Tunneling Work on a Steep Slope Directly Below a Prefectural Road by Utilizing BIM

— Shin-Tomei Expressway Kayanuma Tunnel Construction Work —

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1. Introduction

Shin-Tomei Expressway Kayanuma Tunnel constructed in this project crosses in an east-west direction between Hatano City and Matsuda Town; and extends for approx. 1,350 m (the inbound line of 1357.8m long and the outbound line of 1,350.6m long), and the inbound/outbound lines to be installed in parallel has new four lanes in total. The area surrounding the tunnel portal on the west side is configured by an old landslide terrain consisting of a fault fracture zone of Nakatsugawa fault system and a hydrothermal alteration zone; and Prefectural Road No.710, an important community road, passes directly above the tunnel portal. Thus, as several issues have been identified for the construction around the tunnel portal on the west side of Kayanuma Tunnel, we have utilized the three-dimensional BIM models and visualized the countermeasures (works inside the tunnel and for slopes) for construction work and planning and execution of works.

2. Utilization and Effects of BIM Models

(1) Planning of construction road

By repeatedly conducting field survey by a drone, we have created three-dimensional BIM models for the area around the west side tunnel portal area including construction roads. Creating of the three-dimensional BIM models as shown in the Figure-1, the following effects have been achieved:

1) Reduction of time for on-site measurement;
2) Sharing of final image to non-experts;
3) Improved understanding by workers through clarified work procedures;
4) Improved efficiency in soil volume calculation for cutting and banking;
5) Prior confirmation of slope gradient plan which is difficult to judge by a plan view;
6) Prior confirmation of finished cut oil in view of property border; and
7) Drafting of a safety equipment plan (taking into account of the road shoulder clearance to install a fall prevention fence on the top of slope).

(2) Planning of slope work and tunnel auxiliary construction method

The Figure-2 shows the three-dimensional BIM model for the slope work and the tunnel auxiliary construction method. This figure shows the three-dimensional model from the view point inside the ground. For example, in a conventional tunnel auxiliary construction method for tunnelling, reaching position for AGF and fore-piling driving position have been determined by a two-dimensional cross-sectional view or a plan view. On the other hand, by utilizing the three-dimensional BIM models, we could have made reasonable plans for countermeasures including verification of scope of application of countermeasures against circular slip on the surface layer of slope and tunnel auxiliary construction method, confirmation of the interaction between slope reinforcement and tunnel auxiliary construction method, etc.

3. Summary

By utilizing the three-dimensional BIM models, we have improved the efficiency of construction work, productivity of office work, and safety of construction work in the preliminary construction work and the main tunnel construction work. We expect that the models will be actively utilized in future tunnel construction works.

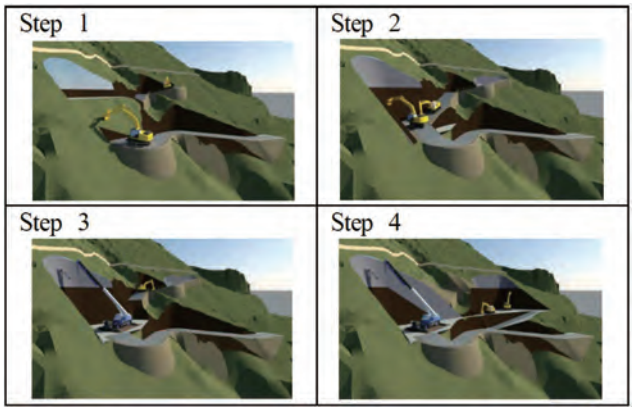

Fig. 1 Three-dimensional model of the construction road

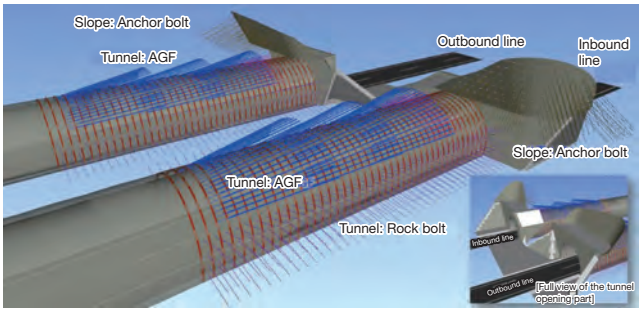

Fig. 2 Three-dimensional model of slope countermeasures and tunnel auxiliary construction method (showing the inside of the ground)

Photo 1 Tunneling for the inbound and outbound lines at the opening on the west side of tunnel