Construction of a long-distance deep shield that passes through the central part of the Tokyo Chiyoda Trunk Line Project

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1. Overview of the Chiyoda Trunk Line Construction Project

Many of the existing sewerage trunk lines in the central part of Tokyo have deteriorated considerably, and the water level is consistently high. To deal with this issue, the Bureau of Sewerage of the Tokyo Metropolitan Government is implementing projects for construction of new alternative trunk lines and switching the destination of sewer water in order to reduce water levels in existing sewage trunk lines and reconstruct the sewage system using the rehabilitation method, etc.

A representative example of such projects is the construction of the Chiyoda Trunk Line, a sewage line that starts at Iidabashi (the uppermost region), passes through the central part of Tokyo where numerous government ministries and agencies are located, collects sewage water from six existing sewage trunk lines, and ends at a sewage water treatment facility. A large-face shield with an external diameter of 5.5 m (internal diameter of 4.9 m) was necessary in order to build the sewage main line. With its total length of 8.7 km and maximum overburden of approximately 60 m, this shield tunnel construction project is without precedent in terms of depth and scale of construction work. Furthermore, in order to improve the quality of water in Tokyo rivers, the Chiyoda Trunk Line construction project will also serve to improve the combined sewerage within the drainage area by significantly reducing the spillage of sewage water in public waters during rainy weather.

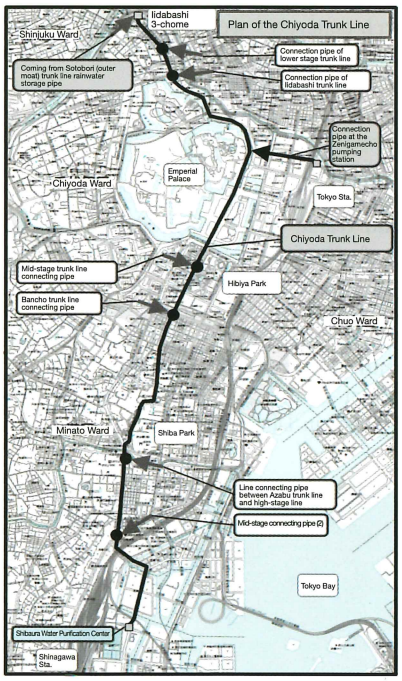

Fig. 1 Plan

2. Overview of design

The starting shaft was located in close proximity to a railway line in service, so the Pneumatic Caisson Method was adopted because it has little effect on the surrounding environment. Also, the construction yard was quite narrow because of its location in the central part of Tokyo, so part of the road was utilized and construction was carried out underneath the road.

The mud water compression shielding technique, which features degree tight seal to the ground and enables automated control of the intake of soil, was adopted in order to deal with the envisioned high water pressure of 0.5-0.6 MPa in the tunnel. In order to be able to control the water effluence caused by the increase in pressure during excavation, a shaft entrance capable of handling high pressure was adopted.

In addition, a multistage bit arrangement with protruding advance cutters was adopted as a measure to handle long-distance excavation in hard ground with an N value ranging from 100 to 150. In this arrangement, extra-hard bits were used in the reinforced advance cutters in order to eliminate the necessity of bit replacement. Furthermore, an emergency water shutdown device was installed to deal with deterioration of the tail brushes, and specifications were adopted to enable replacement of tail brushes in emergency situations.

Construction and connection of manholes for water intake, was designed presuming adoption of the Urban Ring Method, which can be utilized at significant depths, and the freezing method, which is commonly used with good results by the Bureau of Sewerage in the Tokyo Metropolitan Government.

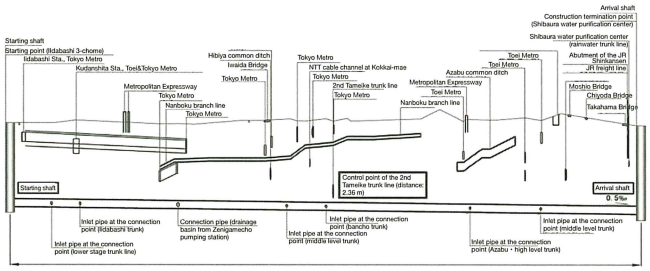

Fig. 2 Longitudinal section

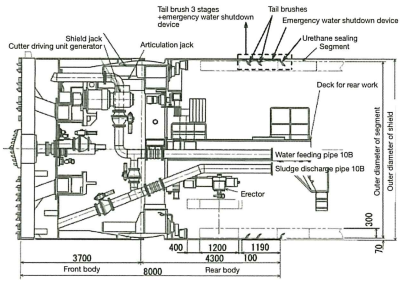

Fig. 3 Shield machine (standard plan)

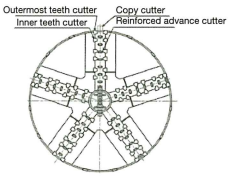

Fig. 4 Shield machine (face plate)

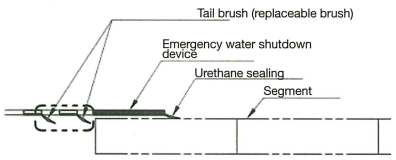

Fig. 5 Overview of the tail brush replacement

3. Conclusion

The progress of the Chiyoda Trunk Line Construction Project is as follows. Construction of the starting shaft was launched in March 2014 and completed in December 2016, shield operations started in November 2016, and shield machines and segments are currently under construction.

Sewerage construction work is conducted almost entirely underground, and the public lacks sufficient awareness of such projects. To deal with this issue, details of the Chiyoda Trunk Line Construction Project are published on the website of the Tokyo Metropolitan Government Bureau of Sewerage as an example of a large-scale construction project, in order to disseminate information in a manner that is comprehensible to the general public.