

Development and Implementation of Automated Construction Techniques Around the Tunnel Face

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Aiming to make all work around the tunnel face (which is accompanied by high risk of accidents such as collapse) during construction of mountain tunnels unmanned, KAJIMA is promoting the automation of all such work by adopting A4CSEL. A4CSEL (pronounced “quad-accel”) is a next-generation construction production system with automatic operation of construction machinery at its core. A4CSEL is based on the concept of operating multiple automated construction machines with few workers in a manner that assures to construction work is performed effectively and safely.

In order to improve safety, productivity, and quality in mountain tunneling, “A4CSEL for Tunnels” automates the six construction steps involved in excavation work for constructing mountain tunnels. It thereby enables efficient, unmanned work at the tunnel face which until now have relied on skilled workers.



Fig. 1 Kajima's concept of “A4CSEL for Tunnels”

We had succeeded in mucking work with an automated wheel loader and shotcreting work with an automated machine by the year 2021.



Fig. 2 Automated shotcreting machine



Fig. 3 Automated wheel loader

To demonstrate the blasting planning technology developed to accomplish “blasting excavation without overbreak” and many other automation technologies developed to date in an environment equivalent to that of an actual construction site, we are trying an industry first by actual excavation of a test tunnel. Through demonstration tests in the field, we aim to automate the six steps in tunneling, namely, drilling, explosives loading/blasting, mucking, scaling, shotcreting, and rock bolting, to achieve unmanned operation around the tunnel face. In this way, we will establish a construction system that achieves a high degree of both safety and productivity by enabling optimal automatic operation.

Slide Loader™: Special Bucket for Safety and Productivity in Muck Loading —Improved Operability for Remote and Automated Control—

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1. Overview

The surplus soil from tunnel excavation is removed by a transport vehicle using a wheel loader. They are placed next to each other and the bucket of the loader is tilted for the soil to be loaded to the transport vehicle. This conventional method, called “side dump bucket mechanism,” requires sufficient space above the bucket and skilled techniques of the operator to avoid contact with the ventilation equipment or lighting. The newly developed Slide Loader™ enables easier and space-saving loading of the soil by moving the blade installed in the bucket horizontally in the discharge direction. (Photo-1)



Photo 1 Wheel loader equipped with Slide Loader™

2. Improved productivity using a larger machine

Compared to the “side dump bucket mechanism,” Slide Loader™ enables soil dumping at a lower position with a larger and higher-performance machine than the regular wheel loader. The increase in the bucket capacity results in less loading time, reduced by about 30% (tested results by Obayashi Corporation). (Figure-1, Figure-2)

3. Improved operability

While the “side dump bucket mechanism” requires the operator to avoid contact with the surrounding equipment, with the simple operating mechanism of Slide Loader™, the risk of contact damage is reduced and skilled operators are no longer needed, helping solve the problem of a shortage of skilled workers. Obayashi Corporation aims to remote and automate the loading operation with further verification of the Slide Loader™.

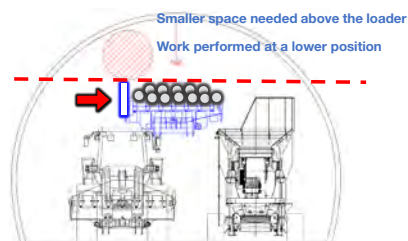


Fig.1 Loading by Slide Loader™

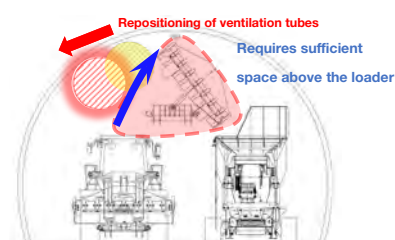


Fig.2 Loading by “side dump bucket mechanism”