

# Remote-Controlled Face Assessment by Digital Transformation

— Kanmuriyama Pass Road's 2nd Tunnel in Phase II —

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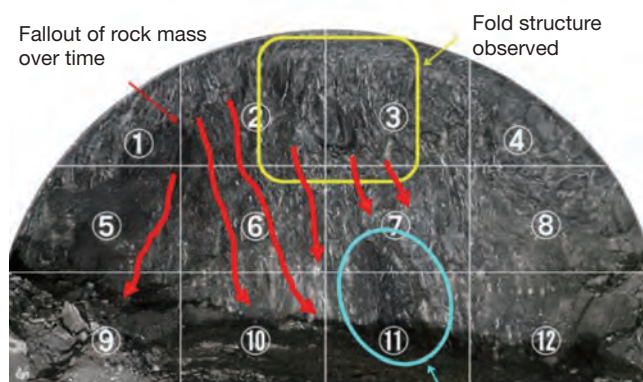


## 1. Outline of the Construction

During mountain tunnel construction, periodic “rock assessment meetings” are held between the contractors and contractees to determine the support pattern for subsequent cycles. The project of Kanmuriyama Pass Road's 2nd Tunnel in Phase II, saw sudden and frequent changes in the mountain conditions resulting in additional burdens on the parties involved with more meetings and suspensions of the construction. For operational efficiency, the contractors considered use of ICT tools and embarked on a trial project of remote observation.

## 2. Verifying the assessment system of remote observation

Prior to the trial, three raters were assigned to verify the difference and accuracy of the evaluation in the remote location and on site. Figure 1 and Table 1 show the face



※ Information transferred from face to remote location

Fig. 1 Face evaluation results (photographic image)

Table 1 Face evaluation results (remote location and on site)

Evaluation results by categories (ground condition and behavior at excavation point)	Evaluation results in the remote location			Evaluation results on site		
	Rater A	B	C	a	b	c
(A) Face condition	222	211	222	221	111	221
(B) Excavation surface condition, unsupported	221	111	222	221	211	221
(C) Compression strength	332	222	222	222	222	222
(D) Alteration by weathering	221	222	222	222	222	221
(E) Crack frequency	332	322	233	332	332	332
(F) Crack condition	332	222	222	222	222	221
(G) Crack configuration	331	333	333	333	332	333
(H) Springwater	112	112	112	112	112	112
(I) Degradation by water	221	111	222	222	111	221
Weighted scores Weighted average scores	2.2	1.8	2.2	2.1	1.8	2.1

Entry in three digits Upper left (hundreds digits), Crown (ten digits), Upper right (ones digits),  
Numbers in red : Score differences (+)

conditions and evaluation results. Conditions were rated on a scale of 1 to 5. Comparing the evaluation results between the remote location and on site, there was a  $\pm 1$  point difference in categories (A) to (G), but no tendencies were seen between the two locations, and the weighted average of the weighted scores was within 0.1. The results suggested that the accuracy of determining the support pattern can be ensured by the remote observation evaluation. However, to ensure validity, one of the three raters were assigned to make evaluations on site.

## 3. Full-scale trial of remote observation

For remote observation, a mobile terminal (i-Pad), a video call application (ZOOM) and a digital field notebook (eYACHO) were used to communicate with the on-site rater. Figure 2 shows the flowchart of the remote observation. The trial revealed the difficulty in recognizing in the images and videos of the bedrock the frequency and condition of fracture spacing, and the display of a scale on the screen of the terminal was suggested to make it easier to identify them at the remote location. The location of water inflow was also difficult to identify, requiring detailed explanations from the on-site workers.

Another issue was the means of communication with on-site workers. Even when the heavy equipment was stopped, conversations with all involved were difficult due to the noise of the blower and electrical equipment such as the electrostatic precipitator. After much trial and error, a self-build sound system with echo canceler function of car audio equipment was developed and utilized (Photo 1).

The remote observation of the “rock assessment meetings” was introduced during the excavation which coincided with COVID-19 pandemic, and this improved the productivity of future construction work and promoted work style reforms and digital transformation.

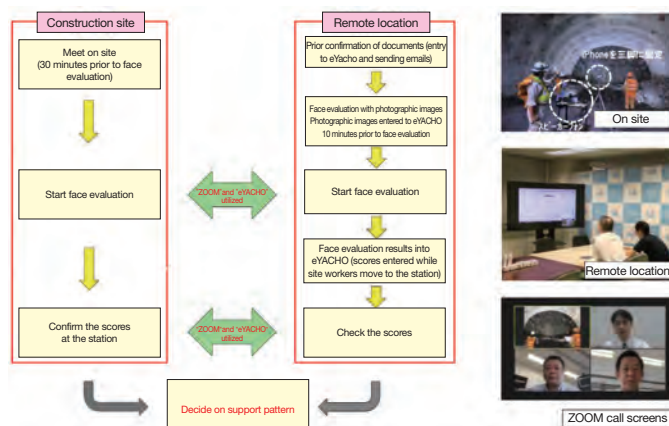


Fig. 2 Remote observation flowchart