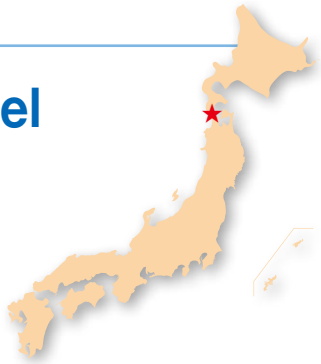
Repairing the Pilot Tunnel of the Seikan Tunnel Tappi Pilot Tunnel Repair Works



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Introduction

The Seikan Tunnel is a long undersea tunnel with a total length of 53 km 850 m. The undersea section of 23 km 300 m consists of three tunnels (the main, working, and pilot tunnels). The deepest part of the tunnel is 240 m below the sea surface and is subjected to strong water pressure of up to 2.4 MPa. The tunnel is used under unique conditions as it is constantly exposed to strong water pressure and inexhaustible spring water from the seafloor. (Figure 1)
Due to the unique environment of the Seikan Tunnel, various measurements have been carried out continuously since its opening. A wide range of items is measured including the displacement of the inner space of the main, working, and pilot tunnels, the amount, pressure, and quality of water inflow, the neutralization and strength of the concrete, and the deterioration of the injection material. Significant changes were discovered at the pilot tunnel, and these changes had to be controlled through various measures, which is reported in this paper.

1. Background to the repair work

The 1km 050m area of the Tappi pilot tunnel showed periodical displacement measurements. From 1993 to 2011, a reduction in the inner space cross-section and a rise in the roadbed (300mm) were observed (Figure 2).

2. Design of the repair work

To fix the reduction in the inner space cross-section and a rise in the roadbed, the effect of rock bolts and invert concrete was verified by reproducing the deformation using numerical analysis. As a result, six rock bolts per section after removing the roadbed concrete was decided the best for minimizing the effect on the tunnel (the amount of internal air displacement).
As a result of the verification, the existing roadbed concrete was removed, and the invert concrete was reconstructed after the rock bolts were placed on the uplifted roadbed concrete. It was decided to manufacture the concrete on site because it took 90 minutes (23 km) to transport the concrete from the aboveground plant to the place where it was placed. Since the tunnel is too narrow to install a plant, the concrete was mixed on site using a small mixing machine. (Figure 3)

3. Conclusion

As a result of the repair work, the work was completed safely without any internal air displacement. Three years have passed since the repair work was completed, and no deformation such as internal air displacement or uplift of the roadbed has occurred.
We will continue to conduct follow-up investigations on the repaired roadbed in the future.

Fig. 1 Outline of the Seikan Tunnel

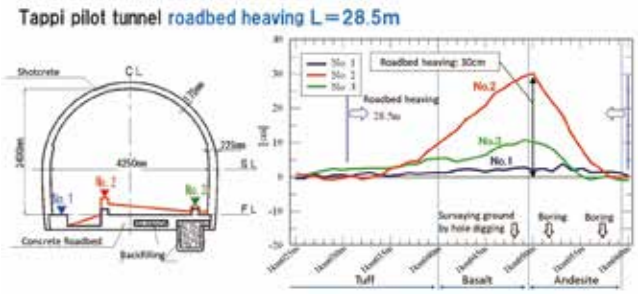

Fig. 2 Roadbed heaving

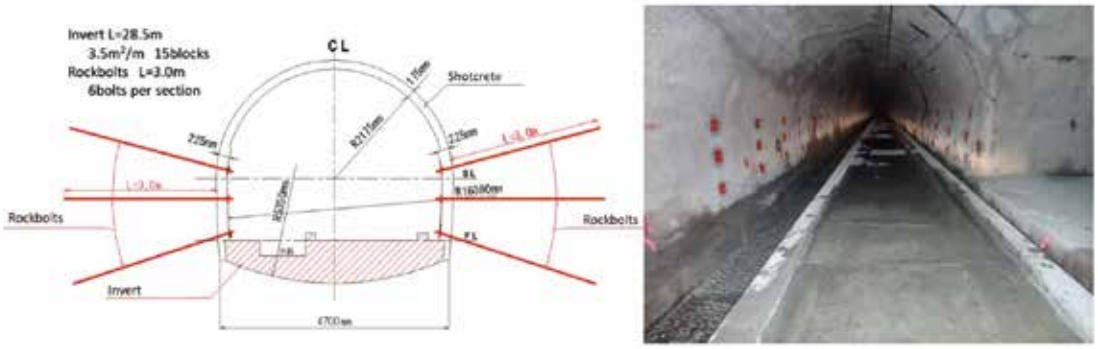

Fig.3 Section of repair works and Construction completion