FORENSIC SITE INVESTIGATION & INSTRUMENTATION

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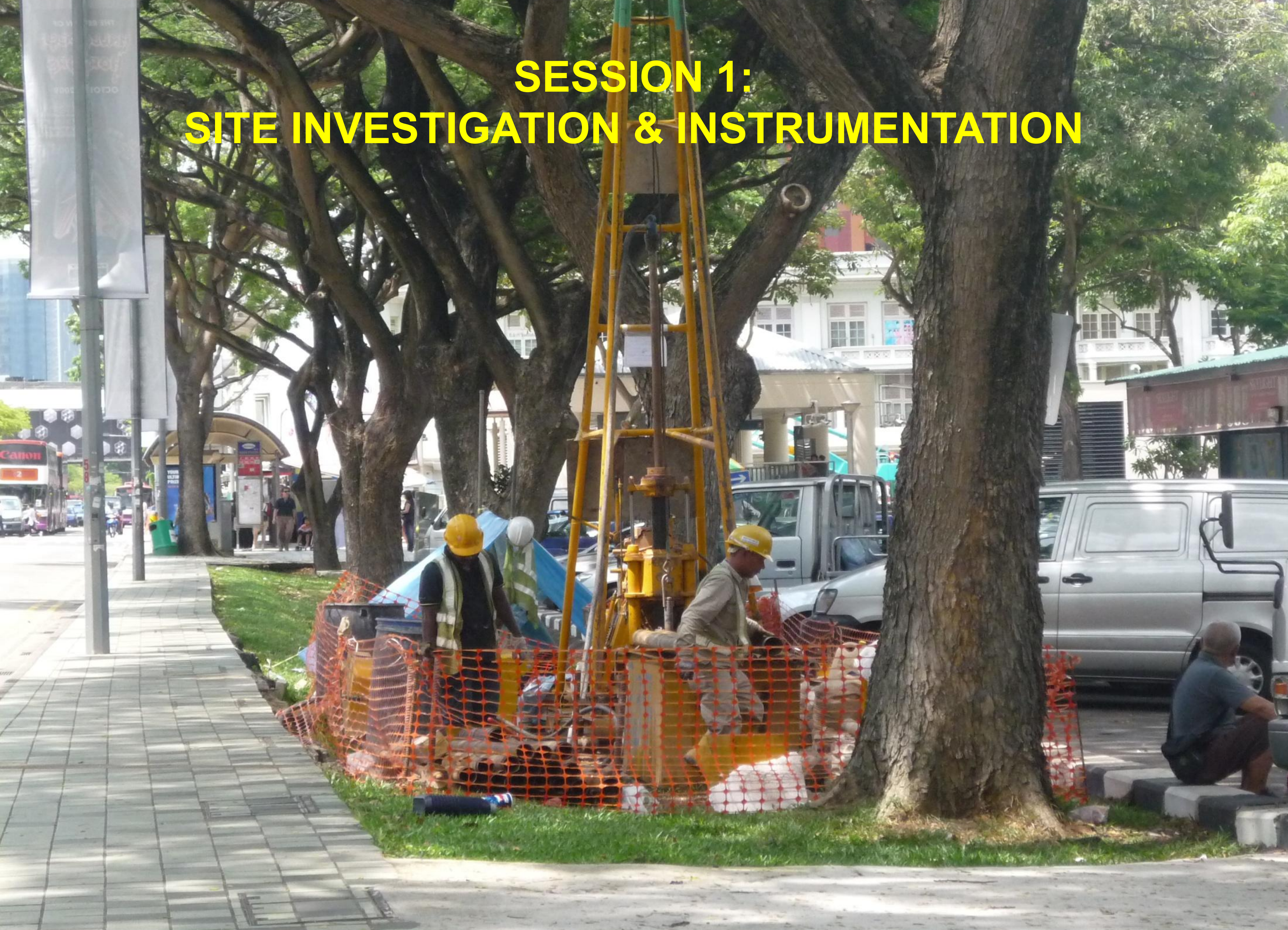
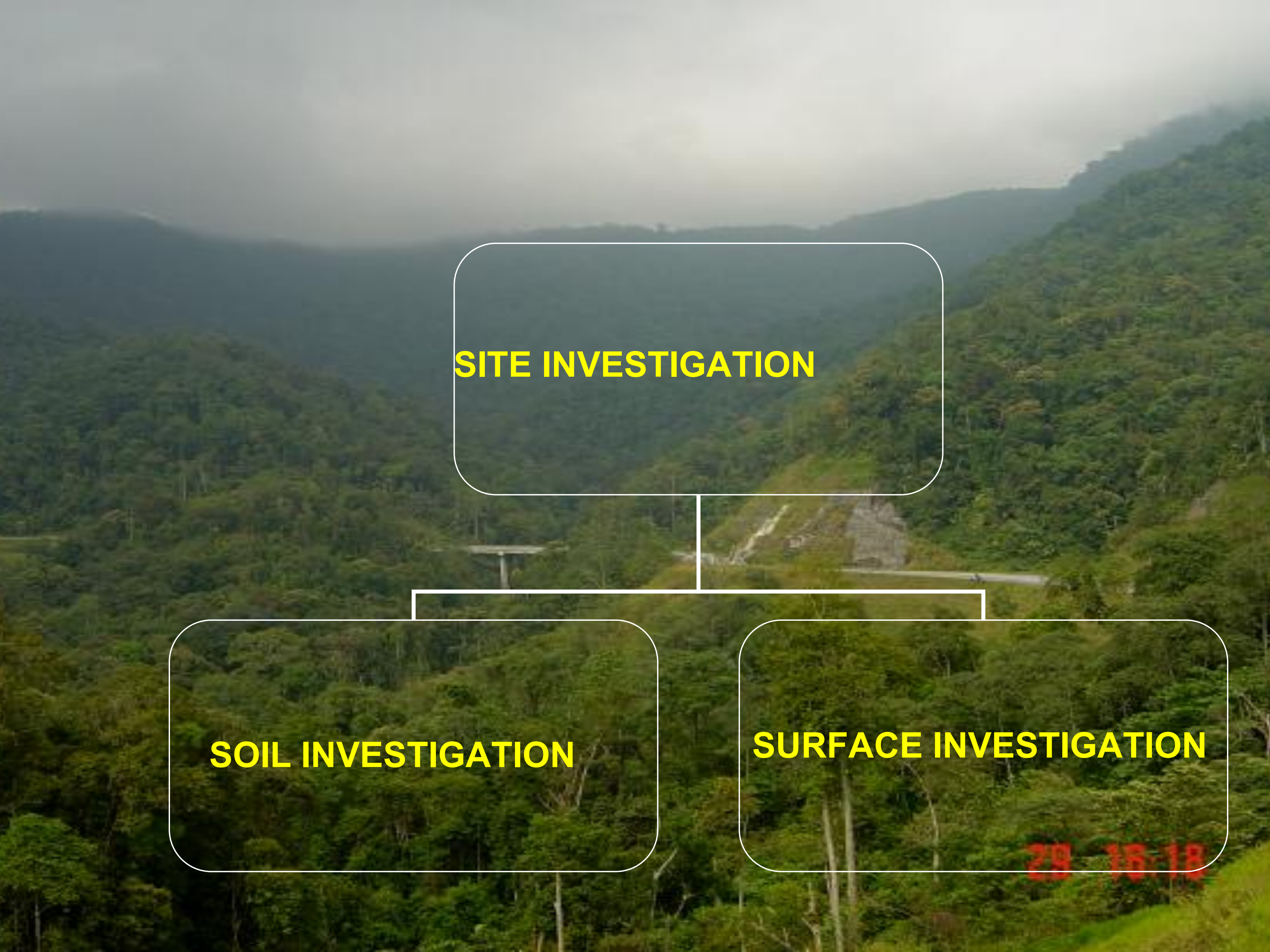
SESSION 1:
SITE INVESTIGATION & INSTRUMENTATION




SITE INVESTIGATION
SOIL INVESTIGATION
SURFACE INVESTIGATION
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SOIL INVESTIGATION

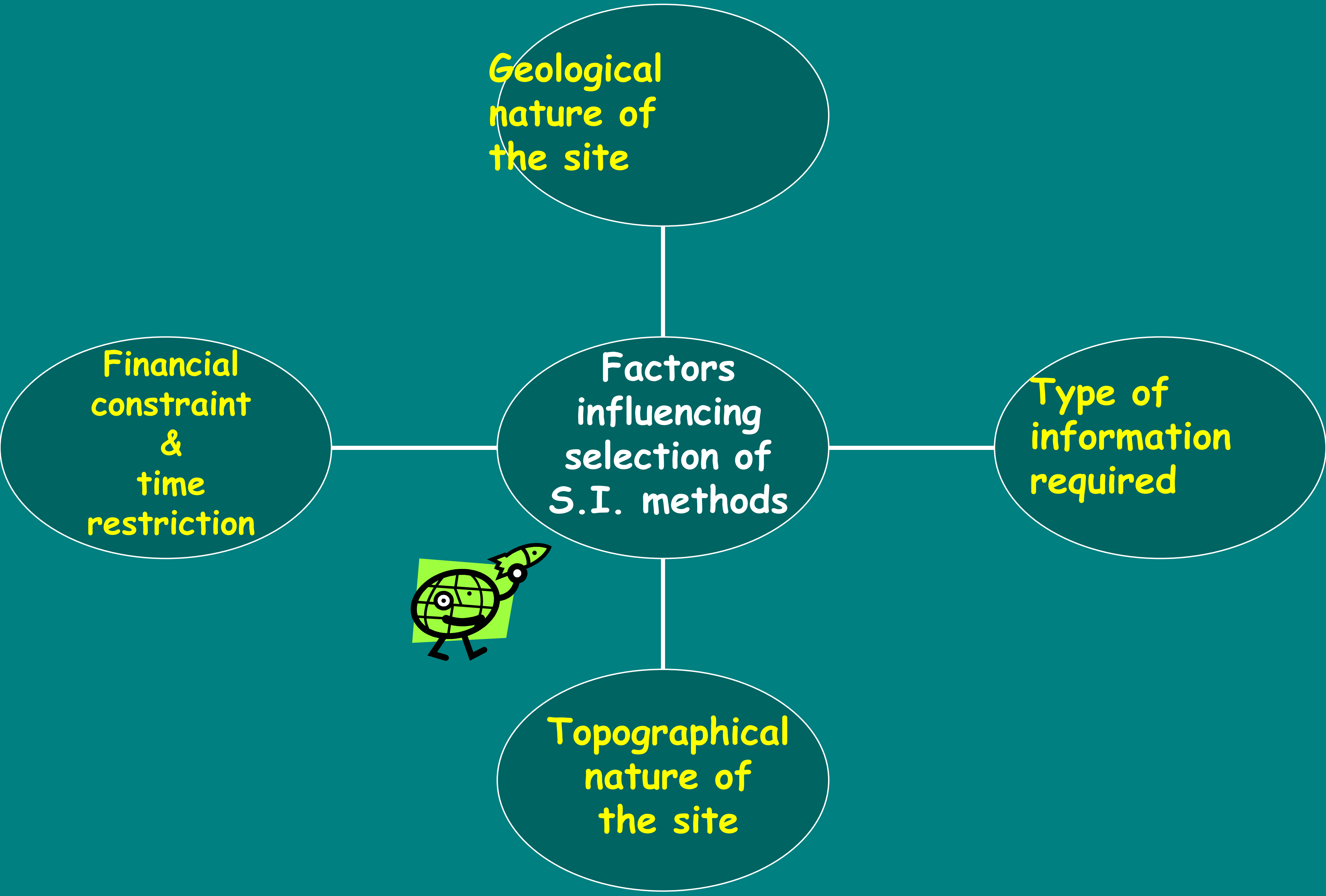
OBJECTIVES

- To study the general suitability of the site for a construction method or an engineering project (feasibility studies)
- To enable a safe, practical and economical design to be prepared.
- To determine the possible difficulties may be encountered by a specific construction method.
- To study the suitability of construction material (soil or rocks).

STANDARD PENETRATION TEST (SPT)

OBJECTIVES

- The most economical means of obtaining subsurface information
- A split barrel sampler 450 mm long is driven by a free falling 65 kg hammer.
- The first 150 mm is called the seating drive and not counted.
- The total cumulative no. of blow counts for the last 300 mm is recorded as N-value



Geological nature of the site
Financial constraint & time restriction
Factors influencing selection of S.I. methods
Type of information required
Topographical nature of the site

SOIL INVESTIGATION

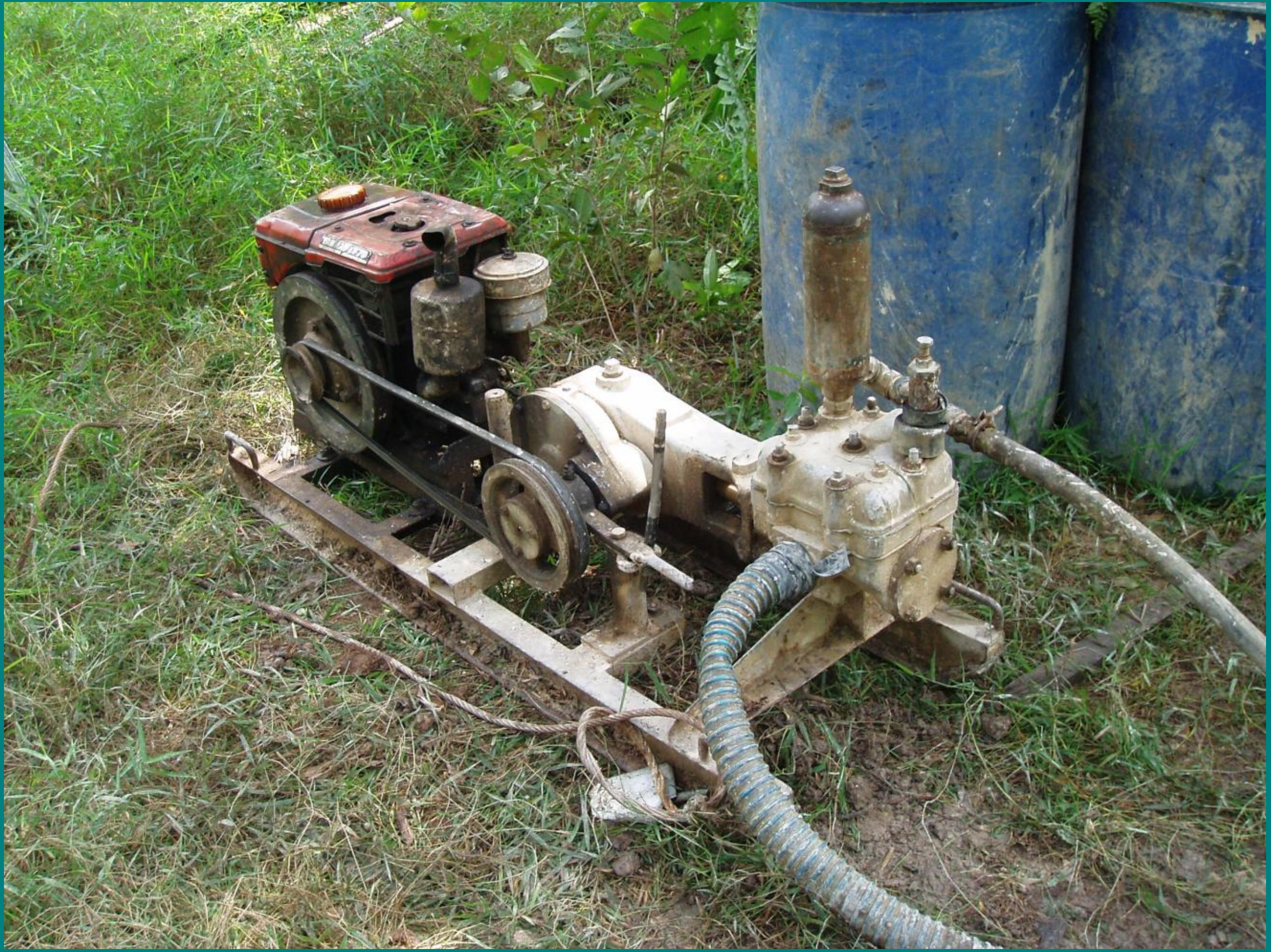
SOIL INVESTIGATION

SPT HAMMER

SPLIT BARREL SAMPLER

CPT CONE

WATER PUMP



CASING SHOE

DRILL BIT

CPT MACHINE

CPT LOGGING

INCLINOMETER

SETTLEMENT GAUGE

SETTLEMENT GAUGE

Types of Triaxial Tests

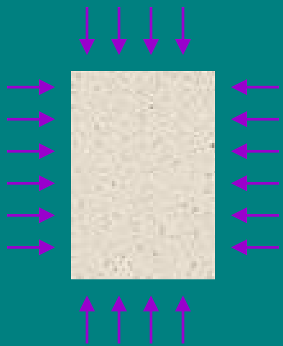
Depending on whether drainage is allowed or not during

- ❖ initial isotropic cell pressure application, and
- ❖ shearing,

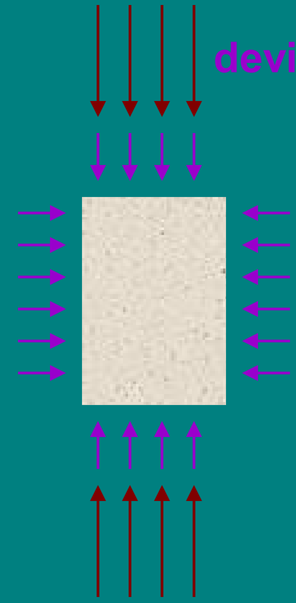
there are three special types of triaxial tests that have practical significances. They are:

Consolidated Drained (CD) test
Consolidated Undrained (CU) test
Unconsolidated Undrained (UU) test

Types of Triaxial Tests



Under all-around cell pressure σ_c



Shearing (loading)

Is the drainage valve open?

- yes → **C**onsolidated sample
- no → **U**nconsolidated sample

Is the drainage valve open?

- yes → **D**rained loading
- no → **U**ndrained loading

PERMEABILITY TEST

TRIAXIAL COMPRESSION TEST

EXTRUDING OF SAMPLE

STORAGE

SURFACE MARKER

PIEZOMETER

MAGNETIC EXTENSOMETER

INCLINOMETER

SAMPLING TUBE

MACKINTOSH PROBE

OBJECTIVES

- Results are used to determine thickness of unsuitable material to be removed and also for preliminary design of embankments.

- Usually carried out near hand auger or deep boring positions and filling areas to verify the consistency of subsoil.

MACKINTOSH PROBE

- Light dynamic test
- Cone is driven directly into the soil by driving a hammer (5 kg) through a free drop of 280mm.
- The results are recorded as number of blows per 300mm penetration.
- Maximum penetration is 12m or 400blows/300mm; whichever comes first.

Mackintosh Probe

LABORATORY TESTS

- Laboratory testing of soil and rock should be as recommended in BS5930:1999.
- Testing should be carried out in accordance with BS1377:1990.

LABORATORY TESTS

SHEAR STRENGTH

- ***Triaxial load cells*** are the most widely used laboratory shear strength test for fine soils, allowing control of drainage conditions and porewater measurements.

- The test specimen is obtained from carefully extruded undisturbed tube samples.

LABORATORY TESTS

SHEAR STRENGTH

UNCONSOLIDATED, UNDRAINED

With no drainage allowed, which gives an initial *in situ* condition.

CONSOLIDATED UNDRAINED

With drainage allowed, until consolidation is complete, then continue undrained with porewater pressure measurements.

DRAINED

With drainage allowed throughout the consolidation and shearing stages.

LABORATORY TESTS

SHEAR STRENGTH

UNDRAINED STRENGTH

Given in total stress terms (c_u and $ø_u$).

DRAINED STRENGTH

Given in effective strength terms (c’ and ø’).

LABORATORY TESTS

CONSOLIDATION

LABORATORY OEDOMETER TEST – (ONE DIMENSIONAL LOADING)

Used to determine the coefficient of volume compressibility (mv) of clays and silts, from which the coefficient of consolidation (Cv) is obtained.

These two coefficients enable the magnitude and rate of consolidation under full structural applied load to be estimated.

SEIVE ANALYSIS TESTS

OBJECTIVE

To determine grain sizes distribution.

How?

Sieving are performed by arranging various sieves one over the other in the order of their mesh openings, the largest aperture sieve being kept at the top and the smallest aperture sieve at the bottom.

Distributions of gravel and sand particles are determined by sieve analysis; meanwhile clay and silt are determined by sedimentation or wet analysis.

LABORATORY TESTS

- ATTERBERG LIMIT TESTS
  - LIQUID LIMIT TESTS
  - PLASTIC LIMIT TESTS
  - SHRINKAGE LIMIT TESTS

LIQUID LIMIT TESTS

OBJECTIVE

To determine liquid limit soil in percentage.

Liquid Limit?

Moisture content at point of transition from plastic to liquid state.

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LIQUID LIMIT TESTS

- CASAGRANDE METHOD
- CONE PENETRATION METHOD

PLASTIC LIMIT TESTS

OBJECTIVE

To determine plastic limit soil in percentage.

Plastic Limit?

Moisture content at point of transition from semisolid to plastic state.
When the soil is rolled into threads of 3.2mm diameter it start to crumbles.

SHRINKAGE LIMIT TESTS

OBJECTIVE

To determine shrinkage limit soil in percentage.

Shrinkage Limit?

Moisture content at which volume of soil mass ceases to change.

SPECIFIC GRAVITY TESTS

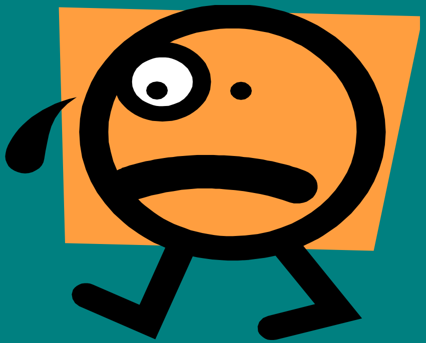
OBJECTIVE

To determine specific gravity of soil.

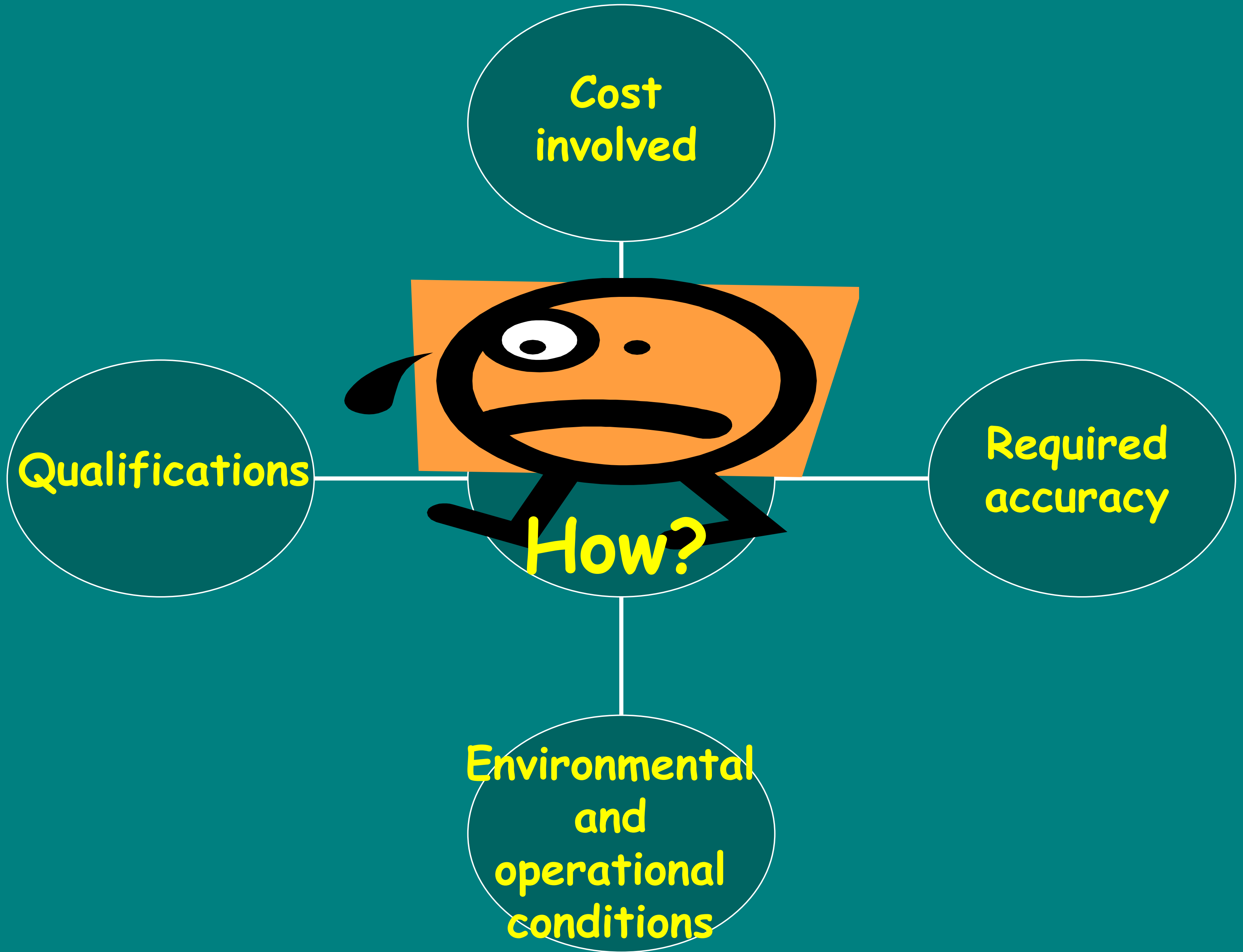
Specific gravity?

Ratio of weight of certain volume of soil solids to the weight of an equal volume of distilled water at a constant temperature.

INSTRUMENTATION



How to choose the proper type of instrument?


Cost involved
Qualifications
How?
Required accuracy
Environmental and operational conditions

INSTRUMENTATION

Standpipe Piezometer

Vibrating Wire Piezometer

Magnetic Extensometer

Inclinometer

PIEZOMETER

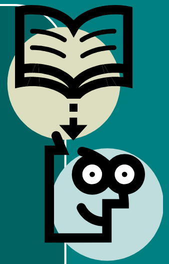
OBJECTIVE

To monitor water level (static, perched, artesian) in excavations, slopes and dam embankments, to measure excess hydrostatic pressure beneath dams and embankments and to aid in control preloading operations and placement of fill over soft ground.

PIEZOMETER

DIVIDED INTO

2 SYSTEMS



OPEN SYSTEM

Measurement are made from the surface and the water level is generally below the surface.

CLOSED SYSTEM

Measurement are made remotely and the wate level may be at any location.

STANDPIPE PIEZOMETER

OPEN SYSTEM

APPLICATION

Coarse-grained granular soils, free-draining rock masses.

ADVANTAGE

Simple, rugged, inexpensive

DISADVANTAGE

Indicates average head, relatively insensitive, time lag in impervious soils.

VIBRATING-WIRE PIEZOMETER

CLOSED SYSTEM

APPLICATION

Fine-grained soils and slow-draining rock masses.

ADVANTAGE

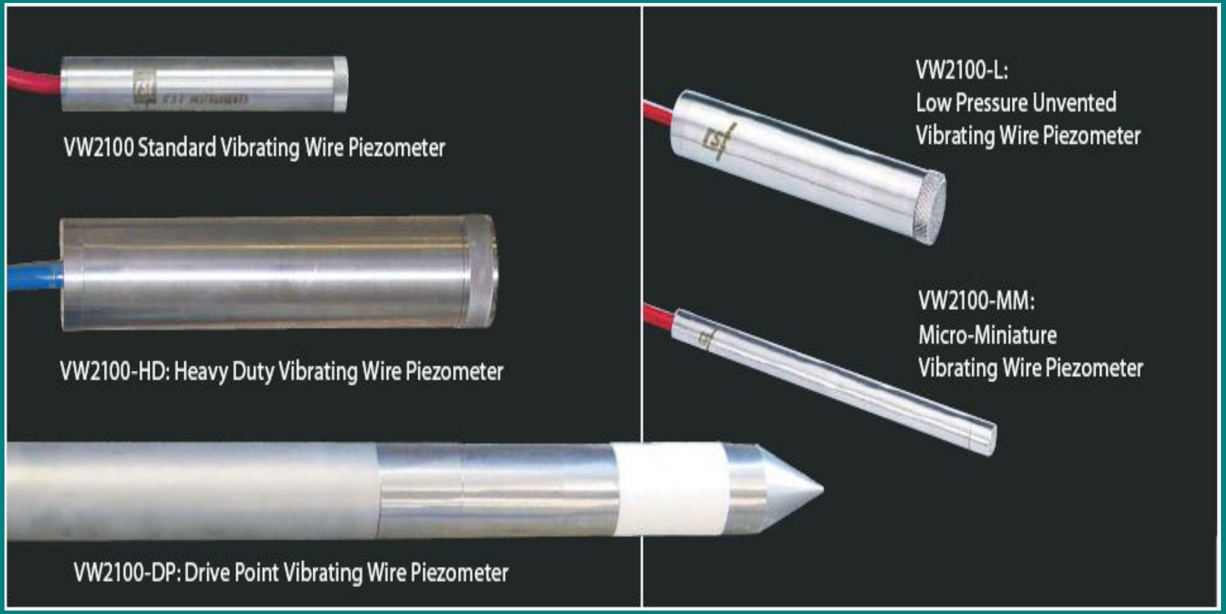
Extreme sensitive, fast response, continuous recording possible

DISADVANTAGE

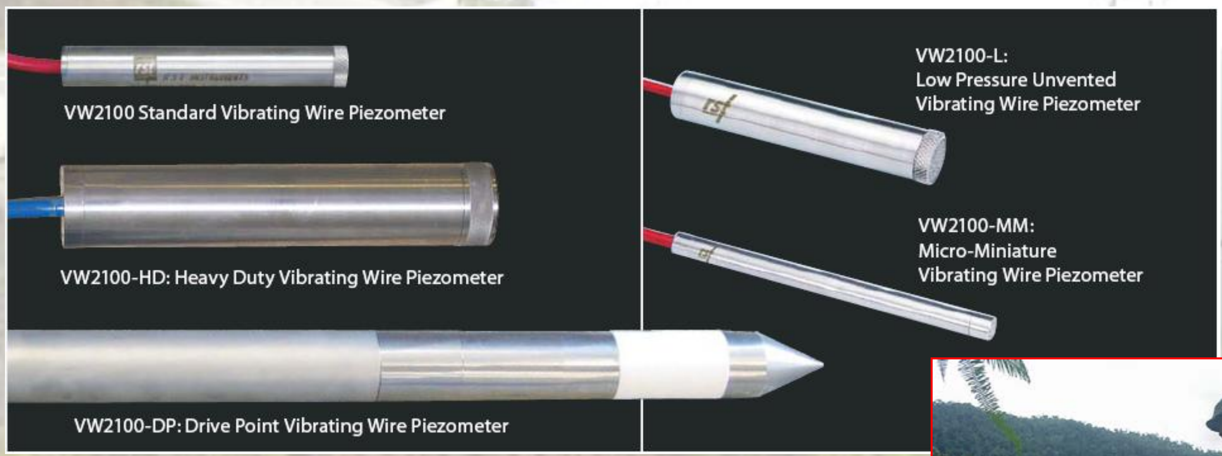
Relatively costly, decreased durability and reliability over other closed systems because of electrical circuitry.

Real Time Monitoring System

Vibrating Wire Piezometer (VWP)



VIBRATING WIRE PIEZOMETER



Pore Water Pressure/Ground Water Table Monitoring.

INCLINOMETER

OBJECTIVE

To measure lateral deflections

APPLICATIONS

- Installed behind retaining structures or in pile foundations.
- Beneath loaded areas over soft soils
- Monitor slope movements

INCLINOMETER

INSTRUMENTS

- Contains servo-accelerometers that can detect lateral movements of the order of ± 0.0001 ft per 2ft of casing.
- Since the voltage output is proportional to the sine of the angle of inclination of the long axis of the sensor, from the vertical, it can be used to measure true deviations from vertical.

INCLINOMETER

INSTALLATION

- Is lowered and raised in specially grooved casing installed in a borehole and extended to a depth below the anticipated movement zone.
- The casing bottom is often grouted into place to assure fixity.
- For monitoring pile and wall movements, the casing is attached directly to the structural member.

Real Time Monitoring System

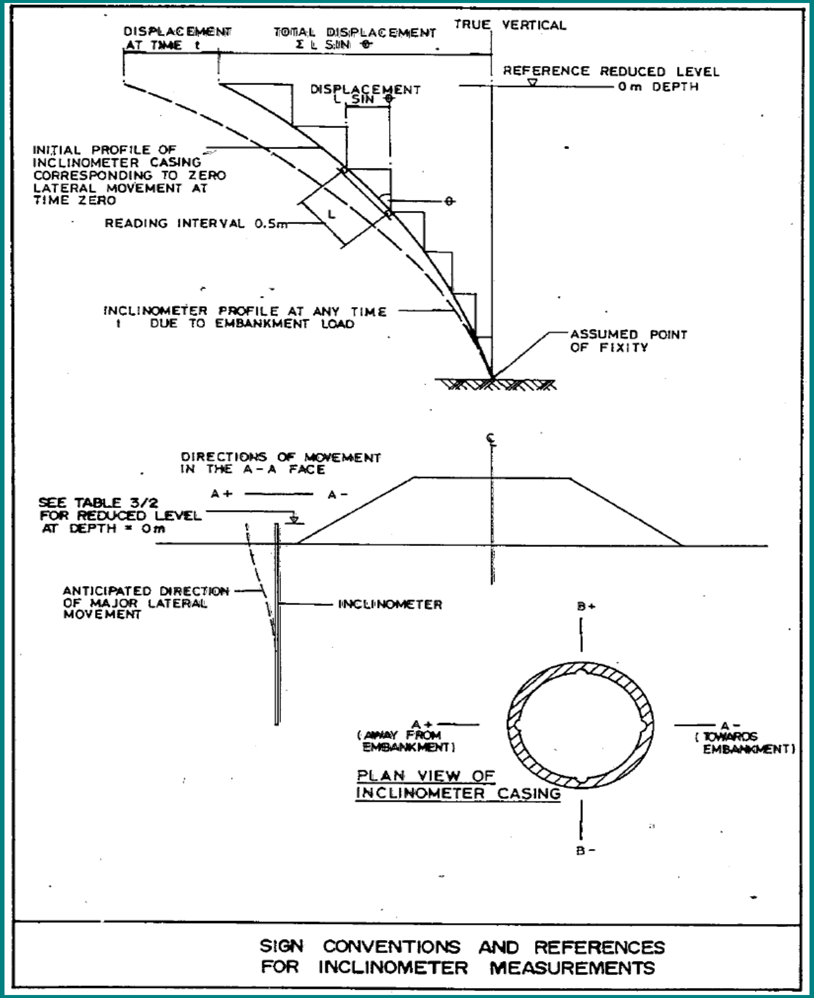
In-Place Inclinometer

IN-PLACE INCLINOMETER

Monitoring Of The Lateral Movement.

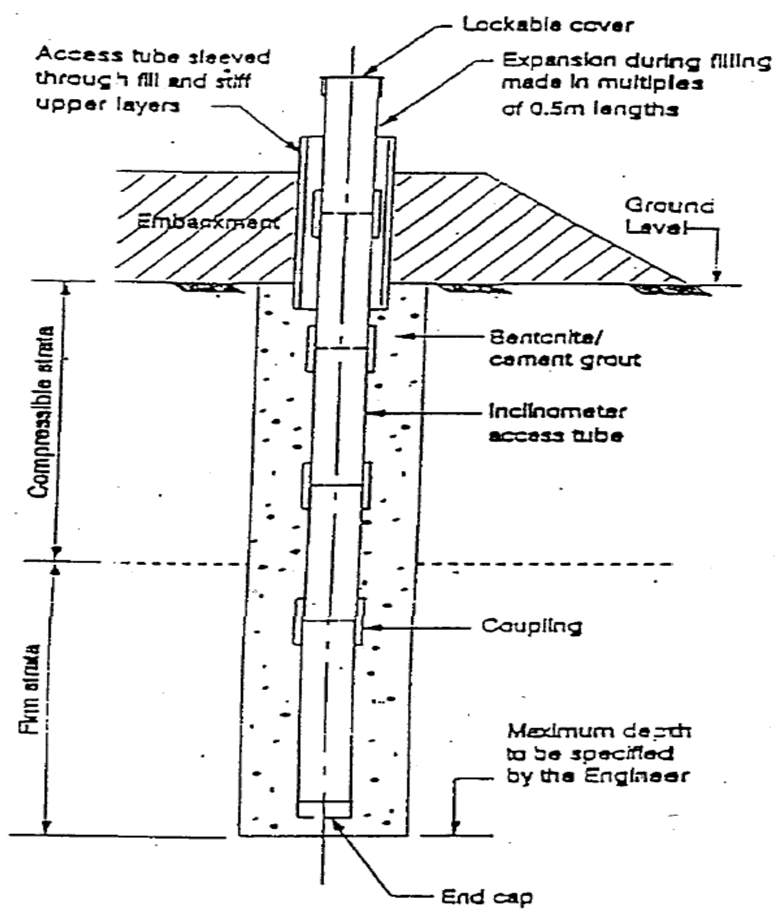
Instrumentation Details

Inclinometer- Sign Convention



Instrumentation Details

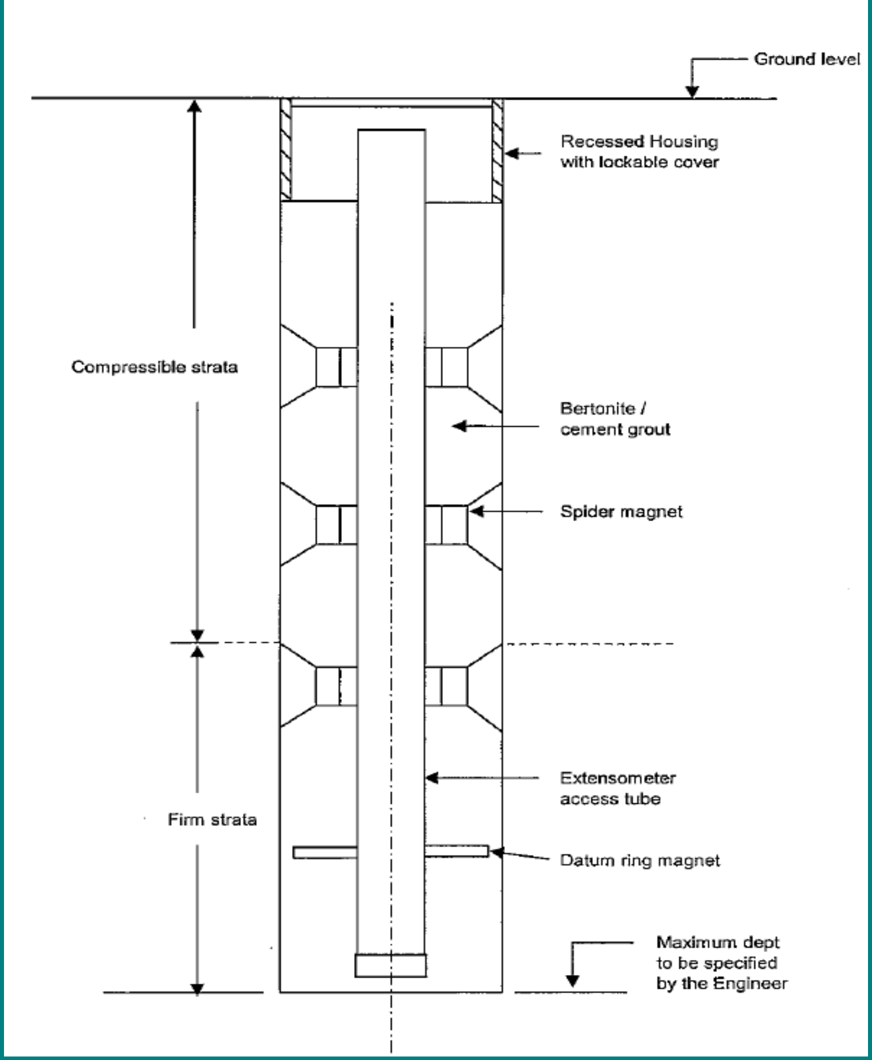
Inclinometer

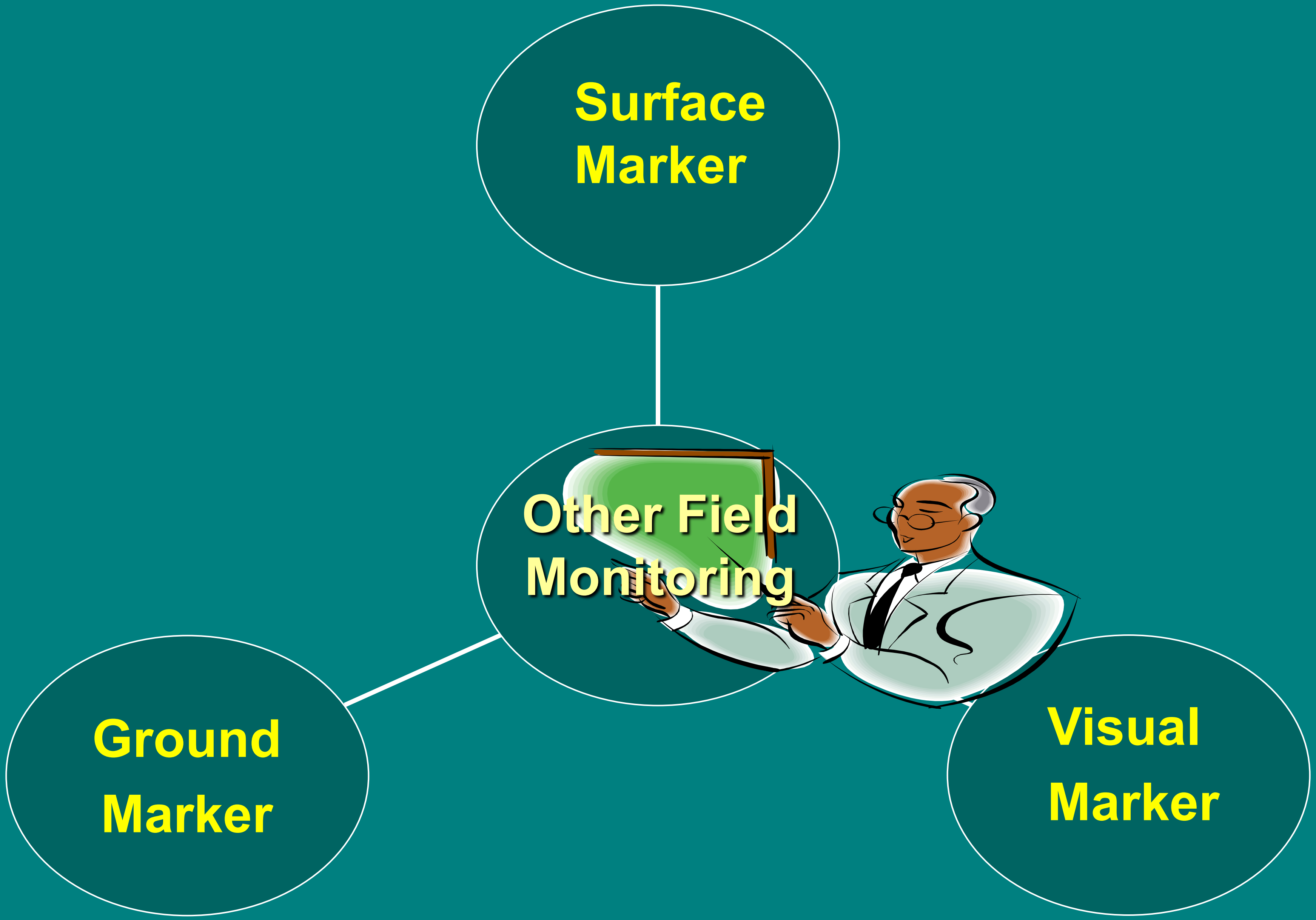


INCLINOMETER

Instrumentation Details

Magnetic Extensometer




Surface Marker
Other Field Monitoring
Ground Marker
Visual Marker