Construction of the Raw Water Reservoir
— The Shin-Ishikawa Water Treatment Plant —

新石川浄水場原水調整池の工事報告



* Tomoki ITO, P.E.Jp: ABE NIKKO KOGYO CO., LTD.
伊藤　朋紀，技術士（建設部門）：（株）安部日鋼工業
** Hiroshi SHIMOKAWA: ABE NIKKO KOGYO CO., LTD.
下川　浩：（株）安部日鋼工業
*** Shin SUGAWARA: ABE NIKKO KOGYO CO., LTD.
菅原　伸：（株）安部日鋼工業
Contact: tomoki.itou@abe-nikko.co.jp
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Synopsis
The Shin-Ishikawa water treatment plant was constructed to replace the old water treatment plant, which was constructed in 1967. The original Ishikawa water treatment plant was designed to meet smaller demands compared to the new plant. The construction site is Ishikawa Uruma City in Okinawa prefecture. The treatment capacity of the new water treatment plant is 165,600 m^3/day. This paper introduces the construction of the two raw water reservoirs in the Shin-Ishikawa water treatment plant. The Shin-Ishikawa water treatment plant is shown in **Fig.1**.

Structural Data
(1) Shin-Ishikawa water treatment plant No.1 system raw water reservoir
Owner: Okinawa Prefectural Enterprise Bureau
Effective capacity: 50,000 m^3
Internal diameter: 80.0 m
Effective water depth: 10.5 m
Contractor: Abe nikko kogyo, Okiei kensetsu, Oohata kensetsu Joint Venture
Construction period: July 2009 - March 2011

(2) Shin-Ishikawa water treatment plant No.2 system raw water reservoir
Owner, Effective capacity, Internal diameter, Effective water depth : same as No.1 system raw water reservoir
Contractor : Abe nikko kogyo, Ooshiro gumi Okinawa PC Joint Venture
Construction period : October 2009 - January 2012

Fig.1 The Shin-Ishikawa Water Treatment Plant

1. Introduction
This project is a construction of two Prestressed Concrete (hereafter, called 'PC') tanks for raw water reservation. The effective capacity is 50,000 m^3, the internal diameter is 80.0 m and the effective water depth is 10.5 m. With these dimensions, it is classified as a large scale construction. These tanks consist of bottom, wall, pillar and roof. The schematic diagram of the tank is shown in **Fig.2**, the cross-sectional detail view is shown in **Fig.3**, and the plan view is shown in **Fig.4**.
The bottom piece is a Reinforced Concrete structure. The wall part is a PC structure with ten pilasters. The roof consists of the beams and the slabs. The beam is a pre-cast concrete product (hereafter, called 'PCa'). The slab is the PCa PC slab, except the part of joint with the wall, which is a cast in place slab. The pillar which

supports the roof is also a PCa. All the PCa components were produced and painted with anticorrosive paint in the factory in Okinawa. After that, they were carried into the site and assembled.

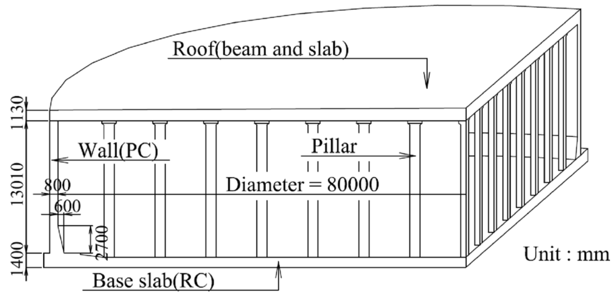

Fig.2 Schematic diagram of the tank

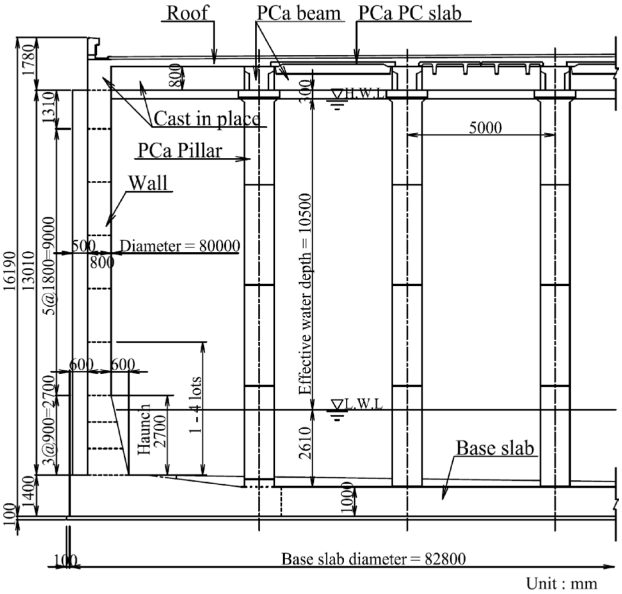

Fig.3 Cross-sectional view

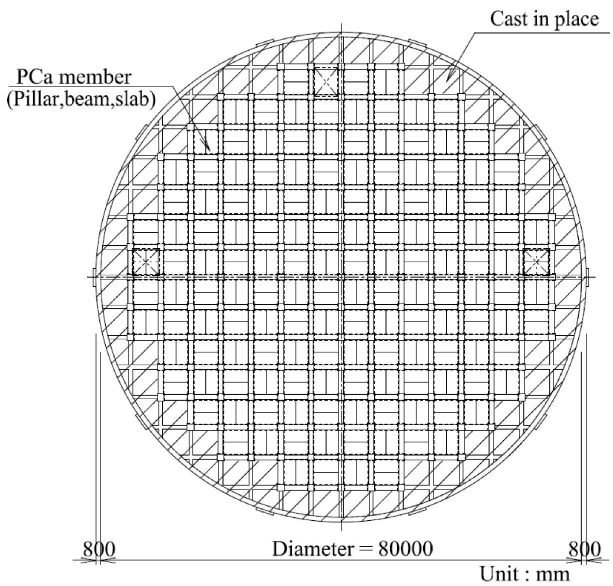

Fig.4 Plan view (roof)

2. Foundation Work

The foundation work was planned to require a period of three months at first. However, because a soft point was found on the foundation ground, the work and time thereof to replace the soil with concrete was added. It took an additional two months for this replacement work to be completed. For the purpose of time compensation for delay of construction, the wall work and the pillar work were executed simultaneously, and the roof work and the painting work of the wall were executed likewise. The situation of the foundation work is shown in **Fig.5**.

Fig.5 Foundation work

3. Base Slab Work

The base slab thickness is 100-140 cm. According to Standard Specifications for Concrete Structures - 2007, materials and construction[1], the base slab was classified as mass concrete, and prevention of thermal cracking was a major problem. Therefore the base slab was divided into 22 blocks and constructed by turns. Additionally, the expansive concrete was used at the circumference area and the spaces for divided slabs. The design strength of the base slab is 30 N/mm^2. For the purpose of lowering concrete temperature at the time of site execution, a shade net was installed in the agitator car waiting space, and a drum cooling covers were also used for the agitator cars. In addition, spraying that using a sprinkling tubes for agriculture were also executed. The situation of the base slab work is shown in **Fig.6**.

Fig.6 Base slab work

4. Wall Work

The height of wall is 13.01 m, and the wall thickness changes from 140 cm to 80 cm at a height of 2.7 m from the bottom of the wall. This haunch part was divided into three lots, and was built in 0.9 m high phases. The thickness of the wall higher than the haunch is 80 cm, and the segments of the wall were built at 1.8 m high intervals. The design strength of the wall is 36 N/mm^2.

The walls of large-sized PC tanks are highly prone to occur thermal cracks due to the constraint by the slabs or the lower parts of the walls. Thermal cracking was an especially critical in this particular project, as the execution time of the wall concrete for the PC tank of No.1 system water treatment plant was in hot weather condition. The environmental conditions required construction on under intense heat conditions, therefore, measures against thermal cracking were needed. Measures were examined based on a material property testing and a three dimensional finite element temperature stress analysis (**Figs.7 and 8**).

Fig.7 Material property testing

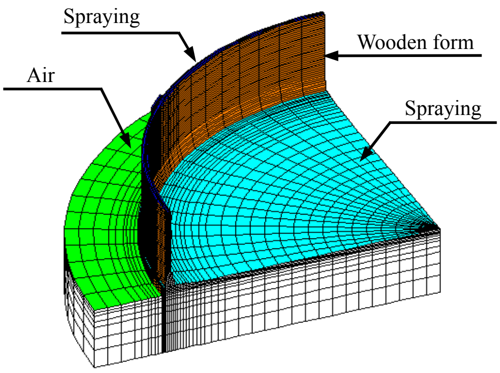

Fig.8 Example of analysis model

As a result, the reinforcing bar was increased from 0.36 % to 0.61 % of the reinforcing bar ratio. Additionally, the concrete of haunch part and the first lot of same thickness part (1-4 lots, **Fig.3**) employed the use of high-range AE water reducing agent and expansion additive. The concrete of the wall after fourth lot employed high-performance AE water reducing agent.

For the purpose of lowering concrete temperature at the time of site execution, the shade net and the drum cooling covers were used, using the same methods as at the time of base slab work. The situation of the wall work is shown in **Figs.9 and 10**.

Fig.9 Wall work (1)

Fig.10 Wall work (2)

5. PCa Pillar Work

The pillar supporting the roof consists of four PCa pillars, and 708 PCa pillars in total were used. The weight of one PCa pillar is about 85 kN, and the pillar was put together sequentially from the base. For the purpose of assembly execution, two 10 ton lift anchors were embedded in the top of the PCa pillar. And for the purpose of movement, four φ24 mm internal threads were embedded in one side of the PCa pillar. The PCa pillar was painted with anticorrosive paint in the factory (**Fig.11**).

The PCa pillar was carried into the tank by a 200 ton crane installed at outside the tank. In the case of the No.1 system water treatment plant PC tank, the PCa pillar was moved onto the base slab with a self-run chassis and 35 ton crane. In case of the No.2 system water treatment plant PC tank, due to considerations of execution characteristics, the PCa pillar was moved using a forklift. A 100 ton crane and transfer platform were used for assembly. The situation of the roof work is shown in **Fig.12**.

Fig.11 PCa pillar

Fig.12 PCa pillar work

Fig.13 Roof work (1)

Fig.14 Roof work (2)

6. Roof Work

The roof consist of 324 PCa beams and 294 PCa PC slabs. The joint with the wall is constructed by cast-in-place method. The heavy machinery and the scaffolding for construction of the PCa beams and slabs are the same as PCa pillar. The lift anchor also was embedded into the PCa beams and slabs. Demonstration of the beam and slab lifting work is shown in **Figs.13 and 14**. After construction completion of PCa piece, the seals were applied into the gap surrounding the pillar, the beam and the slab. The reinforcing rod was arranged, and the roof concrete was placed at the same time.

7. Conclusion

This paper described each process employed for the large scale PC tank construction project. A unique consideration in this project was the prevention of thermal cracking on the slab and wall. Numerous counter measures were employed to address the concern of thermal cracking. In closing, the project was able to be completed successfully. Construction of the PC tanks was concluded without accident. The authors would like to express our deepest gratitude to each individual involved in this project.

Reference

[1] Standard Specifications for Concrete Structures - 2007, Materials and Construction, Japan Society of Civil Engineers, PP.172-173, Mar. 2008 (in Japanese)

概　要

新石川浄水場の原水調整池は，内径80.0m，有効水深10.5m，有効容量50,000m^3×2基のPCタンクで，同種工事では大型の部類に入る。大容量の貯水構造物であることからマスコンクリート対策や工程管理が重要な課題となり，建設地点が沖縄県であることから，暑中コンクリートの対策が必要となった。とくにタンクの側壁は底版や下段の側壁の拘束による温度ひび割れの発生確率が高いため，施工前に物性値確認試験や温度応力解析によりひび割れ対策を検討した。本構造物は大型で工期も長いため，安定した品質が得られ，工期が短縮できるPCa部材が多く採用されており，これらの施工が本工事の特長となっている。

一方，工事当初に基礎地盤に軟弱箇所があることが確認され，以降の工程に遅延が予想されたため，工期短縮のために各工程において，平行作業を行うなどの対策を検討し実施した。本稿ではこれらの施工を行った結果を報告する。