Support Design of River Crossing Tunnel using Keyblock Concept and Its Validation by Monitoring of the Countermeasure by Digital Photogrammetry

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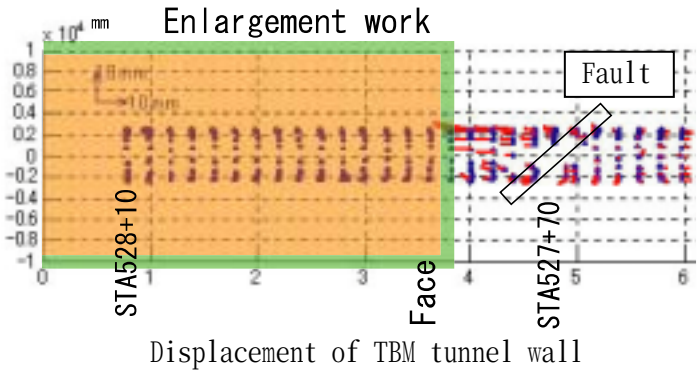
Mountainous sites are increasingly selected for such infrastructure developments as highway or waste disposal plant projects, and the number of works carried out in/on rock masses has increased accordingly. Because rock masses have long been involved in civil works, several good analytical methods have been developed for the evaluation of rock behaviors. However, no effective technique is in place that can perfectly forecast and precisely control the behavior of a group of rock masses that have countless cracks and fragile discontinuities. This paper reports on a research that aimed to develop an integrated technology for controlling civil works in/on discontinuous rock masses, which covers processes from survey, analysis to measurement and combines a block analysis-based design technique with a rock behavior monitoring technique using digital photogrammetry. The block theory is one of the analytical methods capable of dealing with the behavior of discontinuities, which is essentially a 3-D phenomenon, while the digital photogrammetry technique allows mapping measurement targets on 3-D coordinates. Combining these techniques would allow controlling discontinuities from survey to construction processes. Here, these techniques are put into practice in an actual tunneling work, which proved that combining the 3-D design concept with the keyblock analysis, as well as the observation method with digital photogrammetry, was very effective and essential for the evaluation of complex geological conditions.

Suzuka Tunnel was first bored by 5m in diameter TBM and was enlarged to about 250m^2. The tunnel of 17m diameter was designed to pass through under Sosorogawa River and the crown of the tunnel is less than 15m below the bottom of the river. The tunnel excavation may cause rock mass instability in the area and the change of groundwater flow condition could lead to flooding. If any action was not taken, collapse of the tunnel would give considerable impact to the river flow that is important for agriculture in the local society.

Using discontinuity data from TBM wall, we detected some unstable blocks by Keyblock theory. And we designed rockbolts to protect removable blocks. And we planed 3-D monitoring method to verify effectiveness of the countermeasure. We developed digital photogrammetry system to observe tunnel displacement.

The displacement, size and orientation of the rock masses were three dimensionally monitored with this system. A change shown in Figure was detected when the cutting face was approaching the fault (white line), and a discontinuous rock behavior was observed.



Displacement of TBM tunnel wall

Keywords: measurement, keyblock, photogrammetry

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