CS-218 Development of Auto Bolt Setter (ABS) for Reinforced-cutting Method -Improving Rockbolts Inserting Equipment -

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1. Preface

The reinforced-cutting Method is a construction method to reinforce earth with the tensile strength of rockbolts, by installing the rockbolts, in the earth. When excavating slopes with a normal gentle gradient, the side of slopes have become too long and large in recent earth-cutting work in mountainous districts, causing the problem increasing construction work with an increased volume of excavation earth. Demand for the Reinforced-cutting Method, which makes a steep slope, is tending to increase to solve this problem.

The Reinforced-cutting Method aims to reduce construction cost, however, the method includes a lot of manual work in comparison with heavy excavation equipment, and low working efficiency was the problem.

The "Auto Bolt Work Method" was developed to solve this problem, and to reduce total construction cost. This method uses a special mobile bolt-setting machine "Auto Bolt Setter (ABS)", to mechanize and automate a series of work from drilling and grouting, to inserting, to build the cutting reinforced earth.

The ABS had already been developed to perform this working method; however, an "Improved type ABS" was developed to further improve working efficiency. This paper reports on this "Improved type ABS".

2. Outline of ABS

The ABS consists generally of three components: of Base Machine, Guidepost, and Automatic Setting Equipment, as shown in Fig. 1

A 0.9 m3 class hydraulic shovel was used as the base machine of the ABS. The machine is also used as the power source for automatic setting equipment etc. The guidepost, which serves to move the automatic setting equipment along the gradient of a slope, is installed with upper and lower supports, which make the weights of automatic setting equipment and guidepost supported on the slope.

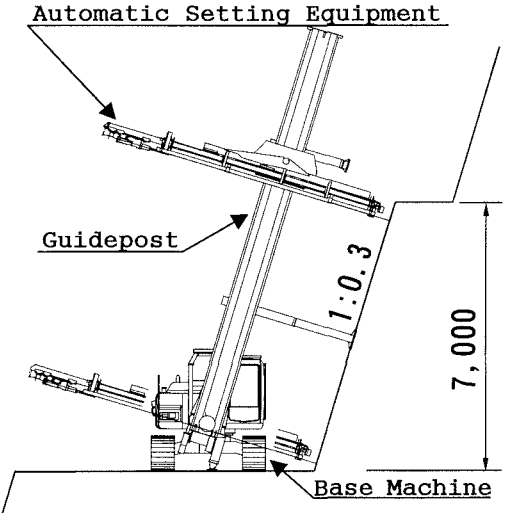

Fig 1 ABS

The working procedure with the ABS is explained in the following. ① Move the ABS to the work site, make the base machine parallel to the slope. ② Set up the guide post, checking the indication of the tilt-meter, to ensure it is perpendicular to the slope as viewed from the front face of the slope. ③ Swing the guide post, checking the tilt-meter, to match the slope. ④ Extend upper and lower supports, and have them supported by the earth. ⑤ Rotate the automatic setting equipment to the prescribed angle, while checking the angle of the tilt-meter, and move it to the prescribed position. ⑥ Drill the hole with the drifter. ⑦ After drilling, changeover the valve, and pull out rod while injecting the grout through the rod up to the port of the hole.

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⑧ After grouting is completed, insert rockbolts into the hole using inserting equipment. ⑨ Move the machine to the next setting position, while maintaining the angle of automatic setting equipment. ⑩ After completion of setting along a vertical row, draw in the the support, and erect the guidepost. ⑪ After moving to the next row, repeat the same work.

3. Improved Point of ABS

It can be found that the efficiency of the process of grouting and inserting rockbolts (especially in rockbolts insertion work) using the Auto Bolt working method is lower than in the case of conventional work. Faced with this fact, a method of improving workability by improving of the inserting equipment was studied. Bolt insertion work had been performed by the ABS as follows. Remove the drill rod from the drifter using equipment called a rod changer, have the drill drifter grip a rockbolt, insert the rockbolt in the drilling hole, then attach the drill rod again to the drifter. This process required more time. In the improved machine, this work is eliminated and workability is further improved.

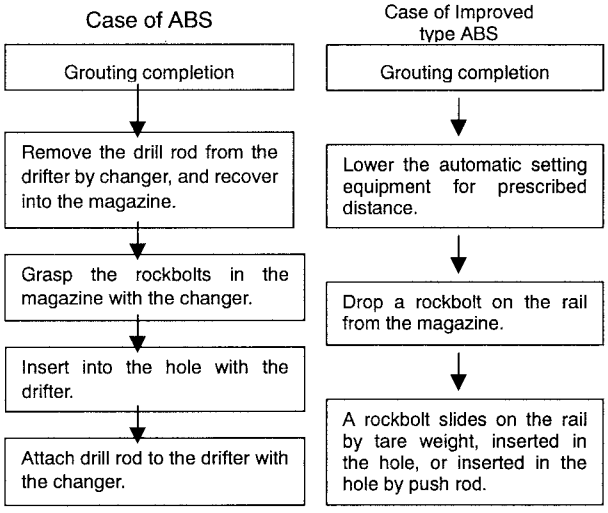

Fig.2 Comparison of Inserting Operation

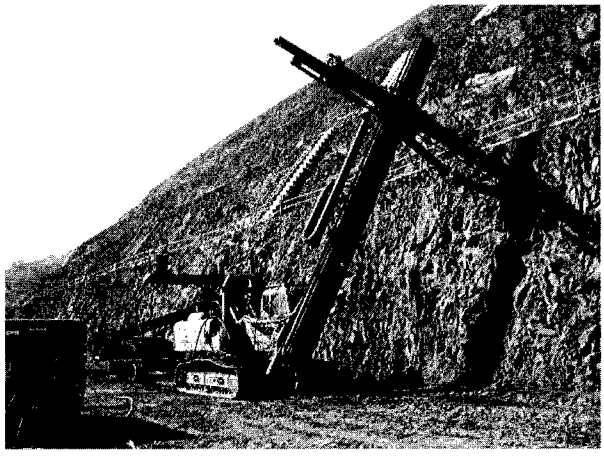
Photo.1 Example of Work Execution

4. New Insertion Equipment

As shown in Fig.2, ABS does not move automatic setting equipment when inserting rockbolts after the drilling and grouting work are finished. Therefore, a process for separatiing and attaching the rod is required to exchange a rockbolt and rod, causing problems of wear at the rod-attaching part and reduced working efficiency. In view of this fact, inserting equipment and drilling, grouting equipment are separate mechanisms, to eliminate the process of separating and attaching the rod in this newly developed equipment. The insertion equipment can be slid automatically for a certain distance by operating a button after the finishing drilling and grouting operation, to match the insertion equipment with the bored-hole level. A guide rail is arranged under the "bolt magazine," which is able to load plural rockbolts and to drop the rockbolts on the rail. The rockbolts slides on the sloped guide rail on their own weight and are inserted efficiently into the hole. Further, a "push rod," which can push the rockbolts from the back when the rockbolts cannot be inserted under their own weight is installed. A "bolt clamp," which can hold and adjust the location of rockbolts, if the position of rockbolts is out of the hole, is also installed.

5. Conclusion

Several work execution results have so far been achieved with the ABS, however, it is hoped that further improvements to workability and reductions of construction cost will be achieved in the future by applying this improved ABS, and increasing work execution.