

Special Feature 1

Machinery Business: The Rock Drill Machinery Segment Helps Develop Social Infrastructure with Machinery for Tunnel Construction

Railways and roads are vital means of transportation in modern society. They also contain many tunnels. Furukawa Company Group member Furukawa Rock Drill manufactures and sells machinery for tunnel construction.



Drill jumbo: Machinery for tunnel construction

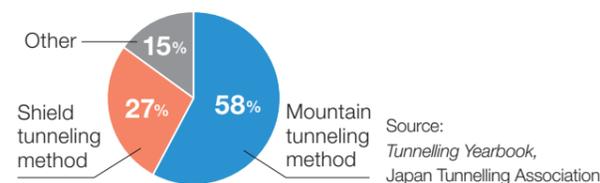
// Drill Jumbos and Robotic Devices that Set Steel Ribs are Widely Used in Tunnel Construction Work

Tunnel construction work is performed differently depending on the soil and other properties of the construction sites. Typical methods include the mountain tunneling and shield tunneling methods. The mountain tunneling method is used where the ground is hard, and the shield tunneling method is suitable for soft ground.

At present, the main form of mountain tunneling is the New Austrian Tunneling Method (NATM), a method of blasting for which Furukawa Rock Drill provides many kinds of machinery. Such machinery includes drill jumbos, which are tunnel construction machines for boring tunnel cross-sections and placing rock bolts, and robotic devices called shotcrete machines, which have

erectors attached for installing the steel frames (ribs) of the inner surfaces of tunnels and spraying concrete onto the surfaces.

■ For reference: Methods used in tunnel construction (FY2020)



// Risk of Industrial Accidents in Tunneling Work

Blasting requires that workers perform their work close to tunnel cross-sections, which are called “faces” and known as places where industrial accidents tend to occur. These accidents primarily occur when areas near the faces collapse.

Boring, i.e., drilling holes in tunnel faces, can also have a substantial impact on safety. Drilling in the wrong place or at the wrong angle can loosen the ground near the face and cause it to collapse. Drilling techniques have a substantial impact on overall tunneling work; for

example, differences between actual and planned blasting locations can add costs.



Illustration of collapse near a tunnel face

// Furukawa Rock Drill's Efforts to Resolve Issues During Tunnel Excavation

① Shortage of Skilled Workers

With a chronically low birth rate and a rapidly aging population in Japan, retiring skilled workers must be replaced with less experienced workers, and youth employment rates are also low. Lack of technical skills and a shortage of people are both issues.

② Ensuring Workplace Safety

Tunneling work accounts for about 0.5%^{*1} of all industrial accidents in the construction business; more than 96%^{*2} of those accidents occur near tunnel faces, which are the front lines of tunneling work.

③ Reducing Costs from the Start to the Finish of Tunneling

Additional costs are generated when construction work does not progress according to plans (e.g. construction schedules, planned excavation ranges, personnel expenses).

Promoting Automation of Drilling Work

Automation of Tunneling Work

Making Progress as Planned by Automating Work

*1 2019 statistics on industrial accidents from the Ministry of Health, Labour and Welfare

*2 2010 study by the National Institute of Occupational Safety and Health, Japan (Steel-rib setting: 43%, Explosive charging: 36%, Excavation: 12%, Spraying concrete: 5%)

// Sharing Information about Issues

The construction companies to which the national government, road and railway companies, and others outsource tunneling work are aware of these kinds of issues; each uses its own method of conveying its requirements to Furukawa Rock Drill at different times, such as when explaining policy at general meetings when the construction work is set to start, or seeking technical guidance on an individual basis. Additionally, the Ministry of Health, Labour

and Welfare has set out safety guidelines for tunneling work (e.g. Guidelines for Measures to Prevent Tunnel Face Collapse During Mountain Tunneling Work).

Furukawa Rock Drill is striving to completely automate the machinery used in tunnel construction to make the work economically rational in addition to prioritizing safety.



// Main Characteristics of Furukawa Rock Drill Machinery

■ Fully Automated Drill Jumbo J32RX-Hi ROBOROCK®



Considering the environment

Out of consideration for the environment, the drill jumbo is equipped with a clean engine that satisfies the 2014 criteria of the Act on Regulation, Etc. of Emissions From Non-road Special Motor Vehicles.

① Programming Computers to Position Boreholes with at Least the Same Expertise as Skilled Workers

- Furukawa Rock Drill added an automatic positioning function to the drilling boom which, coupled with the navigation function that guides the boom in line with drilling plans, enables computer control of automated positioning using the shortest routes.
- Automatic adjustments to the three critical elements of drilling control—impact, rotation, and feed in response to changes in the bedrock—result in smooth, fully automated drilling, vastly streamlining and enhancing the precision of drilling work.
- With this productivity-improving technology, drilling work can even be done by one person.



② Ensuring Safety under Many Different Methods

- The boom is equipped with two large sliding retractable charging cages for improved efficiency and safety of work on tunnel faces.
- The three-stage extendable charging boom was designed to allow work on a supplementary bench up to 4.5 m long, improving productivity in supplementary and incidental work.
- The sensors sound an alarm and work is halted if anyone tries to enter the space between the machinery and the tunnel face during automated operation.



■ Robotic Devices that Set Steel Ribs

① Equipped with a Simple Navigation System for Positioning

The steel rib positioning navigation system, which comprises an automatic tracking total station and more, and the high-performance erector, which is capable of making minor adjustments to the position of the ribs, make it possible for one operator to position the steel ribs.

② Maximizes Reduction of Work in Dangerous Places

Using one-touch quick joints to fasten crown joints,^{*3} and spraying concrete while holding steel ribs in place with pre-installed wire nets and fall-preventing anchors minimizes the need for workers to work near tunnel faces.

③ Increases Work Operations by Leveraging ICT

Innovations such as leveraging ICT to position steel ribs, eliminating the onsite installation of wire nets and the like, and spraying concrete and setting steel ribs at the same time have made it possible to set steel ribs about three times faster than the normal working speed.

④ Improves Working Precision by Leveraging ICT

Furukawa Rock Drill leveraged ICT to improve the precision of steel rib positioning and setting, and eliminated the conventional cut-length joining materials to improve the precision of rib setting in curved tunnel sections.

*3 The work of joining the left-hand and right-hand ribs at the top of a tunnel.

// Future Challenges

Drilling work is now fully automated, but this does not mean that all tunneling work is also fully automated; some work must still be done by hand. Specifically, filling boreholes with blasting powder is done by hand and requires workers to work near tunnel faces as always. Regarding explosive charging work, there are laws and regulations on blasting work and handling and controlling explosives, but partnerships working toward amending the laws are also needed in order to make tunneling work safer.

Manufacturers are also looking to automation to solve two issues with rock bolts, namely safety with regard to mortar injection and some rock bolt insertion work being performed by hand, and, given the long, narrow shape of rock bolts, shortening the time needed to both drill boreholes for and insert the bolts.

Currently it is difficult for Furukawa Rock Drill to solve these issues with fully automated drill jumbos, and thus the company has developed

and is marketing a dedicated machine called a rock bolter for rock bolt work. The rock bolter makes it possible to perform the series of tasks from drilling and mortar injection to rock bolt insertion from the operator's deck, with no manual procedures.

Meanwhile, on the issue of safety for robotic devices that set steel ribs as well, there is still work that must be done by hand. For example, if we can automate the fastening of crown joints using one-touch quick joints, we could completely remove the need for workers to work near tunnel faces for rib setting, eliminating the cause of 43% of accidents in tunnel construction.

Furukawa Rock Drill intends to continue advancing the frontiers of automation technology with the aim of improving safety and productivity.

Comments from Key People

We have advanced mining development technology since the Group's founding in 1875. Currently, our technology is being used in the construction of tunnels, an essential social infrastructure.

We believe that our Group's strength lies in the fact that we have developed technology that we have passed down since the company's founding, and established technology distinct to the Group. We have passed down excavation technology, and continue to use our own technology to manufacture nearly all parts of the drifters (rock drills) that form the core of our rock drills. This is an excellent strength to have in the rock drill business.

A major source of our motivation is the fact that we can actually see and use tunnels and other infrastructure constructed in public works projects using our Group's machinery in everyday life.



Furukawa Rock Drill Co., Ltd.
Left: Susumu Murakami, Deputy General Manager, Tunneling & Mining Equipment Department, Marketing Division
Right: Yoichi Koroku, Principal Engineer, Life Cycle Support Division/Deputy General Manager, Takasaki Yoshi Works