

Unattended Construction Work on the Slopes of Mt.Ohnagi Excavating Work by means of Rock-climbing Machine

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1 .Works by means of Rock-climbing Machine

Performance evaluation on the hillside work implemented on the slopes of Mt.Ohnagi last year shows that the efficiency of excavation work was $5.36\text{m}^3 / \text{day}$ at the maximum.

It will take five of them 172 days to excavate $4,600\text{m}^3$ in this year. The work period might be reduced to 82 days if the work force could be doubled. It was however virtually impossible to deploy more than ten workforces at the site because of high risk of slope failure. Specific method for excavation by means of rock-climbing machine was employed in order to shorten the work period. The rock-climbing machine has been used in Tochigi prefecture and is proved to be efficient.

The advantages of the rock-climbing machine are to make;

- 1) working environment safer --- automated excavation work requires no manual labor
- 2) a work period shorter --- because of higher efficiency than simple hand excavation
- 3) a work more cost-effective --- because a site-specific machine is available

A 03-type machine which excels in excavation capacity, $127\text{m}^3 / \text{day}$, was employed. As a result, it was estimated that the excavation work took only 36 days.

2 .Rock-climbing Excavation Machine

The construction sites in Japan are, in general, featured by unfavorable conditions such as steep slopes and fractured rock. Excavation works carried out on steep slopes are therefore human intensive. Rock-climbing Excavation Machines had been developed in response to the needs in the construction market in Japan.

A rock-climbing excavation machine is originally a radio-controlled power shovel. It is, in order to enable it to do excavation work on steep slopes, equipped with a specific mechanism to keep the engine horizontal and a winch system. An operator can drive it and monitor the progress of works by remote control standing at a safer site. Furthermore, it is able to move up and down freely using the winch system so that excavation work on long steep slopes can be done much more safely and efficiently than simple hand excavation. In the case of excavation work at higher positions and on wide

slopes, it is required to set up anchor piles to help the machine move lengthwise and crosswise. It is therefore much more advantageous, from financial point of view, to do simple hand excavation.

The work sequence of this method is as follows (Figure 1);

- 1) put anchor posts at the top of the slope,
- 2) tie the rock-climbing machine to the first anchor post by wire
- 3) drive the machine by pulling the wire
- 4) move the machine and wire to the second anchor post.

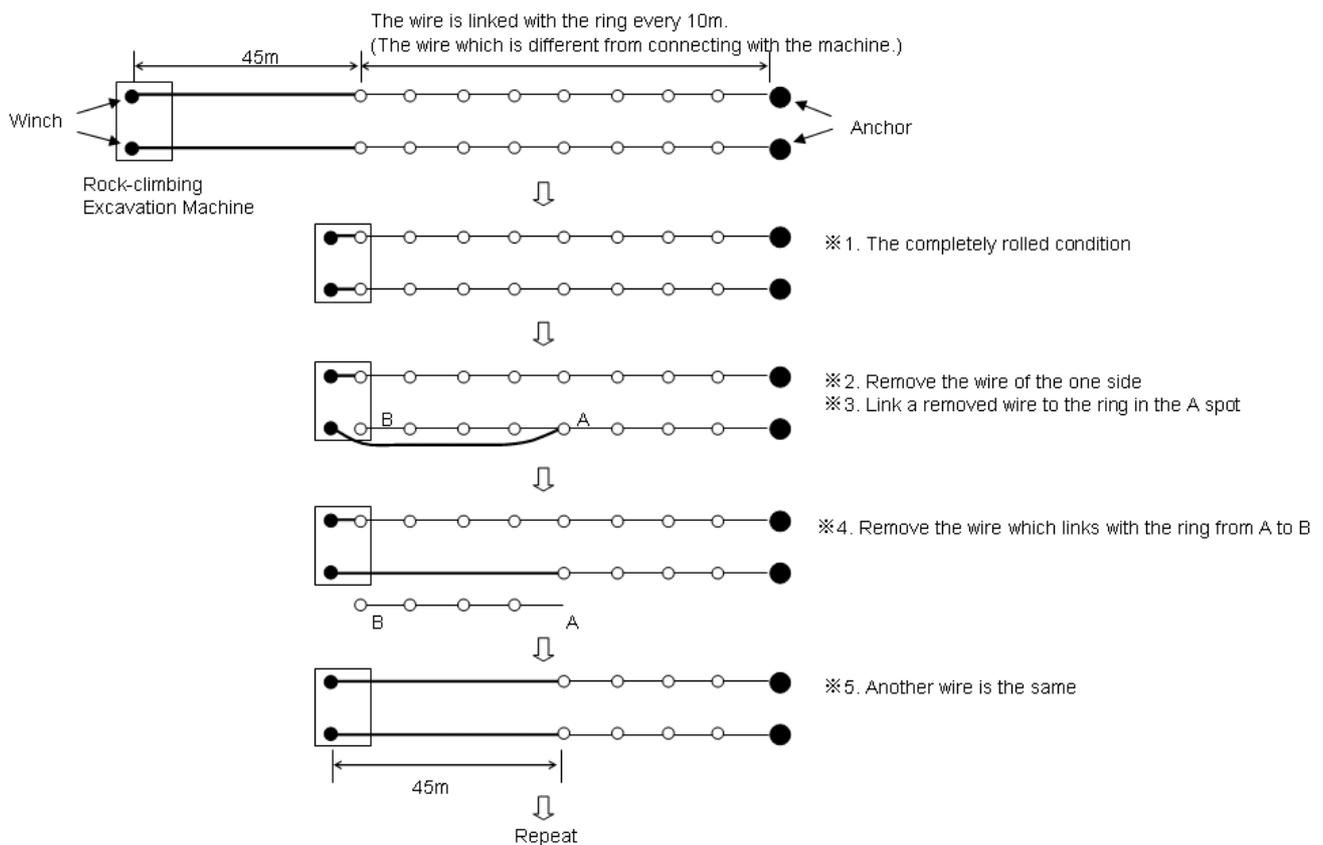


Figure-1 The climbing schematic

The rock-climbing machine is hitched to a pair of anchor posts by two main wires each of which is composed of units of a ling and a 10 meters-long wire. A pair of 45 meters-long wires are attached to the lower end of the main wires and work as the tow apparatus driven by two winches as illustrated.

The machine can continue working within a single leg, a 45 meters long. As soon as it completes excavation work, another pair of upper 45 meters-long main wires are replaced by the tow wires in order to elevate the machine. Thus, another upper leg of the slope can be excavated. This cycle of operation is repeated to the anchor post at the

top of slopes. This operation requires one winch operator and another worker for operations such as wire replacing and monitoring practices on slope materials and workability of the machine.

Table-1 Models of Rock-climbing Machine

Model	RCM01	RCM03	RCM06
Gross Weight	1,620 (1,650) kg	5,670kg	8,775kg
Overall Length	5,200mm	5,200mm	5,900mm
Overall Height	2,500mm	3,030mm	3,080mm
Overall Width	1,000 (1,200) mm	1,980mm	2,780mm
Ascent Grade	0 ~ 80 degree	0 ~ 80 degree	0 ~ 80 degree



Photo-1 Excavating Work by Rock-climbing Machine



Photo-2 Seeing from the upper part of the slope

3 .Challenges required

The rock-climbing machine has been used for the three projects at Ohnagi, Hanyazawa and Inarigawa and, as a result, a lot of experiences were acquired and lessons were learned.

It is necessary for us to prepare standards for safety management, machine model selection in accordance with the size of slopes and excavation volume.