Ultra-large cross section tunneling by widening from inside - Isshiki Tunnel, Chubu Odan Expressway -

Minoru HOSHINO ▶ Supervisor for Construction Work, Engineering Work 2nd Section,
Kofu River and National Highway Office, Kanto Regional Development Bureau,
Ministry of Land, Infrastructure, Transportation and Tourism

The Chubu Odan Expressway has total a length of 132 km, linking key expressways crossing the central part of the Japanese archipelago. Isshiki tunnel is a road tunnel with a single lane in each direction for two-way traffic, located west of Mt. Fuji, the highest mountain in Japan. This tunnel project is a segment of 685 meters on the north side, part of the total length of 1,275 meters.

1. Boring a working drift to shorten the work process drastically

In this project, since a new interchange was to be built, the amount of removal earth at the portal was approximately doubled to 280,000 m^3 in comparison with the initial estimate, and the construction period also was required to be greatly reduced. To cope with this problem, a 240 m-long working drift was constructed to proceed the excavation of main tunnel and soil removal forward in parallel. We were able to complete construction two years earlier than planned (Fig. 1).

2. Enlargement of the main tunnel to an ultra-large cross section

The portal of this tunnel is designed to consist of four lanes for merging and branching, so the soil removal to be excavated there amounts to approximately 200 m^2 in cross section, the largest scale ever attempted in Japan (Fig. 2). Considering these conditions, handling excavation starting from the working drift whose area of excavation section would be about 60 m^2 and reaching an ultra-large section of the main tunnel was challenging.

The portal was initially planned to be bored with a regular side drifting method for a large boring section. Referring to the boring survey where samples were taken from places of excavation to determine actual physical properties, and with the two dimensional FEM analysis, it was possible to use a multi-staged bench cutting method, which was more economical and superior in performance (Fig. 3). Based on this method, excavation was started by boring a working drift which has a face area of about 60 m^2 with a single center circle shape, and gradually was extended to form the intended upper half of about 100 m^2 with a large aspect ratio, by altering the excavation cross section through construction of several benches (Fig. 4 1) to 2)).

After the upper half was reached, the face was excavated following a very flat geometry, using a long size steel forepiling technique while minutely monitoring the displacement that took place up to the portal (Fig.4 (3), Photo -1). Then, as excavation was reversed, the heading was integrated into the section of the main tunnel, and then the lower half was excavated (Fig.4)

3. Breakthrough of the tunnel by cutting at the tunnel portal

By providing a working drift to allow the main tunnel to be bored in an easier way, the portal was opened and penetrated by an open-cutting technique with few precedents in Japan (Photo 2). At this point, the load acting on the tunnel was to be released, under which the tunnel would be likely to be deformed. To cope with this problem, we conducted a 3 dimensional FEM analysis to predict stress and deformation, and by confirming the safety of supports, excavated the portal section by cutting. As a result, although the crown of the tunnel suffered a slight upward displacement due to unloading on the earth covering, no remarkable deformation on the supports was recorded, and we successfully completed soil removal safely.

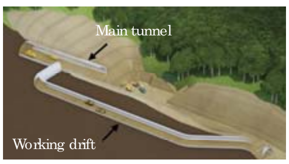

Fig. 1 Bird's view of the tunnel

Fig. 2 Rendering of the tunnel portal

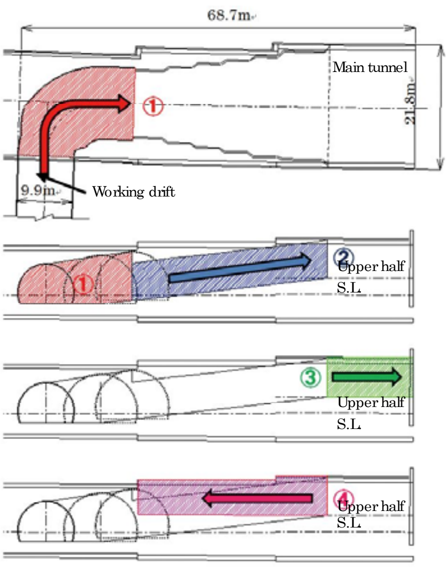

Fig. 3 Multi-staged bench cutting method

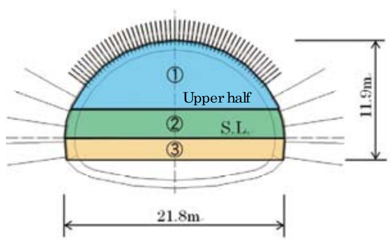

Fig. 4 Schematic drawing of main tunnel widening process

Photo 1 Tunnel face of upper half

Photo 2 Penetration of tunnel portal with earthmoving