TECHNIQUE FOR REMOTE MONITORING OF LANDSLIDES AT RISK OF SECONDARY DISASTER

DEVELOPMENT OF TARGET CAPSULES AND REMOTE SETTING UP TARGETS FOR NONPRISM TOTALSTATION

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INTRODUCTION

Sediment deposited at the foot of landslides stabilizes them temporarily, but removal of such sediment when installing emergency measures requires extra caution to avoid reactivating the landslide. It is therefore necessary to remotely monitor the movement of landslides to avoid secondary disasters for safety reasons as well as for reliable monitoring.
One of the main remote monitoring methods is to use a non-prism type optical theodolite, which is useful for measuring the ground displacement from observation stations because no measurement target is needed. However, the measurement error may be higher than that of an optical theodolite that uses targets, and measurement at night is extremely difficult. To overcome these problems, in this study we developed a new method of remotely setting up targets for an optical theodolite from landslides.

REMOTE MONITORING METHOD

The new method uses a crossbow (Fig.1). By launching an arrow tipped with a capsule containing rose-color painted glass beads of 50 micrometers in diameter, the target on the hill slope is marked when the arrow strikes the ground. The target shows high laser reflection due to the glass beads and increases visibility from a long distance. The crossbow was specially developed for this study.

FIELD TEST

A field test was carried out at a dam site to check the performance of the new monitoring method. The riprap of the rockfill dam was a suitable substitute for a failed slope because we could check the conditions of the targets on the slope by approaching or entering the slope safely.
The results of the field test were as follows:
1) The crossbow could set up targets with an error of ±50 cm at a distance of 300 m.
2) The laser beam reflection at the target points was higher than that at other points.
3) The target points could be measured by theodolite at night.

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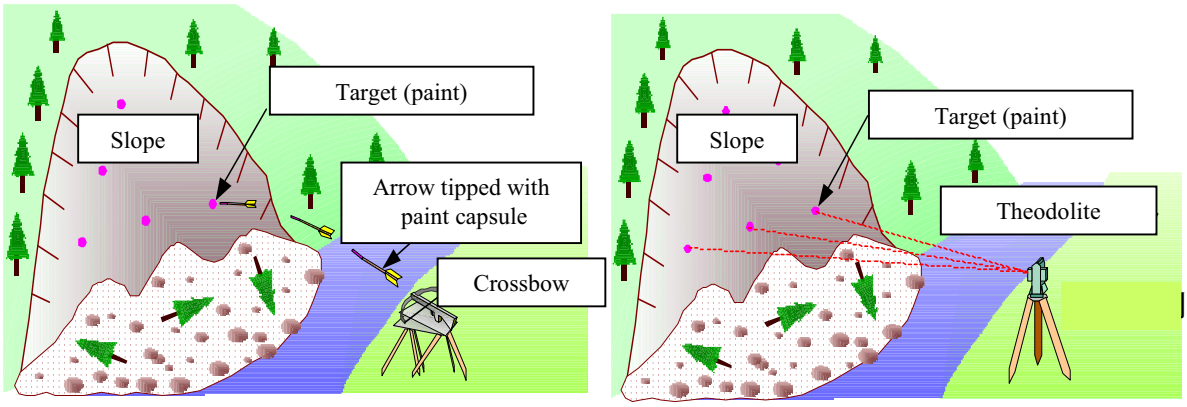

Fig. 1: Schematic diagram of remotely setting up targets and monitoring the landslide

EXAMPLE OF PRACTICAL USE

The new monitoring method was applied to an actual failed slope at risk of secondary disaster. The slope failure had occurred at a stone pit and the resulting sediment needed to be removed. The removal work required remote monitoring to ensure safety and it was dangerous to enter the slope to set up theodolite prisms, so the new method was used (Fig.2).

As a result, the measurement accuracy was found to be higher using the new method than a non-prism type theodolite without targets.

Furthermore, as a result of application of new method to unstable vertical cliff also, it was possible to set targets up and measure without special climber installing prism (Fig.3).

We will further improve our method to help establish safer monitoring systems under emergency dangerous situations where direct monitoring is not possible.

Entire view of failed slope | Location of target on slope | Installed target

Fig. 2: Circumstance of setting up targets at failed slope (Stone pit in Okayama Pref., Japan, 2007)

Entire view of vertical cliff | Setting target up by Crossbow | Observation of targets in cliff

Fig. 3: Circumstance of setting up targets at unstable vertical cliff (Ishikawa Pref., Japan, 2007)

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