An Automated Monitoring System on the Yamaji Landslide

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1. Introduction

As a result of the rock slide taken place at the location of Yamaji, nearby residential area was at risk of subsequent landslide. An automated monitoring system was installed in order to secure safety of the residential area and the project site for land slide prevention.

2. Topographical and geological conditions of the area of the Yamaji landslide

The Yamaji landslide is located on the slope of the hill of Mayu which is situated in the center part of Tokushima city. The slope facing the north consists of green schist of the Sanbagawa metamorphic belt which is dominated by northward inclined segments. The slope is therefore vulnerable to landslide.

3. Rockslide

The earthquake named "Tottori Prefecture West Earthquake" took place on October 6, 2000 and jolted, crossing the Seto Inland Sea, the area of Tokushima city, too. The seismic intensity was 5 lower on the Japanese earthquake scale.

The earthquake and subsequent rainfalls triggered a rockslide of which size is 60m high, 25m wide and 6 to 7m deep and had hit an apartment house and a parking lot located at the toe of the sliding slope.

4. Destabilization of the slope

The sliding slope was destabilized because of an erosion which had taken place at the toe of the sliding slope. As a result, a sliding surface was cropped out and a lot of cracks were identified on the surface of the slope. Tension meters put on the slope and crossing the cracks showed considerable displacement.

All the data on the displacement clearly showed imminent danger of destabilization of the B-2 and B-3 blocks of the sliding slope and further sliding of destabilized rock mass. Closer monitoring and disaster prevention works were needed as shown in Figure-1.

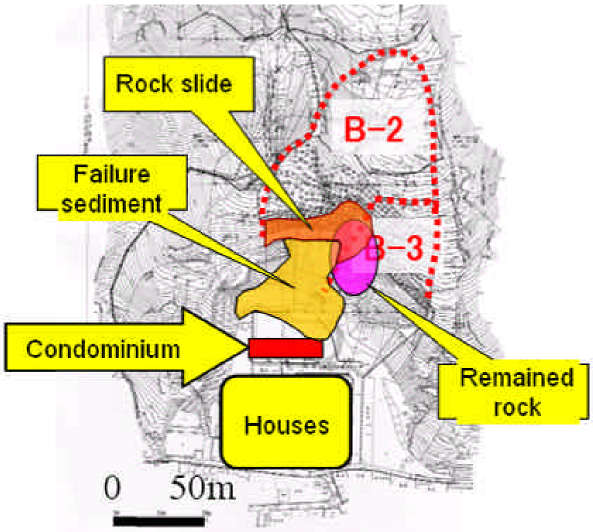

Figure-1 Location of the landslide and its block division
Area of rockslide, Collapsed material, Apartment building, Housing lots, Residual rock mass

5. Outline of the landslide prevention works

Based on the analysis making the most use of the data acquired by boring, it was decided that a specific measure which could ensure 3486.9kN/m of resistance force was required. Anchoring work was selected as the preventive measure.

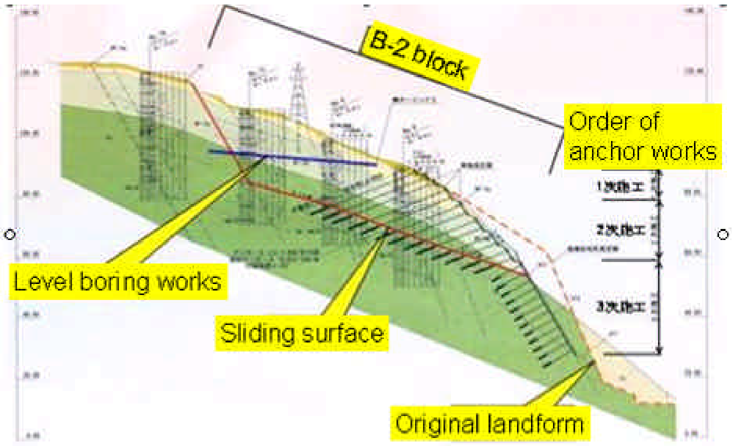

Figure-2 Longitudinal section of the slide (Anchoring works, 13 rows, Σn= 440)
Sliding mass, Order of the anchoring work, Horizontal boring, Sliding surface, Initial landform

6. Monitoring practices on the displacement on the slope

Monitoring practices on the displacement on the slope is important in order to secure safety of both the residential area and the work site in which the anchoring work was implemented.

For this purpose, a Realtime Monitoring System (RMS) which enable the people concerned to make closer monitoring and to give warnings in case of emergency was set up. RMS was also used for monitoring practices on load pressure for the anchoring works.

The RMS consists of the key station, four (4) tension meters, eight (8) load meters, one rainfall gauge and one camera. Each device has a wired connection with the key station at which field data are displayed once every 10 seconds. A warning signal is issued as soon as field data exceeded designated value by means of internet and cellular phone.

Photo-1 Anchor load meter (left) and tension meter using strain gauges (right)

The RMS transmits the field data, through internet, once every 10 minutes so that people concerned can use the data on a 24 hours basis.

Load to anchors can fluctuate depending on temperature of the air, ground and bearing plate. RMS is also used to monitor the changes in load to anchors. Unfavorable change, if any, can be identified by means of camera built in the RMS through internet.

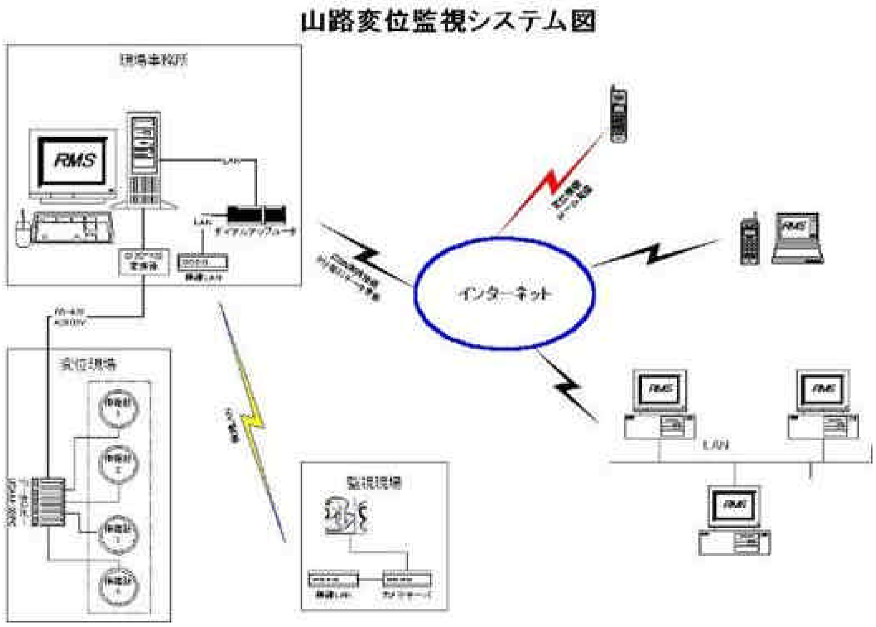

Figure-3　Diagram of the RMS

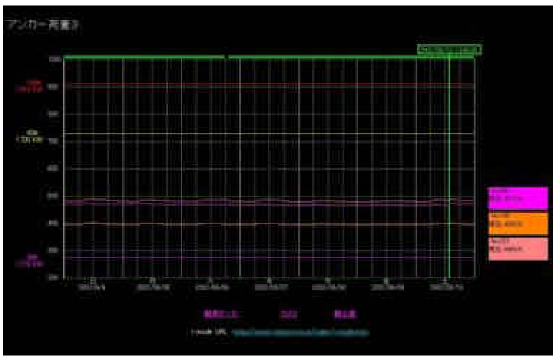

Figure-4 Screen of Internet (load meter)

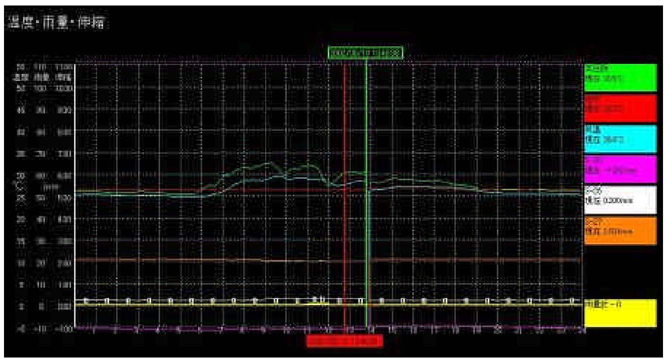

Figure-5 Screen of Internet
(rainfall･temperature･tension meter)

7. The Effects of RMS and future program

After the completion of the anchoring work, monitoring practices on the effect of the anchors and the changes in stability of the landslide are underway. The RMS will therefore stop functioning as soon as the effects of the anchoring works are identified.

The RMS has advantage to incorporate various sensors depending on field conditions and demands of a project. The RMS is therefore widely applicable to projects which require the automated remote control function.

※Translated from Journal of Japan Sabo Association, Sabou to Chisui, Vol.168, pp.47-49, 2005