Excavation of World's Largest Urban Mountain Tunnel

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Introduction

Shodo Tunnel is a 0.5 km long tunnel located where the Yokohama South Ring Expressway (3 lanes on each side, total length 8.9 km), which is a part of the Metropolitan Inter-City Expressway, connects with the Kamariya Junction of the Yokohama-Yokosuka Road.
There is a junction in the Shodo tunnel where 4 main line tunnels and a ramp tunnel branch and join, and an extra-large tunnel with a width of 29.5m and a cross-sectional area of 485 m2, encompassing a maximum of five lanes, is excavated using the mountain tunneling method. As a highway tunnel by the mountain tunneling method, it has one of the world' s largest excavated cross-sections. In this paper, the characteristics and implementation status of the construction of the junction.

1. Outline of Junction Section

As the junction where the main lines and a ramp tunnel branch/join, the cross-sections of two large-section outbound/inbound tunnels are widened approximately every 20m to 30m to form an extra-large cross-section with the maximum width of 29.5 m for inbound line and 25 m for the outbound line. The construction can also be characterized by the fact that the two large-section tunnels are constructed extremely closely with the separation of about 1m (Fig. 1). The earth covering is less than 1D (D: tunnel diameter) with 7m to 14m, and the minimum separation from the residence on the ground is 6m (horizontal distance to the ground).

The geology is dominated by tuff sandstone (Nts layer) of the Neogene Pliocene ~ Quaternary Pleistocene, and the sandstone-mudstone alternating zone intervening with the pumice mudstone layer is distributed on the lens.
The Nts layer is massive homogeneous soft rock formation with few fractures, but the uniaxial compressive strength varies largely between 1.4 to 5.9MN/m2, and with thin layers of pumice and mudstone interbedded, there was concern that these may affect tunnel deformation and face stability.

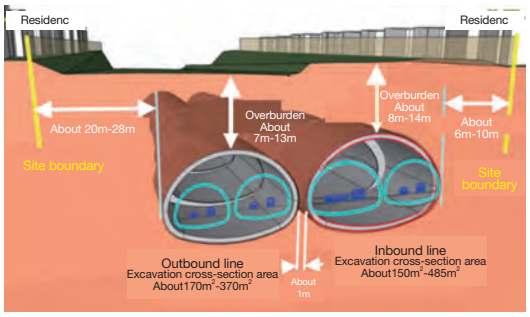

Fig. 1 Schematic Diagram of Junction Section

2. Construction Status

The excavation of the confluence section was a procedure for widening the large cross-section after excavating the advanced conduit shaft.
The division of heading in the original plan was 3 sections (upper, lower, and invert section) assuming a general machine configuration, but it was anticipated that the deformation of the tunnel would be relatively large due to the rather flat cross-sectional shape of the temporary closure of upper half section. Therefore, a large excavation machine was used to lower the formation level of the upper half section down to the S.L. (spring line) to give the temporary closure cross-section more stability (Fig. 2).
In addition, in order to shorten the time until excavation and temporary closing, all construction machines such as excavation, shoring, erection, and spraying were organized into two units.

Besides, the lower section and invert were excavated and supported by 1 meter together to shorten the time that the natural ground is exposed and improve the closure effect through prompt installation of supporting.

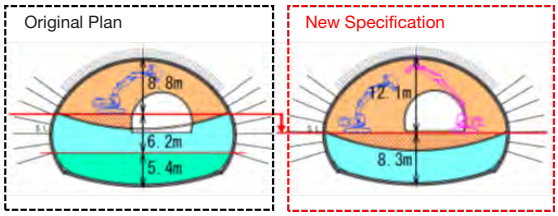

Fig. 2 Change in Division of Heading

During excavation, various measurements and monitoring such as surface settlement and underground displacement were conducted. The standard control values are set for each construction phase in anticipation of future increases in measured values. The measurement results at the completion of inbound line excavation were generally within 50% of the standard control values. The excavation behavior was confirmed to be within the range of predicted analytical values.

Fig. 3 Maximum Cross-section Excavation Completed

・Excavation for widening of the inbound line began in January 2022, and excavation of the largest cross-section was successfully completed in March 2023 (Fig. 3, 44 order-takers lined up).

In the future, we are going to excavate its twin tunnel, an unprecedented large-scale tunnel with a minimum separation of 1m from the other, as the outbound line tunnel, which has about the same cross-section as the inbound tunnel. We will pursue safe and secure completion of the construction through construction innovations and monitoring of measurement data.