

Report of Monitoring Surface Displacement on Primary Landslide with the Ground Tiltmeter using Accurate Tiltensor

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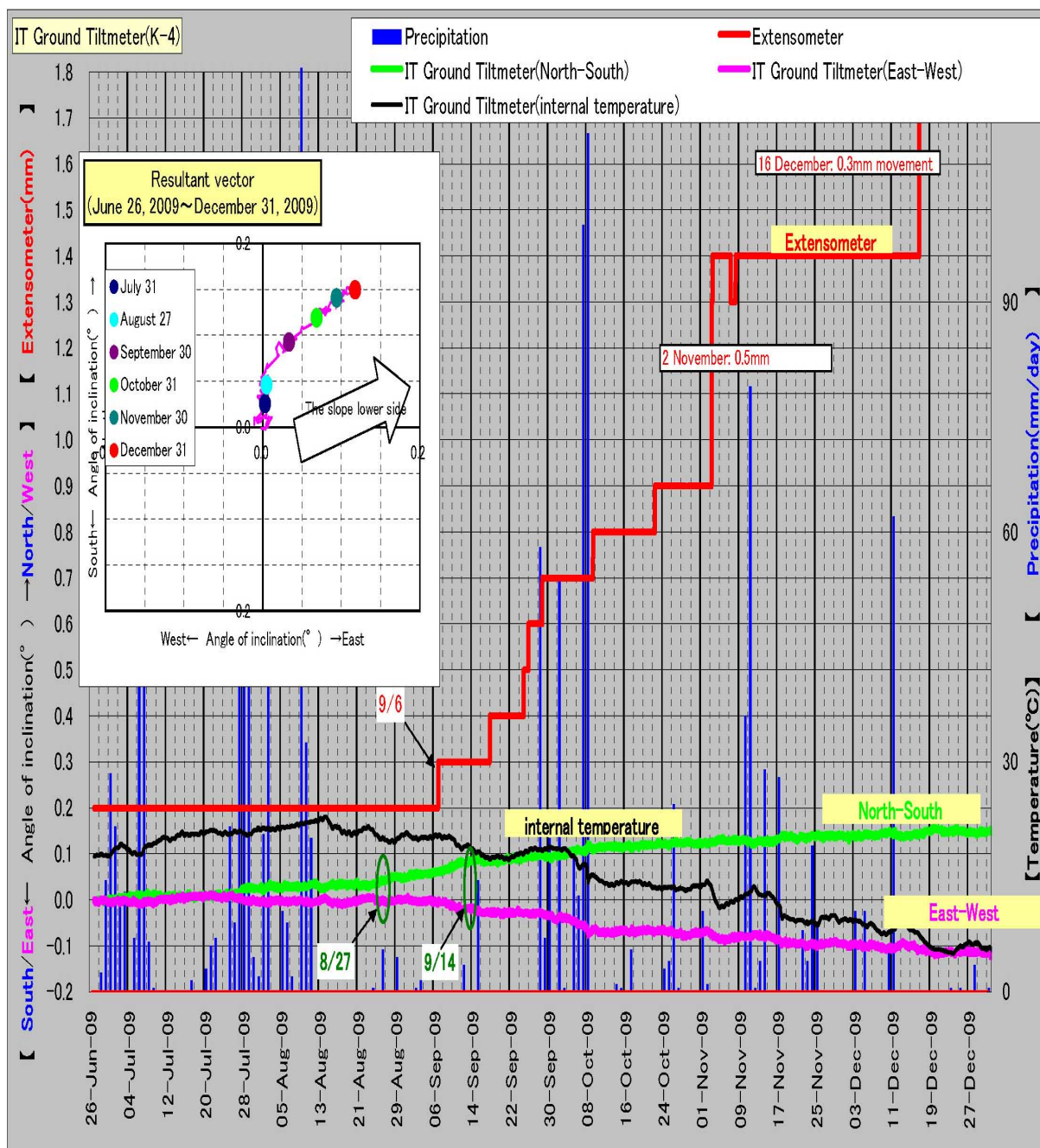


Fig 1 Result of observation of IT Ground Tiltmeter and Extensometer

An endless series of slopes without a history of sliding have suddenly collapsed, with destructive results. To prevent or mitigate destruction caused by such primary landslides, initial minute motions must be accurately sensed and later large sliding predicted. But because primary landslides are not revealed by clear landslide topography, it is difficult to reliably identify them, and measuring technology is still not established, so there are many unclear points concerning this motion. PWRI installed the IT Ground Tiltmeter System, that has been developed through joint research with Akebono Brake Industry Co., Ltd and Kawasaki Geological Engineering Co., Ltd (below, "IT Ground Tiltmeter") to measure tilt of surface layers of a primary landslide. This resulted in minute motion suggesting the progress of creep deformation; a phenomenon which is a precursor of a primary landslide. The following is an outline of this test.

An IT Ground Tiltmeter is an embedded type equipped with an accurate tiltsensor which detects gravity acceleration direction. Its features are: (1) ability to measure many areal points by linking up to 100 sensors to one data logger, (2) large measurement range of $\pm 20^\circ$ and precision of $\pm 0.01^\circ$, (3) remote monitoring ability using cell phone circuits, (4) and rapid installation ability simply by inserting and fixing the sensor in a single pipe poured on site.

The survey site was selected by a topographical reading using aerial laser scanner data. It is in a region where many primary landslides have occurred in recent years, and where Cretaceous Shimanto Group with steep topography formed by river erosion action is distributed. At the test site, ridge topography is enclosed between talus slopes, collapsed topography etc., and there are gentle gradients at the top of slopes, so it is a rock slope where, presumably, creep deformation has loosened mountain sides.

The IT Ground Tiltmeters were installed at a total of 5 locations: at 4 locations in the loosened range, in other words, near the immobile posts and mobile posts of ground extensometers already installed at the top of predicted primary landslides, and at 1 location on the slope behind the primary landslide.

The results of measurements by IT Ground Tiltmeters installed within the primary landslide site are shown in Figure 1 along with the results of ground extensometer measurements. According to this figure, minute motion showing cumulate tilt towards the bottom of the slope was observed in the IT Ground Tiltmeter Data beginning August 27. And beginning on September 14 when the accumulation speed slightly fell, almost stable displacement was continually observed, identifying progress of creep deformation of the mountain side.

And another characteristic of these observations is that the motion shown by the IT Ground Tiltmeter was sensed before displacement was obtained by the ground extensometer. A tiltmeter (observes tilt of ground surface), which can measure accumulation of fine displacement earlier than a ground extensometer (measures horizontal motion of ground surface) which shows displacement trends in stages, is assumed to also be a superior way to measured creep deformation which continuously shows fine displacement.

To predict change of a primary landslide, its motion must be accurately clarified, so continued performance of this measurement is scheduled. The results obtained in this way can contribute to the "development of monitoring systems for primary landslides", which has still not been established, and to the "understanding of the mechanism of origination of primary landslide movements."

Keywords: Primary Landslide, Creep Deformation, IT Ground Tiltmeter System, Accurate Tiltsensor