

# Automated Construction System for Drill and Blast Tunnels

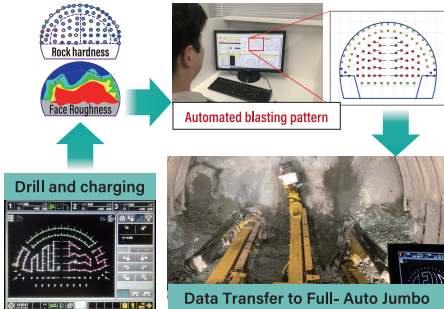
## Technology Automation of 6 steps in drill & blast tunnel construction

Kajima has successfully automated 6 steps in drill & blast tunnel work: "drilling", "charging and blasting", "mucking", "scaling", "shotcreting", and "bolting", so-called, the development of "A<sup>4</sup>CSEL for Tunnel". This achievement significantly enhances its quality, safety, and productivity.

## A<sup>4</sup>CSEL for Tunnel

### Drilling Productivity / Quality

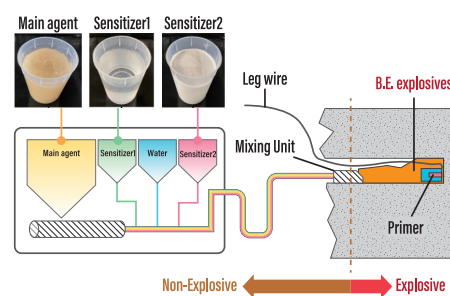
#### Automated optimal blast design system



Based on the data from the rock drilling, the system automatically creates the optimal blasting pattern.

### Charging Efficiency / Safety

#### Bulk emulsion (B.E.) explosives



Bulk emulsion is an on-site manufactured explosive being active only after mixed in the hole. An automated charging with this explosive is currently developed.

### Mucking Safety / Productivity

#### Automated mucking



The wheel loader fully automates the entire mucking process, from scooping up muck at the face to transporting and unloading into the hopper.

### Scaling Safety / Productivity

#### Scaling guidance system



A 3D scanner on the breaker captures tunnel shape, enabling quantitative and automated judgement for over/underbreak area.

### Shotcreting Labor saving / Productivity

#### Automated shotcreting



Concrete is automatically sprayed onto the face using 2 booms, followed by the installation of steel support by the guidance system.

### Bolting Labor saving / Safety

#### 2-boom automated bolting machine

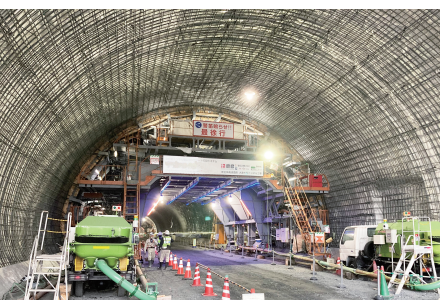


The system automatically performs the whole bolting process, guiding to the position, drilling, mortar injection, and bolt insertion.

## Other automation technologies

### Concrete lining Labor saving / Quality

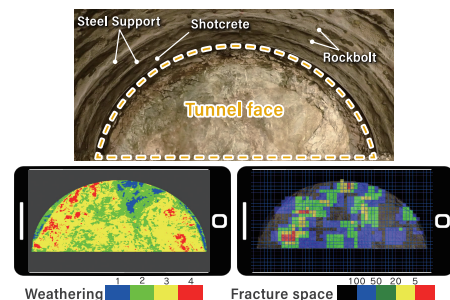
#### Fully automated concrete lining system



The innovative concrete pumping system can automate the formerly labor-intensive concrete lining work

### Survey Safety / Productivity

#### Face picture analysis system / JudGeo



Face photos taken by mobilephone are analyzed to evaluate weathering and fracture spacing and its conditions.

### Auxiliary methods Labor saving / Safety

#### Complete mechanization of AGF method



The steel pipe installation, "AGF (All Ground Fasten) method" are fully mechanized, enabling labor saving and safety.