpours with more than 100 mm/hr in Tokyo. In order to cope with this situation, Tokyo Government Bureau of Sewage is rapidly reinforcing the main sewage line and pump station so that they can cope with 50 mm/hr rainfall in order to cope with the increase of rainwater inflow as a result of the urbanization. As one of these measures, the rainwater pump station “Senjusekiya Pump Station” is built to increase the capacity enough to cope with the increase of rainwater in Senju basin, Adachi Ward, Tokyo.

2. Outline of the Construction

Senjusekiya Pumping Station is a rainwater pump station designed to cope with the increase of the rain runoff in the basin of the existing pump station. Additionally, it has a rainwater reservoir to reduce the pollution load of combined sewerage.

General Information of the Facility:
Name of the Facility: Senjusekiya Pumping Station
Drainage area: 292.85 [ha]
Design Drainage Discharge, amount of rainfall: 37.3 m³/s
Rainwater Reservoir: 17,600 m³
Structure and Scale: Reinforced-Concrete building, two stories over ground, five stories underground.

Construction was done in “Pneumatic Caisson Method,” dividing the underground structure into two caissons. This construction project builds two caissons simultaneously in order to realize the purpose of the construction, in the method which requires high technology.

Plan of the pump station is shown in Figure 1. In the two-dimensional view, the station is divided into two blocks: one has the inlet passage of the main line and a sand settling basin, and the other has the pumping well and a rainwater reservoir. The left block is denoted “West-side caisson” (excavation area 2,614 m², depth 53.8 m), and the right one “East-side caisson” (excavation area 2,289 m², depth 50.1 m).

Scale of Construction: West-side Caisson 53.9m × 48.5m (depth: 53.8m), Final Air Pressure: 0.450MPa
East-side Caisson 39.8m × 57.5m (depth: 50.1m), Final Air Pressure: 0.417MPa
Excavation Area: 4,983 m², Amount of Earth Excavated: 265,555 m³
Concrete: 14,018 m³, Reinforcing Steel: 19,913 t
3. Feature of this Construction (simultaneous installation of 2 caissons)

3.1 Adoption of two-caisson boxes

In case of one-box excavation of this pumping station, the digging area would be 4983 m². There was no experience of similar sized project, and it would have not been adopted. The main reason of the rejection was the structural problem of dropping caisson. It is prefer to be able to sustain the construction load of the drop only by the proof strength of structural members. However, in case of a large excavation area, it has a high risk of cracking and buckling for the lack of strength of deck slab because the less construction height makes the planar structure unstable in the beginning of the dropping. This pump station also needed not only the deck slab was increased for the rigidity but the temporary member called lift beam was necessary to reinforce. This is a temporary structure to build a wall to connect the upper floor slab and the base version, and it will be removed after completion. If the one-box excavation is employed, size and quantity of the lift beam would be large, and their removal could lead to be less cost efficiency and more construction period. Moreover this pump station would not be adopted rectangular shape caisson but heterotypic shape caisson. The heterotypic shape caisson is considering new scheme, which causes a twist phenomenon, and it could not be the safest and the most certain construction because it would have been the largest project ever.

In addition, because the inflow trunk sewer is shallow than the pump well, the drop caisson will get depth difference by dividing into two boxes, and it will be designed economically.

3.2 Adoption of simultaneous two-box construction

When the construction is divided into two boxes, there are two ways that they construct one by
one and two boxes together. The former needs longer construction periods, but a yearly investment is lower.

In consultation with local residents, the entire construction period of this pump station is constrained within 10 years. Thus, the simultaneous construction is adopted even if the yearly investment is higher. In addition, the necessary space was reserved by compacting noise control building into 2-storied to accommodate air facility, and by using the neighboring road, parks, and river sites as the work yard.

4. Study of simultaneous construction
4.1 Setting the stress shield wall and controlling the construction period

When neighboring two caissons are dropped simultaneously, it has a risk of phenomena that the one box drags the other box with surrounding ground, so-called “co-drop (tomo-sagari)”. And when there is an air leakage from the work chamber of the one box, the risk that the poor oxygen air, which is passed through the oxygen deficient layer, flows into the work chamber of the other box. To prevent them, we decided to place steel sheet piles, which are called stress shield wall between the two boxes.

In addition, the commencement of the drop construction is adjusted so that the one box does not complete dropping the first than the other. It is easy to control the position if it is the drop construction, and it can be modified even if the leaning is occurred with co-drop.

4.2 Clearance of two boxes

This project is planned 2.0 m clearance between two boxes. In determining the clearance, the mutual influence of inclinations between boxes and the effects of boxes and the stress shield wall are investigated.

According to the work progress control standard of the caisson method, the displacement distance per a box is less than 300 mm, and the inclination is less than 1/100. If the two boxes inclined toward each other, the total displacement distance is 600 mm, and the horizontal displacement is 1 m (calculated with the depth of this pump station). Thus, the clearances were necessary over 1.0 m between two boxes and over 1.0 m between shielding boxes and wall. So, the clearance of two boxes is determined at 2.0 m.

With this clearance, it is considered that there are no obstacles to set a general scaffold.
4.3 Combination of two boxes

Because the caisson of this pumping station was divided into two and each separated at the distance of 2.0 m, each caisson is an independent facility. After finishing the installation of the two caissons, the walls connected to them must be removed and the walls and slabs are connected into one (hereinafter, “connection work”).

It is planned that the two places circled in black are dug and underground walls connecting the caissons are constructed on them.

5. Consideration

This project is facing at the start of the main construction. As the first example of two-box simultaneous construction, the knowledge of accumulation as the aspects of the construction management, such as co-down and air leakage, and the extraction of new issues in design stage are expected.

Installation of the two caissons has finished now. The construction work to connect the two caissons is going to be launched. The connection work of this great depth has never been done before. Therefore careful plan considering construction management must be prepared in the design stage so that the construction work may be sure and safe.