Excavating Mixed Rock, where Risk of Landslide is High

—South Construction Site of Yoshinomoto Tunnel, Higashikyushu Expressway—

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1. Introduction

The Higashikyushu Expressway is 436km long, with Yoshinomoto Tunnel being 1,880.0m of it. Soil of the area surrounding the tunnel is weak, consisting of disorderly mixed layers of psammite and shale. There were many cases nearby tunnel constructions had difficulty excavating. This tunnel was first planned to be excavated only from the northern entrance, but tunnel support was deformed by natural ground load larger than expected. It took extra time to consider measures to prevent landslides and other issues. In the end, excavation of the tunnel was done from the southern entrance too, for 581.4m of the whole 1880.0m length.

2. Supporting Structure

Excessive natural ground load at the north site made the rigidity of the tunnel support insufficient. Fig. 1 shows the deformation made at the connection point of the invert strut. Data collected from the north site was analyzed and used to re-design the supporting structure of the south. The basic strategy was to allow early closure (Total spray thickness t=250mm, invert strut H-200 along the whole perimiter) and make the cross-section of the invert closer to circular shape than usual. This reduced the concentration of stress in corners and increased the rigidity of the tunnel support (Fig. 2).

Fig. 1 Deformation

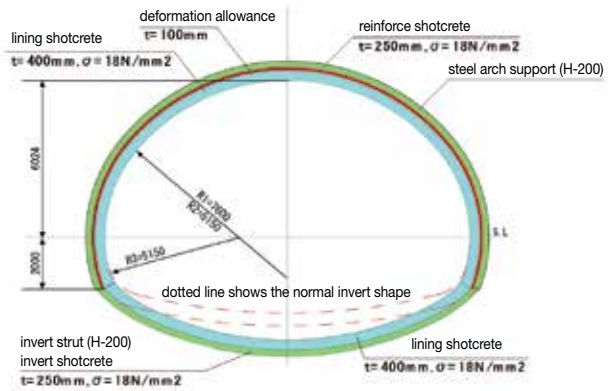

Fig. 2 Support Structure

3. Construction Work to Prevent Landslides

Active landslides were found at the portal of the south site. The tunnel was under the landslide surface (Fig. 3). The method chosen was “counterweight fill works”. During the excavation, long steel pipe forepilling and long face reinforcing were used to minimize loosening of natural ground as much as possible. After the banking was made, the central heading was dug before the main tunnel, for geological survey and monitoring of landslide behavior, as in Fig. 4.

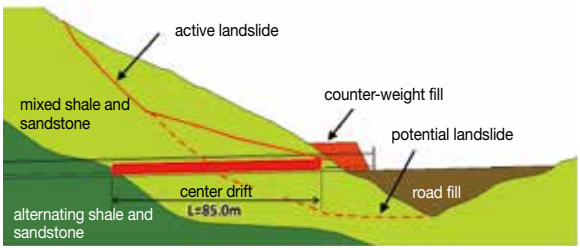

Fig. 3 Geological Profile of South Site Portal

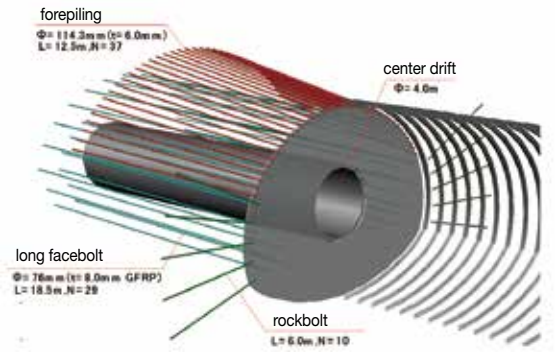

Fig. 4 Summary of Countermeasures to Prevent Landslides

4. 3-D Modeling of Field Observation of Landslide

Ground surface was measured to observe behavior of landslides. Ground surface changes were judged whether they were 1) direct deformation of the ground due to excavation, or 2) could cause active landslides. 3-D models were made from the measurements to determine detailed movement of the whole ground soil for the progress of the tunnel works (Fig. 5). This model showed that no landslides were caused. The excavation was finished safely.

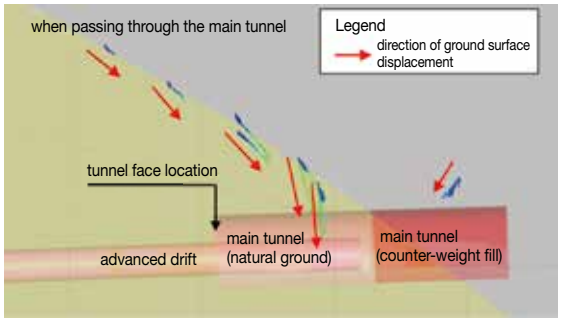

Fig. 5 3-D Modeling of Measurements