

Streamlining the Boring of an Urban Railway Tunnel by Using Two Methods Jointly, SENS and Shield Tunneling

- Joint through service between Sagami Railway and Tokyu Line, Hazawa Tunnel

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The Hazawa Tunnel is a double track tunnel which is located about 25 km from the Tokyo metropolitan center as part of a new 3,499 m-long line directly connecting two urban railways, the Sagami Railway and the Tokyu line. From an economic viewpoint, the structure of the support lining is designed to use shield method type segments at each of the two portal sections, while the lining of the mid-section is constructed with SENS-based cast-in place concrete.

1. Characteristics of SENS

The SENS (Shield tunneling method, Extruded concrete lining, NATM system) uses a closed type shield machine for excavation, and constructs the primary lining with cast-in place concrete.

The steps for tunneling using the SENS are as follows. First, the shield machine is put in operation for tunneling, while at the same time, concrete is placed under pressure from the tail of the shield machine to keep the in-situ ground sturdy, prior to placement of the primary lining. The second step is to confirm the reliability of the primary lining, and finish the secondary lining after checking that displacement has completed. This step is repeated until this project is completed. In the SENS, the primary concrete lining has a unique role as a support equivalent to that given in NATM.

In situations where the ground surrounding the tunnel is barely able to remain intact during excavation, the SENS method is superior in safety and workability over the NATM method, which requires various auxiliary methods for tunneling, whereas the SENS method is more advantageous than the shield method because it does not place high-cost segments.

2. Study of the application of SENS to the Hazawa Tunnel

The ground through which the tunnel is to be excavated belonged to the Kazusa Group, as in the case of the Nishiya Tunnel on the Sagami Railway - JR direct line which was bored by SENS prior to this project. Although the groundwater level was higher than for the Nishiya Tunnel, SENS-based excavation was determined to be possible. At the starting and arrival portal sections, this tunnel runs close to the viaducts of a trunk road, and at some places, it crosses or runs parallel with said road. Considering these conditions, we studied the possible impact of the project on the neighboring structures in advance and validated the resistance of the primary lining. From the results of the study, it was predicted that the subsidence of the road viaduct piers corresponding in location to the portion of on-site lining placement, might exceed the reference control level of the starting portal section, but at the portion where the segments were placed be less than said level.

It was also revealed that at the arrival section, there was a

distance of only 1.8 m from the lower end of the viaduct to the top of the lining, and it was predicted under such conditions that the lining placed by SENS on site may produce a stress larger than the resistance, but in the section with segment the stress will be lower than the allowance. From the reason above, it was decided that at both extremities of the tunnel, the lining be constructed

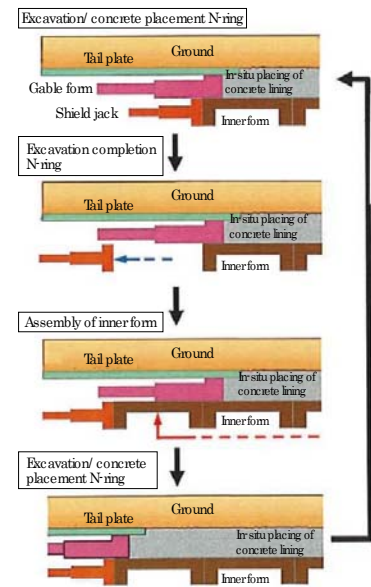


Fig. 1 SENS excavation and placement cycle of primary lining

with segments, and for the remainder of the tunnel, SENS type lining could be used for reasons of economy in the same manner as the construction of the Nishiya Tunnel. For this construction project employing two different methods, we decided to resort to a single shield tunneling machine. This is the first attempt using a single shield machine to change over from the shield excavation to SENS's for the construction of a tunnel.

3. Construction progress

Preliminary construction of the Hazawa Tunnel was completed in March 2016, and then main construction was started in July 2016. The project had already been finished for a 502.8 m section of segment placement at the starting portal section, and in September 2016, arrived at the point to switch from shield method to SENS. The equipment of the shield machine has been changed for SENS tunneling, and since December 2016, SENS excavation is under way.

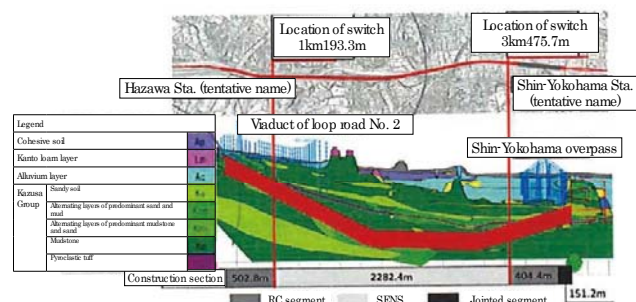


Fig. 2 Longitudinal geology profile of Hazawa Tunnel