Rational Construction Work on the Fissured Ground by Utilizing ICT Technology

— Shin-Tomei Expressway Takatoriyama Tunnel West Construction Work —

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1. Introduction

Shin-Tomei Expressway extends for approx. 253 km from Ebina City in Kanagawa Prefecture to Toyota City in Aichi Prefecture. Takatoriyama Tunnel West construction work covers the construction section on the west side of the mountain tunnel with inbound and outbound lines passing in an east-to-west direction through the southern foot of Tanzawa Mountains in Hadano City, Kanagawa Prefecture, and respectively extending for approx. 3,900 m. This construction section is located on the Hadano City side from the border of Hadano and Isehara cities.
The geological condition of this site mainly composed of tuff / tuff breccia with prominent fissures. Although the rock core in the fissured rock are relatively hard in nature, as the weathered cracks partially reach the rock core and they are open or with clay, collapsing of rock mass along the fragile crack surface were concerned. Thus, overbreak reduction by eliminating bumps on an excavation face affected by the heterogeneity of the ground and the crack properties has been identifed as the issue in this work.

2. Overbreak Reduction in Blasting Excavation of Fissured Rock

As a solution for this issue, we have jointly developed "BLAST MASTER", a system to reduce overbreak, with Sandvik K.K. and ENZAN KOUBOU Co., Ltd.
This technology provides a system which automatically controls / optimizes the insertion angles of outermost circumference holes (drilling angles) according to the size of overbreak occurred by blasting excavation. We have implemented this technology to Sandvik DT1131-JP Tunneling Jumbo as shown in the Figure-1. The overview of BLAST MASTER is as shown in the Figure-2. Repeating of this cycle several time will securely reduce overbreak.

3. Evaluation of the Effect of Overbreak Reduction

Regarding some sections (Cycle 1 ~ Cycle 11) where overbreak reduction effects were obtained, we have organized the average overbreak amount and variations in overbreak amount in chronological order. The results are as shown in the Figure-3.
Cycle 1 shows the result of blasting excavation by a blasting pattern (to be set according to previous experiences, ground strength, etc.) without insertion angle control. Cycle 2 shows the re-evaluated result of overbreak amount after automatic control of insertion angles according to the evaluation of overbreak amount in Cycle 1. These results confirm that repeating of insertion angle control each time after evaluating the overbreak amount can securely reduce overbreak step by step.
Cycle 9 has the least overbreak amount and the average overbreak amount was 5.0 cm. In the last Cycle 11, the average overbreak amount was 7.0 cm, achieving approx. 78% reduction in average from the initial overbreak amount. By securely reducing overbreak and smoothing the excavation surface through the application of this system to the fissured rock mass section, we have been able to prevent the expansion of loosening areas and secure the support stability, and completed the construction work safely without face accidents.

Fig. 1 Sandvik DT1131-JP Tunneling Jumbo

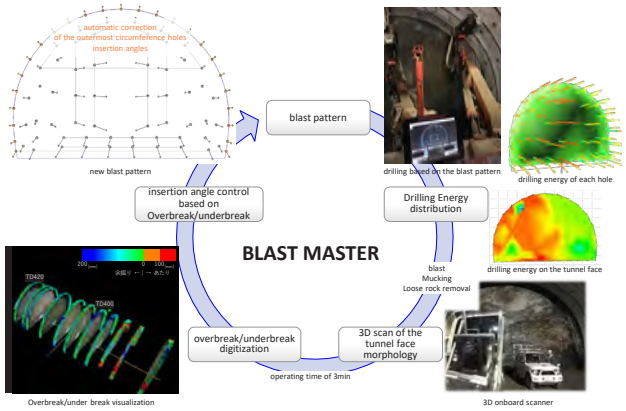

Fig. 2 Overview of BLAST MASTER

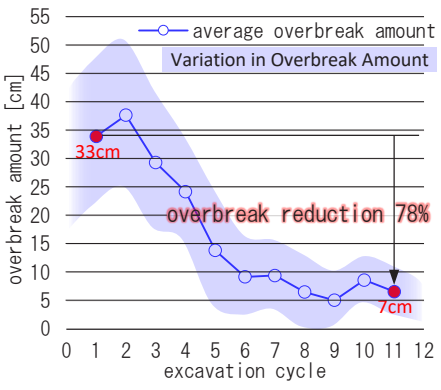

Fig. 3 Effects of overbreak reduction