

LESSON 9

TOPIC 1

Construction Monitoring and Quality Assurance – Instrumentation

**CONSTRUCTION
MONITORING AND
QUALITY ASSURANCE**

*Lesson 9 - Topic 1
Instrumentation*

Header.

Slide 9-1-1

**CONSTRUCTION MONITORING
AND QUALITY ASSURANCE**

*1. Recall the Basic Types of Geotechnical
Instrumentation*

ACTIVITY: *Question-Answer*

Objectives

Slide 9-1-2

**Construction Observation and
Monitoring**

- *Visual*
- *Instrumentation*

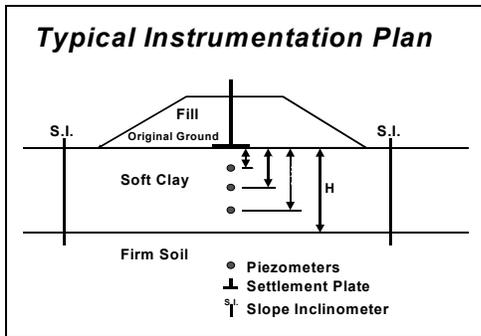
Instrumentation introduction. Instructor should note that some material in this lesson could apply to design as well as construction. The observational method is commonly used in design and construction of highways over soft ground. In these situations the designer realizes that critical conditions may exist which can not be predicted by normal geotechnical analysis and must be dealt with during construction.

Slide 9-1-3



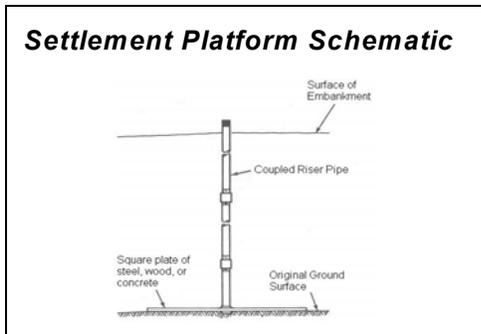
Slide 9-1-4

Case history showing that cracks (visible to the eye) appeared before the instruments detected the problem. Shows importance of trained inspectors.



Slide 9-1-5

Discuss layout of basic pattern and reasons for instrument types. Then show a series of schematics and pictures of common instruments used by geotechnical engineers. Emphasize the importance of instrument selection, installation, reading frequency, and transmittal of data to proper authorities in a timely fashion.



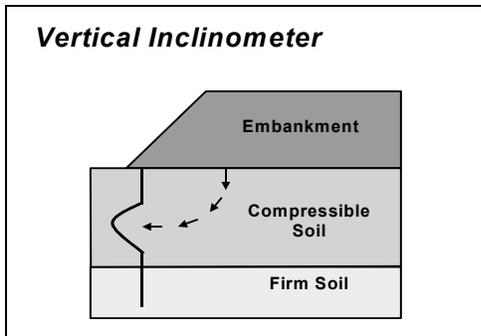
Slide 9-1-6

Basic settlement platform installations consists of a square plate on the original ground attached to a steel pipe. Pipe sections are added as the fill is extended upwards. Advantages are the low cost and the use of optical survey for readings. The disadvantages are the interference with construction and the need for protection against damage.



Slide 9-1-7

In the actual installation of a settlement platform, the platform is placed on the original ground surface and the base is covered with a small amount of soil to stabilize the pipe in a vertical position.



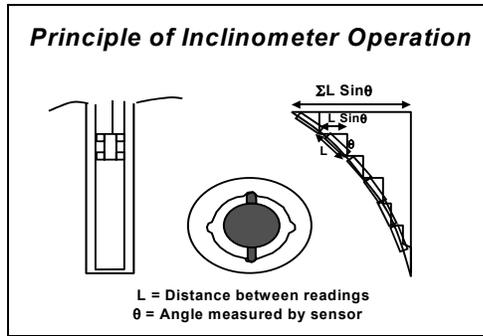
Slide 9-1-8

Schematic of the use of an inclinometer. Although these instruments have several applications, the most popular use is for monitoring lateral ground movements in soft subsoil associated with embankment placement. This is a bread and butter instrument for geotechnical engineers.



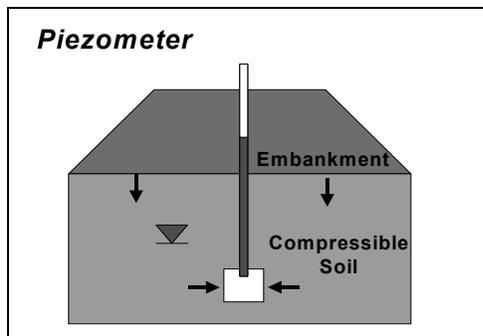
Slide 9-1-9

This is a picture of an in-place inclinometer. The process for installation is to drill a hole through soft soil into a firm base material. The inclinometer casing is then placed in the hole and fixed with grout at the base. The casing for the device is grooved at the quarters point for the entire length of the tube. Casing sections must be accurately coupled to insure groove alignment. The tilt sensor probe is then inserted to the base of the hole and readings taken periodically during withdrawal. Also special features are available such as telescoping casing in situations of large settlement or combination observation well-inclinometer casing.



Slide 9-1-10

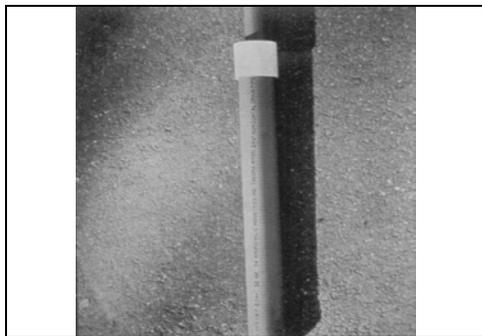
The readings from the tilt sensor device provide a picture of the change in slope of the casing with depth. The probe is inserted in east-west grooves and then north-south grooves to note directional changes in lateral movement. The readings are converted to numerical distance measurements and plotted versus depth to show lateral ground movement. Numerous software programs, such as the IDEAL system from Oregon DOT, have been developed to allow on site review of deflections.



Slide 9-1-11

Schematic of piezometer installation shows the device is used to measure the pore pressure in the ground; generally at more than one depth and at locations where embankment loads are expected to cause large excess pore pressures. Readings are taken periodically after installation to determine the rate of pore pressure decrease.

Ask the students what is the result of pore pressure decrease in terms of settlement of the embankment and the strength of the subsoil.



Slide 9-1-12

Different types of piezometers are available which range from a simple open well piezometer to more complex pneumatic or vibrating wire types. Emphasize the importance of instrument selection, installation, reading frequency, and transmittal of data to proper authorities in a timely fashion. These latter types must be carefully inserted in the hole and properly sealed usually by instrumentation specialist. Care should be exercised in selection of the piezometer type, as the response time may be different for rapid increases in pore pressure.



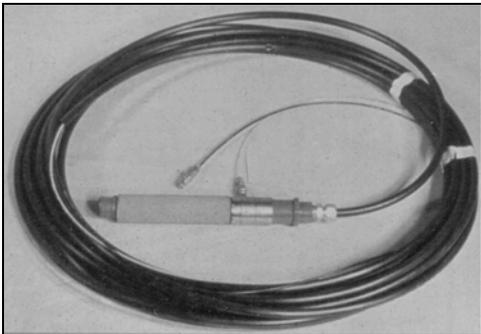
Slide 9-1-13

Basic geotechnical instruments, which are extended up through the embankment need to be protected against damage caused by the contractor's operations. Barriers and/or or flagging are commonly used to alert workers to the presence of instrumentation. Note that the instruments do constrict the work area. Contractors should be apprised of the importance of these instruments in the contract documents and advised that any damage to the instruments will be cause for the engineer to suspend work in that area until the contractor had affected repairs to the damaged instruments.



Slide 9-1-14

Funny slide about an inspector who was frustrated with the contractor continually damaging the instruments located on the embankment grade...left message on stake adjacent to instrument.



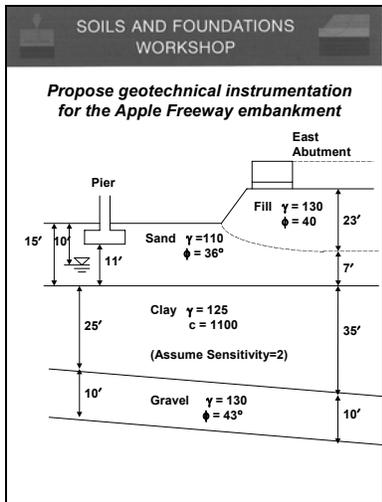
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A better solution is to use remote readouts off the grade. Virtually all geotechnical instrumentation categories have instruments that are suited for remote readout. These instruments have flexible tubes or cables that can be extended under or through embankments.



Slide 9-1-16

Most remote readouts for geotechnical instruments are clustered at location off the grade to permit the engineer to easily read all devices from a central location. Recent developments also permit remote reading and automatic transmission of instrument reading via satellite to a central office computer.



Slide 9-1-17

Apple Freeway used as mini-student exercise to test knowledge of geotechnical instruments. Ask the group to recall the issues for settlement and stability for the Apple Freeway and to suggest which geotechnical instruments if any would be recommended for use on the east approach area. (answer is on next overhead).

SOILS AND FOUNDATIONS WORKSHOP

Recommended Instrumentation:

<u>Instrument</u>	<u>Station</u>	<u>Depth</u>
<u>Below OGS</u>		
Settlement Plate	90+00	At Ground Surface
"	93+50	"
"	96+50	"
Piezometers	93+50	20', 28', 36'
"	96+50	"

Slide 9-1-18

Then instructor shows planned Apple Freeway instrumentation and explains reason for instruments (east approach is most critical area for settlement so use both piezometers and settlement platforms). Note that instruments also recommended at west abutment and at end of east approach fill.

Please refer to the Reference Manual page 10-9 for suggested Instrumentation Layout.

SOILS AND FOUNDATIONS
WORKSHOP

***Construction Monitoring
and Quality Assurance***

- *Recall the basic types of
geotechnical instrumentation*

Activities:
Question-Answer

Slide 9-1-19

Repeat objectives for lesson 9 topic 1. Then go to the reference manual and overview section 9-2. Alert the group that more information is available in NHI course 132041 on Geotechnical Instrumentation.