# The construction of a long-distance deep shield passing through central Tokyo

— Chiyoda Trunk Line, Tokyo sewerage —

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## Overview

The purpose of this project is to construct a new sewerage trunk line ( $\phi$ 4900mm) to reconstruct the aging existing sewerage trunk line and to reduce the amount of sewage discharged from the combined sewerage system into rivers during rainy weather. The construction method involves the use of a slurry shield. A distance measuring around 8.7km from the start to the end will constitute one span. The shield tunnel will be constructed at a maximum depth of 60m because it will traverse under the city center where buried pipes and subway structures are congested.

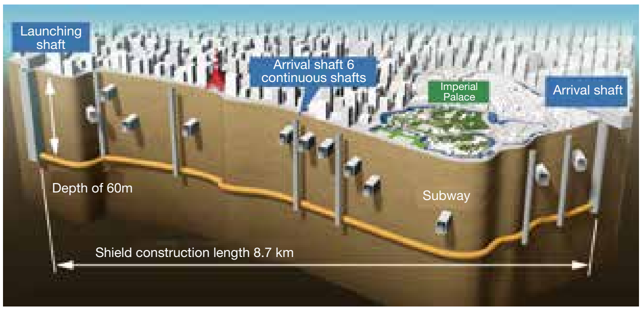


Fig. 1 Shield route map

The ground on which the shield tunnel passes is Diluvium, and the groundwater level is high at about GL-2.0m. At the initial stage of excavation, the soil is composed of consolidated silt and fine sand, which then transitions to sandy silt.
At the later stage of excavation, the soil becomes mainly consolidated silt, which is extremely hard with an N value of over 50.

## 1. Construction challenges and countermeasures

There are three main challenges that must be addressed in the construction of this project: improving the durability of the shield machine for the long-distance construction (approximately 8.7 km), countermeasures against high water pressure for the shield machine for excavating at deep depths (approximately GL-60m), and process control for long-distance construction.

### 1-1 Improvement of Shield Machine Durability in Long-Distance Construction (approximately 8.7km)

Improving the durability of the shield machine is crucial, given the long distance (approximately 8.7km) of one span for this construction. As a countermeasure, a mechanical bit change executed by the slide cutter method was used. This refers to pushing out the rear bit when the leading bit is worn out to allow digging to continue. This method improves the durability of the shield tunneling machine and eliminates the need for bit replacement, making it possible to engage in construction over a long distance of approximately 8.7 km.

### 1-2 Measures against high water pressure for shield machines excavating in deep areas (approximately GL-60m).

The longitudinal alignment of the shield tunnel is at a great depth with an average overburden of about 50m and a maximum overburden of about 60m, and the tunnel is constructed under high water pressure. Therefore, two measures were taken to improve and maintain the water sealing performance. The first measure is the three-stage arrangement of tail brushes, which reduces the risk of water leakage and improves the water sealing performance compared to the two-stage arrangement. The second involves installing an emergency water stopper. An emergency water stopper is installed between the second and third layers of tail brushes so that the first and second layer tail brushes can be replaced during excavation. When the deterioration of the tail brushes is confirmed, the brushes can be replaced to ensure the water stopping performance.

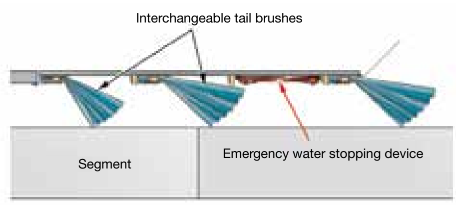


Fig. 2 Three-stage tail brush arrangement

### 1-3 Process management in long-distance construction

For long-distance shield constructions, the shield tunneling and assembly work accounts for a large proportion of the critical path in the process. Therefore, it is necessary to improve the efficiency of the work in order to avoid the risk of extending the construction period and also to reduce the cost. In this project, the number of assembly operations was reduced by widening the segment width from the standard 1.2m to 1.5m, and the digging cycle time was shortened by adopting a segment (honeycomb segment) that enables simultaneous digging and assembly operations.

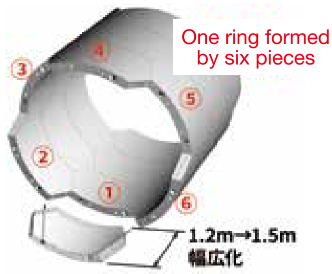


Fig. 3 Honeycomb segmen

Photo 1 Shaft photograph

## 2. Contact

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