The Largest Shield Tunnel Project in Japan

– Tomei-North section of the main tunnel, Tokyo Outer Ring Road

Takashi SHIDOJI ► Director, Tokyo Outer Ring Road Construction Office, Kanto Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism
Kenji KATO ► Director, Tokyo Outer Ring Road Construction Office, Kanto Branch, East Nippon Expressway Co., Ltd.
Junichi SUGII ► Tokyo Construction Office, Tokyo Branch, Central Nippon Expressway Co., Ltd.

Introduction

The Tokyo Outer Ring Road (connecting the Kan-etsu and Tomei expressways) is a 6-lane underground expressway around 16.2 km long, which is to be bored underneath urbanizing Tokyo. The project will construct two tunnels, each having 3 lanes in each direction, by using a shield machine with a diameter of around 16 m, the largest in Japan. Tunneling along the route is required to overcome severe conditions: large cross-section, long distance and excavation at high speed. Therefore, the tunnel will be excavated from two directions, north and south, so that in the event of unforeseen problems, one of the tunnels could be extended since they are coming at each other from opposite directions.
For the placement of orders for the project, there are two ownerships involved, Central Nippon Expressway Co., Ltd. for the northbound tunnel and East Nippon Expressway Co., Ltd. for the southbound tunnel.
Since each route is divided into two segments, there are a total of four segments which are excavated by shield machines (Fig.1), and consequently four shield machines are required. This paper reports the characteristics of the shield machine used for the southern sections and the progress of tunneling.

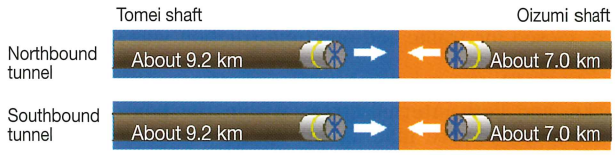

Fig. 1 Segments for outsourcing of construction

1. Characteristics of the shield machine

The shield machine going north weighs about 3,700 tons, and the cutting head is divided into two sections, outer and inner circumferences. This configuration, named "the double cutting system" (Fig. 2), allows the face within the inner circumference for the removal of the core to be excavated first, resulting in approximately 30% higher efficiency in power consumption than tunneling by a single driving system.
The south-bound machine has a weight of approximately 4,000 tons, with 242 pre-cutting bits ("relay bits") (Fig.3) on the cutting head which are able to be replaced a number of times. The system of the cutter head is structured so that a worker is able to enter behind the cutter spokes and safely insert new bits to replace the old ones.

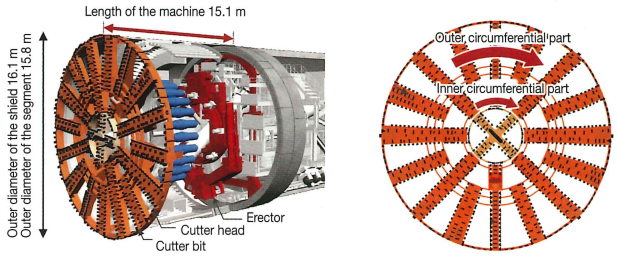

Fig. 2 Shield machine for the northbound

Fig. 3 Shield machine for the southbound

2. Conditions of the construction project

At the current stage, the starting shaft for the tunnel has been completed, and the shield machine, after being assembled, has continuously excavated since February 2017 (Fig. 4).

Fig. 4 Assembling of the cutter and view inside the tunnel

Tunneling is to proceed at a slow speed of approximately 3.2 meters per day for the initial excavation segment, but at the peak, the speed will reach about 30 meters per day. For the excavation, we will use a belt scale to weigh the muck, and a laser scanner to measure the volume of muck, monitoring various measurements in the tunnel and on the surface to improve project safely.