Groundwater Forecasting® system for on-time groundwater environment prediction

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In the progressive adoption of BIM/CIM for mountain tunneling, a number of face-front investigations such as advanced boring or geophysical surveys have been performed. A 3D geological model can be created from those results for the area near and far from the face. Furthermore, predictive simulations can be done relatively easily by adding parameters (hydraulic conductivity, deformation coefficient, etc.) that represent the properties of the ground (strata) to this information

Groundwater Forecasting® uses a virtual drain model and estimates a groundwater environment on a daily and on-time basis through rapid 3D seepage analysis. Fig. 1 shows an overview of the Groundwater Forecasting® (Groundwater Prediction) system. The system consists of a 'real space (physical space)' and a 'virtual space (cyber space)' as a realization of the digital twin concept. In the real space, the system constantly acquires data of water inflows into the face and monitors total daily inflows. This information is stored in the cloud, and at the same time, fed to AI to identify the hydraulic conductivity of the ground for each observed water inflow. Using this identified hydraulic conductivity, a 3D seepage analysis can daily predict the amount of inflow that may occur in the near future. This enables prior detection of safety risks related to the groundwater, providing various benefits, such as the avoidance of work interruptions by implementing necessary proactive measures including auxiliary construction methods or additional drainage and sealing works.

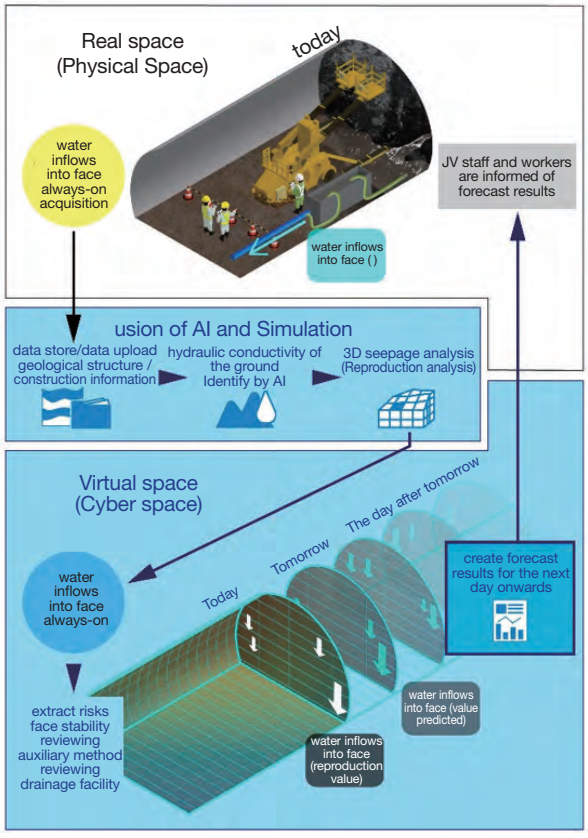

Fig. 1 Overview of Groundwater Forecasting (Prediction) System

Development of the Automatic Optimal Blasting Design and Construction System

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SHIMIZU CORPORATION, FURUKAWA ROCKDRILL CO., LTD. ENZAN KOUBOU CO.,LTD and JAPEX CORPORATION that jointly developed "The Automatic Optimal Blasting Design and Construction System", which automates and seamlessly links a series of operations from rock mass data acquisition to blasting design and drilling in blasting excavation of mountain tunnels(Figure 1).

This system automatically analyzes the geological conditions of the face in cyberspace based on the drilling energy values automatically collected by the fully automatic computer jumbo during the previous drilling cycle, and automatically creates the optimal blasting pattern according to the distribution of hardness and softness of the face. The blasting pattern is displayed on a zone diagram in which the face is divided into five sections, and the optimum number of holes and amount of charge are automatically assigned to each section (Figure 2). Next, the drilling plan corresponding to this created blasting pattern is imported into a fully automatic computer jumbo that can be programmed and controlled. The drilling plan is registered with the drilling sequence without boom interference based on the prior simulation of the drill jumbo boom flow line, thus realizing efficient automatic construction based on the optimum blasting design.

Application of the system resulted in a 69% reduction in the average amount of underbreak and a 41% reduction in the amount of overbreak associated with blasting drilling. The system also reduced the amount of explosives used by 7%. These effects not only significantly reduce cycle time and construction costs, but also improve the quality and durability of the tunnel by smoothing the tunnel excavation surface.

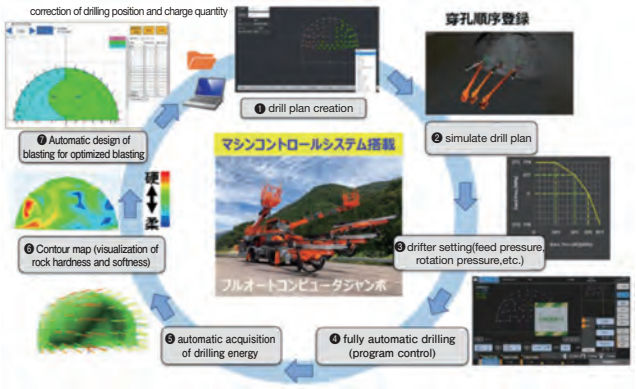

Fig. 1 Workflow of Automatic Blasting Design and Construction System for Optimized Blasting

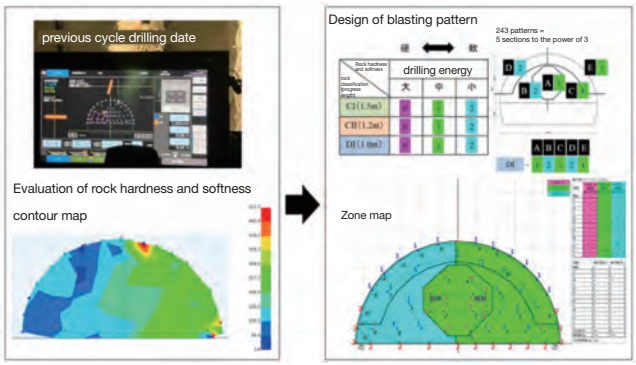

Fig. 2 Evaluation of rock hardness and softness and creation of blasting pattern