Subsurface Movements Monitoring By Inclinometer

Introduction

Inclinometers are used to monitor subsurface movements of earth in landslide areas and deep excavations. They are also used to monitor deformations in structures such as earth retaining wall, dams and embankments.

The inclinometer's casing (that was installed in the Earth retaining wall or in soil) has a groove for guide the inclinometer probe wheel that put in. Inclinometer probe is a Gravity-Sensing transducer that measure a tilt or inclination of a probe (also guide casing) reference to the Gravitational line of the earth. By knowing a tilt angle and probe length, a lateral profile of a guide casing (also Earth retaining wall or soil) can be calculated.

The first survey establishes the initial profile of the casing. Subsequent surveys are compared to the initial. Changes in the profile indicate that movement has occurred.

Objectives

- To monitor the lateral movement of the inclinometer tube. This Inclinometer tube can install in a soil or structure to measure lateral movement of a soil or structure.
- Confirm the design of temporary soil protection system.
- Advance warning system of lateral movement

Equipment

The following equipment will be used :

- The inclinometer system consisting of probe suspension/control cable, readout box, casing and data reduction software
- The inclinometer 's casing for use with the inclinometer probe will be manufactured from ABS plastic. It shall be self aligning and will have four internal orthogonal grooves, precisely manufactured to fit the wheel dimensions of the inclinometer sensor.
- The grooves are spaced on the inside circumference of the casing at 90° to from a symmetrical relationship between successive casing sections.

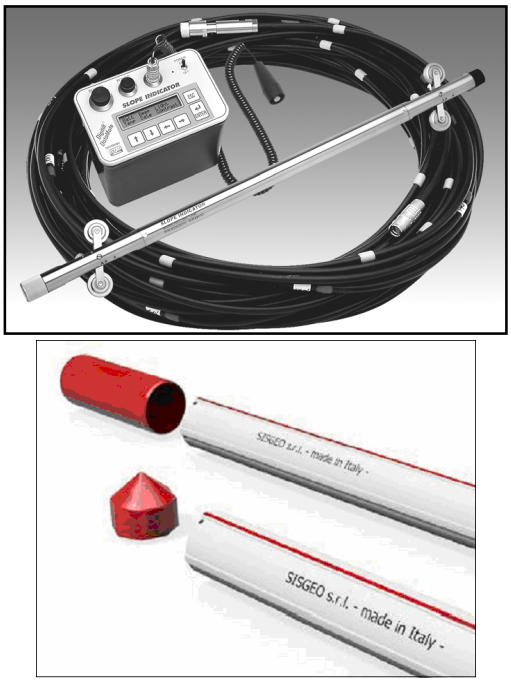


Fig.1 SLOPE INDICATOR inclinometer system (top), SISGEO Inclinometer access tube (bottom)

Methodology

- Install inclinometer 's casing that was installed in the Earth retaining wall or in soil
- Connect sensor, cable and indicator.
- Insert sensor into casing. Orient sensor wheels so that the + A-axis always tracks the same azimuth direction, preferably in the direction of maximum lateral movement..
- Raise sensor to nearest 0.5 m. mark by pulling cable through the jam cleat.
- Operate component switch and record A and B readings at 0.5 m. depth intervals by raising the sensor.
- When the sensor returns to the surface, remove sensor from the casing, rotate the sensor 180o m and reinsert into the same set of grooves.
- Lower the sensor back to the bottom measurement increment without hitting the bottom.
- Repeat readings at 0.5 m. intervals, recording A and B readings.
- Check that sums of the A readings remain approximately constant and check the same for the B readings. The sums should be constant within ten to twenty units
- Monitoring frequency should be done adequate to the construction stage or done repeatedly every 1 week intervals.

Presentation of the Results

Result of subsurface movements monitoring by Inclinometer are presented in lateral movement against depth of each A-axis and B-axis as shown in Figure 2. This will give the tendency and absolute lateral movement.

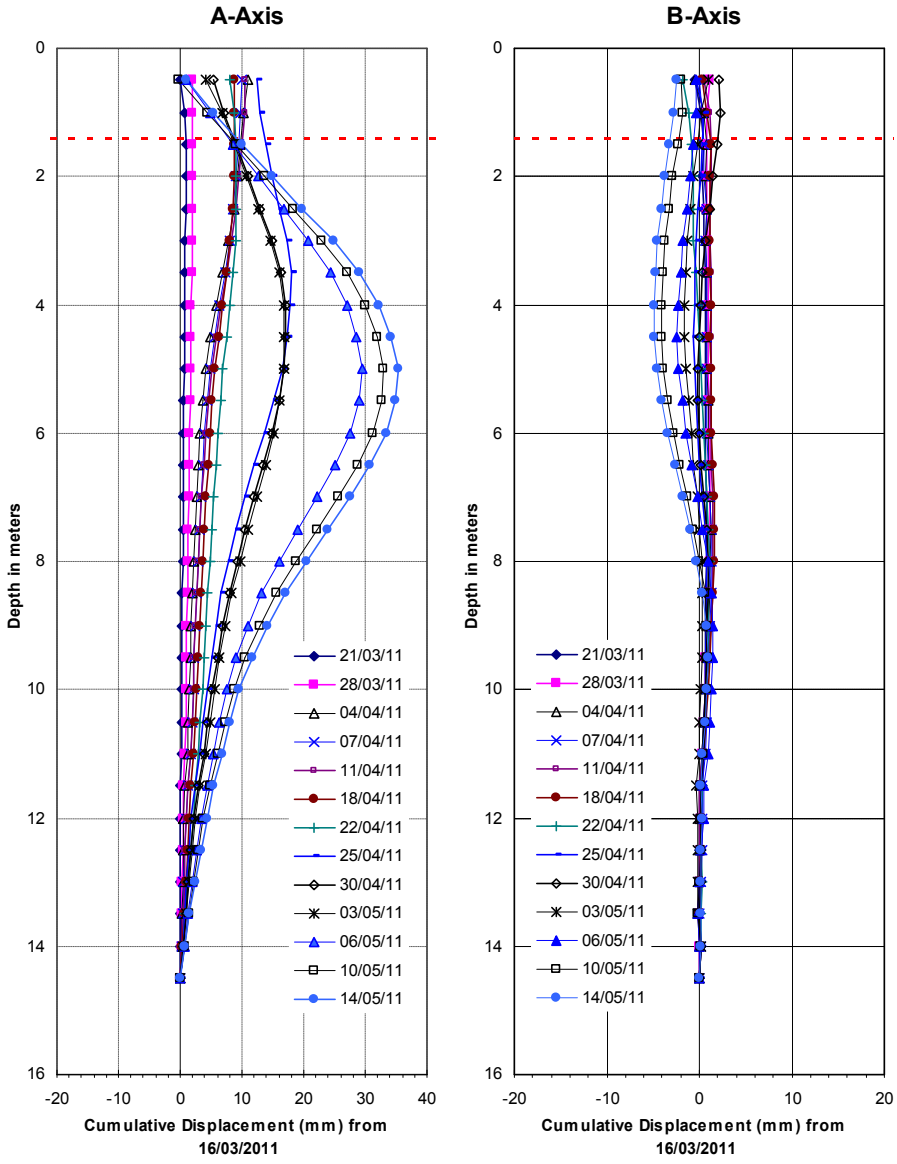


Fig. 2 Plot of lateral movement versus depth

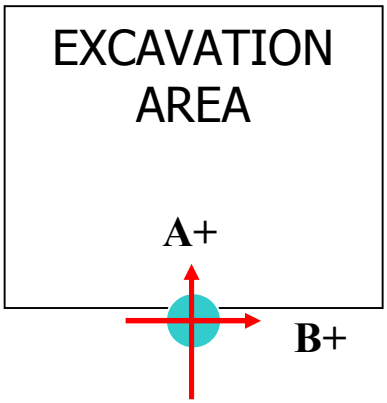


Fig. 3 Instrumentation Plan

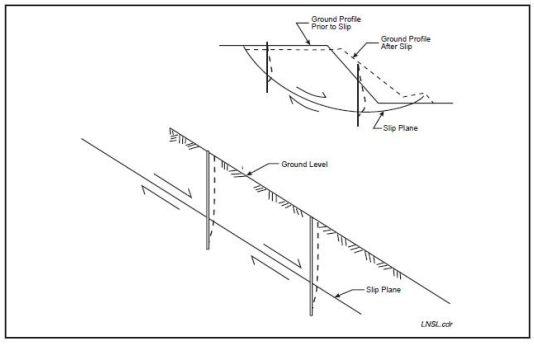
Fig. 4 inclinometer reading on site

For more information, please contact:
STS Instruments Co., Ltd.
Quality Assurance Division
196/10-12 Soi Pradipat 14, Pradipat Road,
Samsennai, Phayathai, Bangkok 10400
Tel. : 0-2270-8899 (10 lines) ext. 265
Fax : 0-2279-8507, 0-2618-6373
http://www.sts.co.th

Subsurface Movements Monitoring By Inclinometer

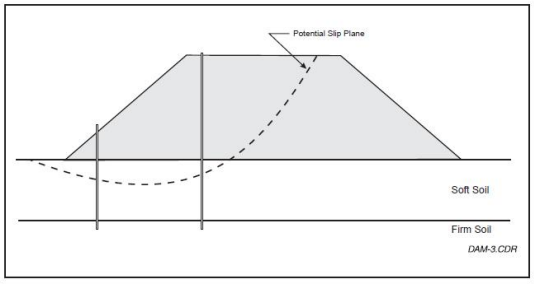
Application (from Slope Indicator Company, 1994)

Slopes and Landslides



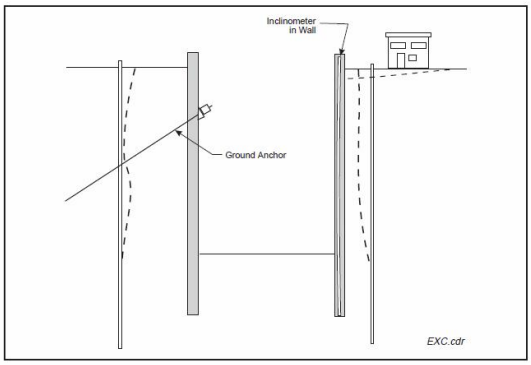
- Locate shear zones. Help determine whether shear is planar or circular.
- Measure movement at shear zone. Determine whether movement is constant, accelerating, or slowing.

Embankments



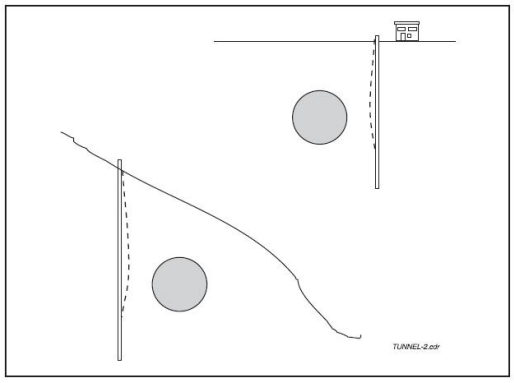
- Locate shear zones and help identify whether shear is planar or circular.
- Measure the movement at the shear zone. Determine whether movement is constant, accelerating, or slowing.

Diaphragm Wall or Sheet-Pile Wall



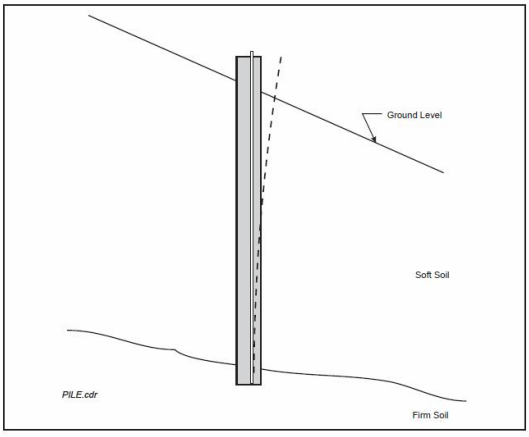
- Check stability of retaining wall. Check that deflections in retaining wall are within design limits.
- Check for ground movement that may affect adjacent buildings.
- Check performance of struts and ground anchors.

Tunnels



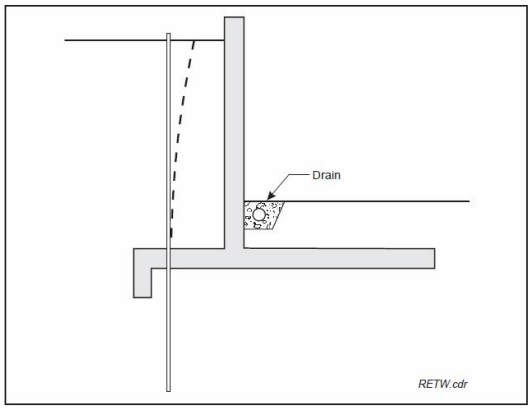
- Monitor soil movement due to tunneling operations. Such movements may damage tunnel or nearby structures.
- Check design assumptions. Verify finite element analysis. If actual conditions are different from assumed conditions, inclinometer data can be used to modify soil model.

Laterally-Loaded Pile



- Monitor bending of pile (indicates slope stability).
- Warn of impending failure (in-place inclinometer).

Retaining Wall



- Measure bending in the retaining wall.
- Check for rotation (overturning) of retaining wall.

Subsurface Movements Monitoring By Inclinometer

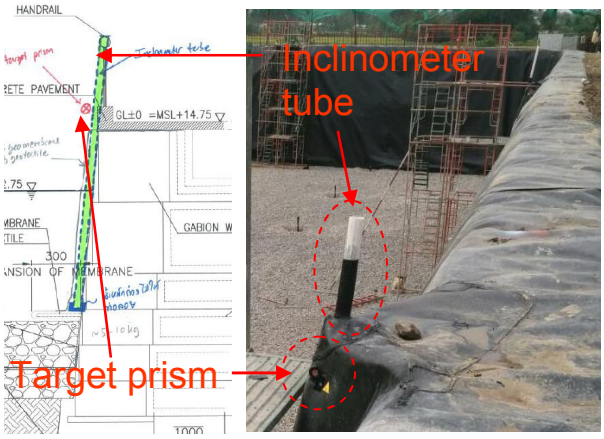


Fig.6 Example of application
measure the actual movement of the earth retaining wall during fill water in the raw water pond
Using precise total station to correct inclinometer data.

Fig.7 Example of application
measure the lateral soil movement caused by pile installation by inclinometer. Behind the fence, have a properties required to protect.

Fig.8 Example of application
Measure the lateral movement of pile by inclinometer during Static lateral pile load test.

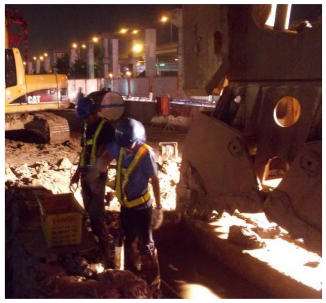


Fig.9 Example of application
measure the actual lateral movement of soil near underground tab water tunnel during Barrette pile construction. Measured data of each step are calculate immediately and present on site, continuously 72 hrs.