Construction of Long-distance Headrace by an Open-Type TBM with Maximum Monthly Advance of 678 m

— Mitsubishi Materials Komatagawa New Power Plant —

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1. Introduction

Construction of the Komatagawa New Power Plant was commenced in April 2019 and completed in December 2022. Water is directly taken from the outlet of the Komatagawa No.4 Power Plant directly under Moriyoshi Dam and led to the downstream new power plant which secures an effective head of 91.5 m and maximum output of 10,326kW and generates approx. 48,500 MWh per year (Photo-1). The total length of headrace tunnel is 8,492.1m; and the channel gradient is 1/1210 ~ 1/1300. With an access to the second construction section for TBM from the horizontal working adit (2), construction of the section extending for 7,658.4 m was executed by TBM (Fig. 1).

Photo 1 Full view of the hydraulic power plant

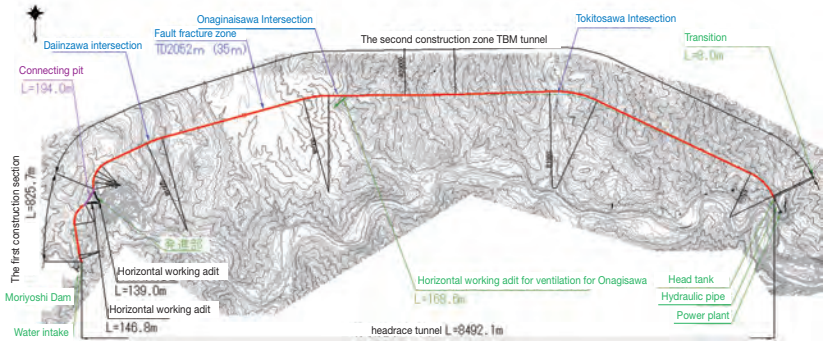

Fig. 1 Plan view of the Komatagawa New Power Plant

2. Headrace Tunnel Plan

We have designed a ϕ 3.52m open-type TBM equipped with 24 17-inches disk cutters (Photo-2). The TBM is assembled in a temporary yard, drawn to the TBM starting place, and executes initial tunneling for a total of 60 m. We have adopted continuous belt conveyors and installed booster drives at two places in the tunnel to secure the mucking capacity of 230t/h. For materials and equipment transportation, we have established separation points at two places in the tunnel to avoid waiting time for materials and equipment.
At the reaching point on the head tank side of the power plant, a transition with a total length of 8.0 m is drilled to pass through this point. The TBM is disassembled inside the tunnel and carried out through the horizontal working adit (2).
The TBM small cross-sectional tunnel support use PF mortar shot (f'ck = 36N/mm^2) and steel ring support (H-100) as the main support members, and the standard support pattern using the combination of these members is used (Fig. 2, Photo-3). Bottom concrete plates use invert blocks (f'ck=18N/mm^2); and they are installed before the following dollies and single-track rails are fixed on them. For lining, fiber reinforced shotcrete lining (f'ck = 18N/mm^2) is used and the lining work is executed after the completion of TBM tunneling work. The ground is composed of tuff breccia, tuffaceous mudstone, dolerite and andesite. The maximum overburden height is 161 m.

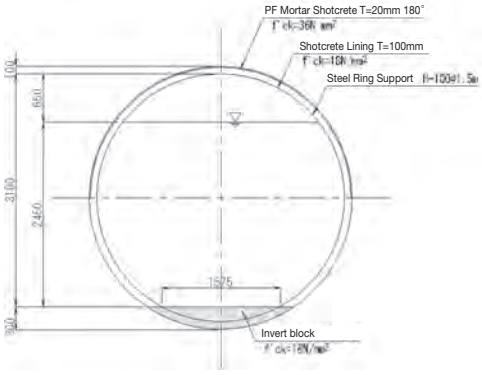

Fig. 2 Example of tunnel structure (Support type C)

Photo 2 External view of the Φ3.52m Open-type TBM

Photo 3 Full view inside the TBM tunnel (support type B1)

3. Results of TBM Tunnel Construction

TBM tunneling was started on January 13, 2020 and completed on August 24, 2021. The tunnel penetration accuracy was a deviation of + 53 mm in the vertically upward direction and - 140 mm to the left in the horizontal direction. The maximum daily advance was 64 m; the maximum monthly advance was 677.5 m; and the average monthly advance was 382.9 m, exceeding the planned monthly advance of 347 m. The operating rate per total work days was 71.5%. It required 20 months for headrace tunnel excavation; 7.5 months for shot lining by dry spray method with the average monthly advance of 1,094 m; and 2 months for removal of temporary equipment, and it took 34 months to complete the headrace tunnel construction work.