# MEASUREMENTS OF MATERIAL PROPERTIES

## Methods of Measurement

1- Laboratory Testing Methods

2- In-Situ Testing Methods

3- Empirical Correlation's

Terzaghi & Peck (1948): $Cc = 0.009 (w_c - 10\%)$

Skempton (1944): $Cc\ 0.007 (w_c - 7\%)$

# Geotechnical Investigation

## MEASUREMENTS OF MATERIAL PROPERTIES

### Soil Properties

1. **Physical properties**
2. **Index Properties**
3. **Hydraulic Properties**
4. **Mechanical Properties**

# MEASUREMENTS OF MATERIAL PROPERTIES

## Methods of Measurement

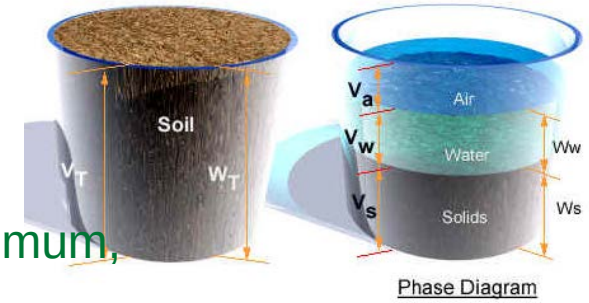
## 1- Laboratory Testing Methods

- Provide better control over the boundary conditions
- Different parameters can be determined individually or in combination
- Results can be produced

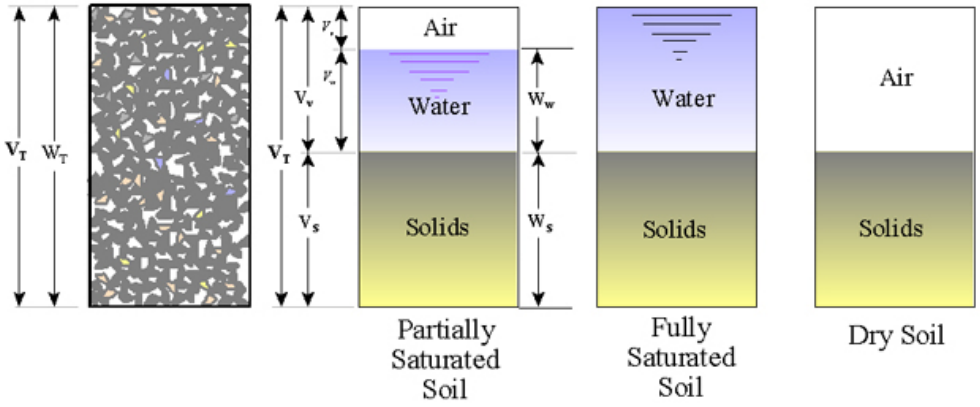
# MEASUREMENTS OF MATERIAL PROPERTIES

## Soil Properties

1- Physical properties: Used to describe the soil. These properties are incorporated with the soil classification systems, and in some cases they are related to the mechanical properties




- Specific gravity
- Grain size
- Density (Saturated, Partially saturated, submerged, minimum, maximum, relative, optimum moisture content)
- Porosity
- Degree of saturation
- Void ratio
- Moisture content
- Hardness (for rocks)
- Durability (for rocks)
- Reactivity (for rocks)



# MEASUREMENTS OF MATERIAL PROPERTIES

## Soil Properties

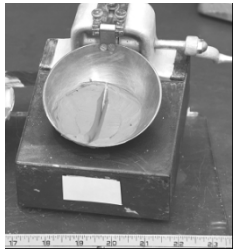
2- Index Properties: Used to classify the soil or to correlate with the mechanical properties.

- Atterberg Limits or Consistency Limits (LL, PL SL)
- Moisture Content vs. Unit Weight Relationship (Compaction)
- Grain Size Distribution
- Relative Density $D_r$

Relative Density $D_r$

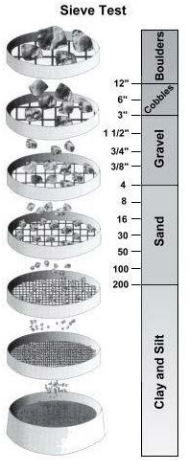
PL

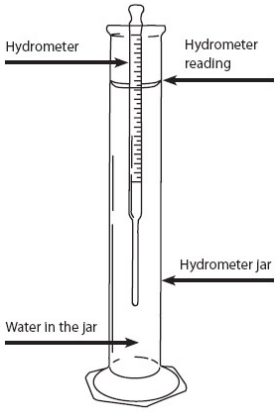
LL



Proctor Test

Grain Size Distribution



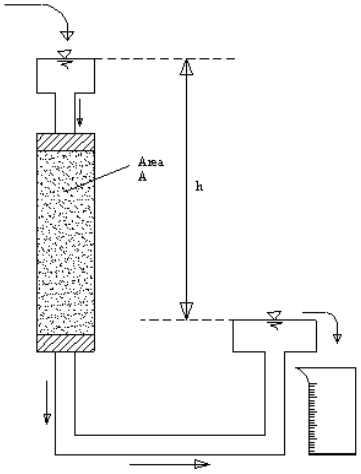



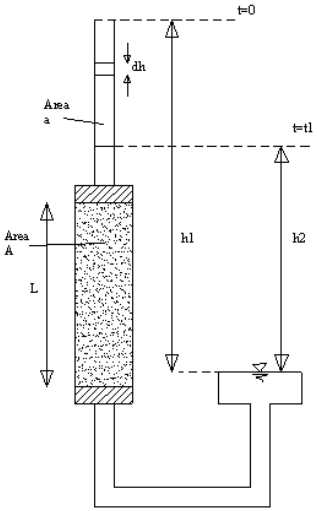
# MEASUREMENTS OF MATERIAL PROPERTIES

## Soil Properties

### 3- Hydraulic Properties

- Permeability or Hydraulic Conductivity (k)
- Infiltration Rate




Double Ring Infiltrometer

# MEASUREMENTS OF MATERIAL PROPERTIES

## Soil Properties

4- Mechanical Properties: To describe the behavior of the soil under different types of stresses

-Deformation Moduli – Young's Modulus (E) & Shear Modulus (G)

-Consolidation ($C_c$, $C_s$, $C_v$, $P_c$, $m_v$, K)
-Strength (c, $\phi$) Unconfined Compression
Direct Shear,
Triaxial Compression

-California Bearing Ratio (CBR) or

-Lime Rock Bearing Ration (LBR)
used for pavement design


Direct Shear

Consolidation Test


Unconfined Compression


Triaxial Compression

# Geotechnical Investigation

## THE STANDARD PENETRATION TEST (SPT) ASTM D1586

- The SPT is one of the most popular and economical means to obtain subsurface information.

- The testing method was standardized in 1958 as ASTM D1568

## The test consists of:

* A 140 lb driving mass falling from a height of 30 in.

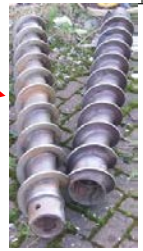
* Drive the standard split spoon sampler a distance of 18 in. into the soil

* Counting the number of blows (N) to drive the sampler 12 in. (6 in. + 6 in.)

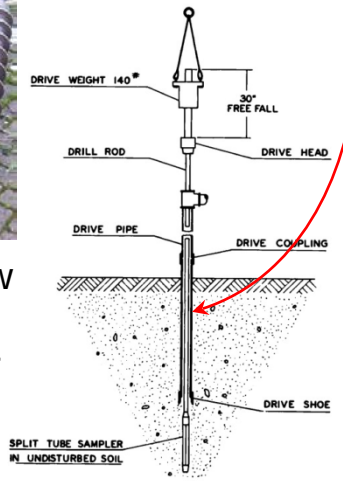
* The boring log should show "refusal" and should be halted if:

*a- 50 blows are required for any 150 mm increment*
*b- 100 blows are obtained*
*c- 10 successful blows produce no advance*

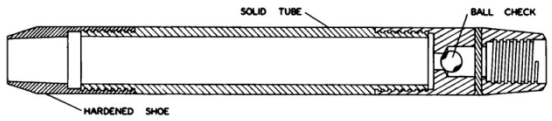
* N should be corrected for the increase of the overburden pressure



Hollow Stem Auger




Driving sample




Solid tube sampler

# MEASUREMENTS OF MATERIAL PROPERTIES

## Methods of Measurement

## 3- Empirical Correlations

- Correlations are usually based on **basic or index properties**
- These properties are correlated with the **mechanical & hydraulic properties**
- Used to provide basis for all engineering analysis
- Reduce the cost of geotechnical investigation
- Presented as ----- Tables, Charts, and Equations

For example Beyer formula for coefficient of permeability (k)

$K = C \cdot (d_{10})^2$

Where :

$C = 4.5 \times 10^{-3} \log \frac{500}{U}$

$U =$ Uniformity coefficient $= d_{60}/d_{10}$

$d_{10} =$ Effective diameter (mm)