Neighboring Construction of a Long and Massive Mountain Tunnel's Fault Crush Zone

— The Shin-Hokuriku Tunnel of the Hokuriku Shinkansen —

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1. Introduction

Hokuriku Shinkansen is a high speed railway that covers 690km from Tokyo to Osaka, with about 125km between Kanazawa and Tsuruga stations being under construction. Shin-Hokuriku Tunnel is a 20km long, long and large-scale mountain cross section tunnel for multiple Shinkansen tracks. The tunnel is divided in six zones constructed by NATM (Fig. 1).

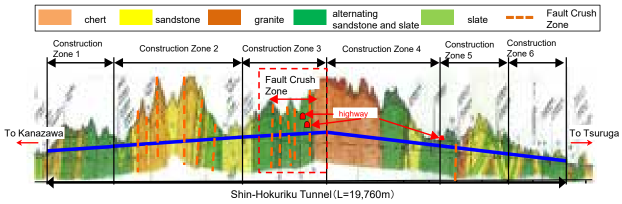

Fig. 1 Shin-Hokuriku Tunnel's Geological Profile

2. Features and Plan of the Tunnel

There are three main geological characteristics of this tunnel. One is "the ground consisting of "complex alternations mainly consisting of chert, sandstone, granite, and slate", and secondly, "multiple faults intersect, resulting in rapid changes of geology", and "ground water accumulates inside the cracks of rocks crushed by the faults". The business requirements, namely the deadline to launch the Shinkansen, has put the construction work under severe conditions such as rapidly finishing the excavation of the fault crush zone while paying consideration to surrounding environment and future sustainable management of the tunnel.

When excavating a fault crush zone directly below an existing highway tunnel for about 40 meters, crushed clay and a high amount of high-pressure water flow into tunnel is found (Fig. 2). So increased carefulness and consideration of safety is necessary in order not to disrupt the highway, which is an important trunk road. Finite Element Analysis (FEA) has been conducted beforehand to assess the amount of settlement and pressure on the lining, along with plans to measure and compare during excavation. In addition to using steel forepiling and long steel face bolt are adopted as auxiliary methods, closure using initial invert within three days after start of excavation is planned so early closure will minimize any influence on the existing tunnel (Figs. 3 & 4).

3. Construction Results

Excavation of the fault crush zone that intersects with the existing tunnel resulted in changed convergence measurement of a maximum of around 100mm. The stress on the settlement and lining of the existing tunnel was smaller than the FEA value estimated before construction. One reason for this is assumed that the various auxiliary methods combined to minimize the influence on the natural ground, and such prudent construction has helped to make the plasticity caused by excavation significantly smaller.

As of October 2019, 96% of the excavation is finished. Though the condition of natural ground rapidly changes, we will keep up the prudent and safe construction work by repeating the cycle of careful forecast at planning stage, measurement during excavation, and post-work assessment.

Fig. 2 Condition of the Fault Crush Zone during Excavation

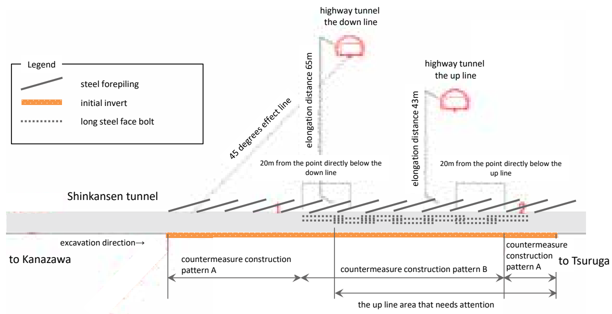

Fig. 3 Excavation Plans Directly under Existing Tunnel

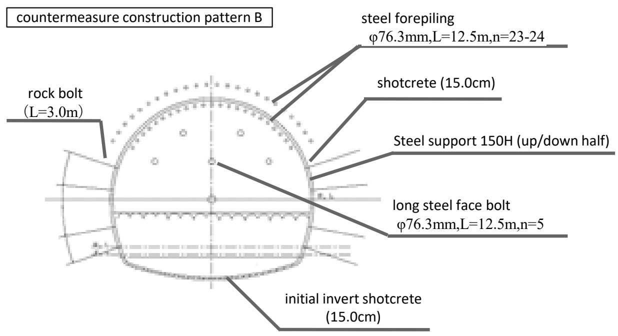

Fig. 4 Excavation Pattern