Long Tunnel Constructed by Excavating Extra-small Cross-section by NATM Method with Rail System the NATM Rail Method

— Seinaiji Hydroelectric Power Station Headrace Tunnel —

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1. Introduction

The headrace tunnel (Photo 1) for a run-of-the-river hydraulic plant being constructed by Chubu Electric Power Co., is a tunnel with an extra-small inner space cross-section of B=2.4m x H=2.55m (about 6m2).
As the geology is mainly solid granite, two tunnels of 2751m and 2396m lengths were constructed by NATM method.
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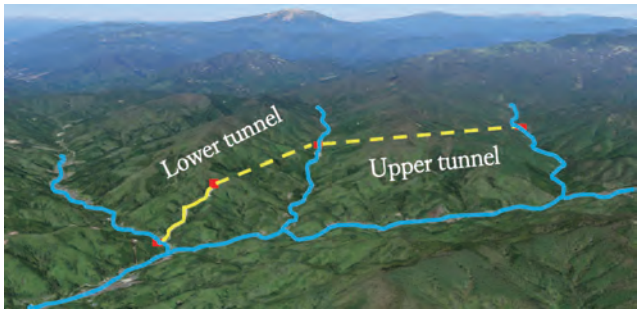

Photo 1

2. Tunnel Planning and Construction Method (adoption of rail system)

The cross section of the tunnel is designed with the minimum cross-section area possible aiming at reducing the construction cost while maintaining the functions as a headrace. The rail system with battery car towing, was adopted considering that the tunnel is long distance with extra-small cross-section area and the deterioration of the underground environment caused by exhaust gas. In order to improve the efficiency for the long-distance construction, widening for passing and widened section for temporary facilities were provided every 900m and 300m respectively. The maximum excavation progress per month was 130m, and the average was CL-class 2.9m/day, CM-class 5.1/day, and CH-class 5.7m/day (Figure 1).

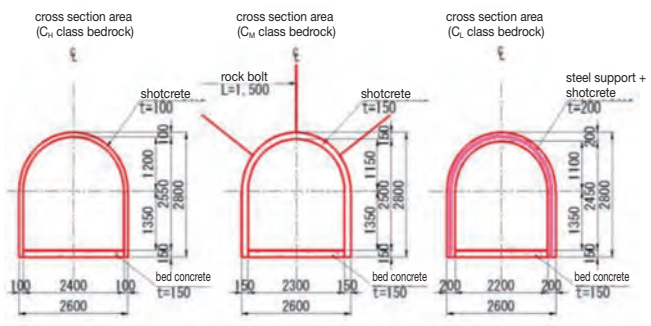

Fig. 1 Supporting Pattern

In order to construct 2 tunnels at a time, a batcher plant, muck dumping site, temporary facility yard for lifting equipment etc., and railyard were combined in one location. Construction machine configuration consisting of (1) drill jumbo, (2) shaft loader for muck loading/shuttle car for transport, (3) spraying robot were used to a series of works of excavating, bringing out muck, and spraying concrete (Figure 2).

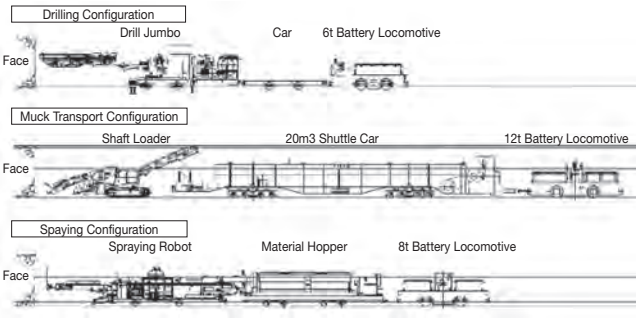

Fig. 2 Tunneling Machine Configuration

3. Safety/Work Environment Measures

Due to the extra-small cross-section area, safety assurance for workers was the most important issue. By installing sensing transmitters cars on rail, an alert and warning light installed at the nearest pull-in was activated to notify workers in the tunnel that a car is approaching. In addition, other measures, such as installing automatic breaking with magnetic sensors for cars, were taken to ensure workers' safety, and achieved penetration without accident. As for the working environment measures, since the extra-small cross section made it difficult to install large ventilation equipment, Φ 300 windpipes and liquid quick setting admixture in shotcrete were used to reduce the dust concentration.

4. Conclusion

Although there were only a few recent records and people with experience, the NATM method with rail system for extra-small cross-section area has been completed without accident or disaster thanks to improvements and innovations.