Salahaddin University, Erbil
College of Agricultural Engineering Sciences

Soil Engineering

The coefficient of linear extensibility

Department of Soil and Water 3rd year students

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The coefficient of linear extensibility (COLE): Is a measure of soils shrinkage-swell capacity, which can be determine by measuring a specimen in wet and dry states using the following equations:

$$COLE = \frac{(\text{moist length} - \text{dry length})}{\text{dry length}} \quad (1)$$

Various moisture states have been used for moist length, but field capacity is often used. COLE is often measured from the clods' volume change rather than change of length. In such cases, Equation 2 is used to calculate COLE:

$$COLE = \sqrt[3]{\text{moist volume}/\text{dry volume}} - 1 \quad (2)$$

COLE generally varies from near 0 to 0.12. The degree of probable limitation on the soil's use is correlated with COLE .

Related with COLE as shown from the table in the next slid.

Table (1) shows the relation between COLE values and hazard of soil to engineering use:

COLE value	Degree of Hazard
Less than 0.03	Low hazard
0.03-0.06	Moderate hazard
0.06-0.10	Severe hazard
More than 0.10	Very sever hazard

Note: Please give some examples to students then solving them.

Some uses made and inferences drawn from COLE data are:

1- If COLE exceeds 0.09, significant shrink-swell activity can be expected.

2- If COLE exceeds 0.03, a significant amount of montmorillonite clay is present .

Example 1:

If the length of the moist soil sample is 42 cm , while after drying the length becomes 40 cm calculate the COLE value , then discuss its suitability for building.

COLE = $\frac{(Moist\ length - dry\ length)}{dry\ length}$ =(42-40)/40 =2/40 = 0.050 it is moderate hazard for engineering use.

Example 2:

If the moist volume of soil clods was is 250 cm^3 , and after drying the volume was 200 cm^3 calculate COLE value then mention its suitability for engineering uses.

COLE = $(250/240)^{1/3}$ -1 ==1.077-1 = 0.077 it is severe hazard for use.

Soil Engineering: Introduction, Importance, Fundamentals, Problems and Limitations:

1. Introduction to Soil Engineering
2. Importance of Soil Engineering
3. Fundamentals of Soil Engineering
4. Soil as Foundation Material
5. Special Soil Engineering Problems
6. Solution of Engineering Problems
7. Limitations of Soil Engineering

Which soil is suitable for a civil engineering structure?

Normally a civil engineer don't get to choose a soil type before constructing any structure. At a given location, depending on the geology and the soil condition, suitable foundation types are chosen and constructed.

To answer this question directly, normally for a structure wherein the loads are relatively smaller and requiring shallow foundations, soils with bearing capacity of 100 kPa is suitable. Single storey buildings, industrial structures fall under this category.

For a structure where in the load is relatively high requiring and high bearing capacity soils are not available at shallow depths, thereby requiring piles, soils with SPT greater than 100 would be suitable.

The above are general answers. This answer is provided to provide a feel of the suitable soils for constructing a structure or a building.

Geotechnics and geology is a wide subject and there are lot of factors affecting the choice of foundation based on the soil properties underneath the proposed structure

Purposes of geotechnical engineering

The main purposes can be summarize as follow:

1-Buildings.

2-Underground working.

3-Tunnels.

4-Roads.

5- Railway.

6-Air ports.

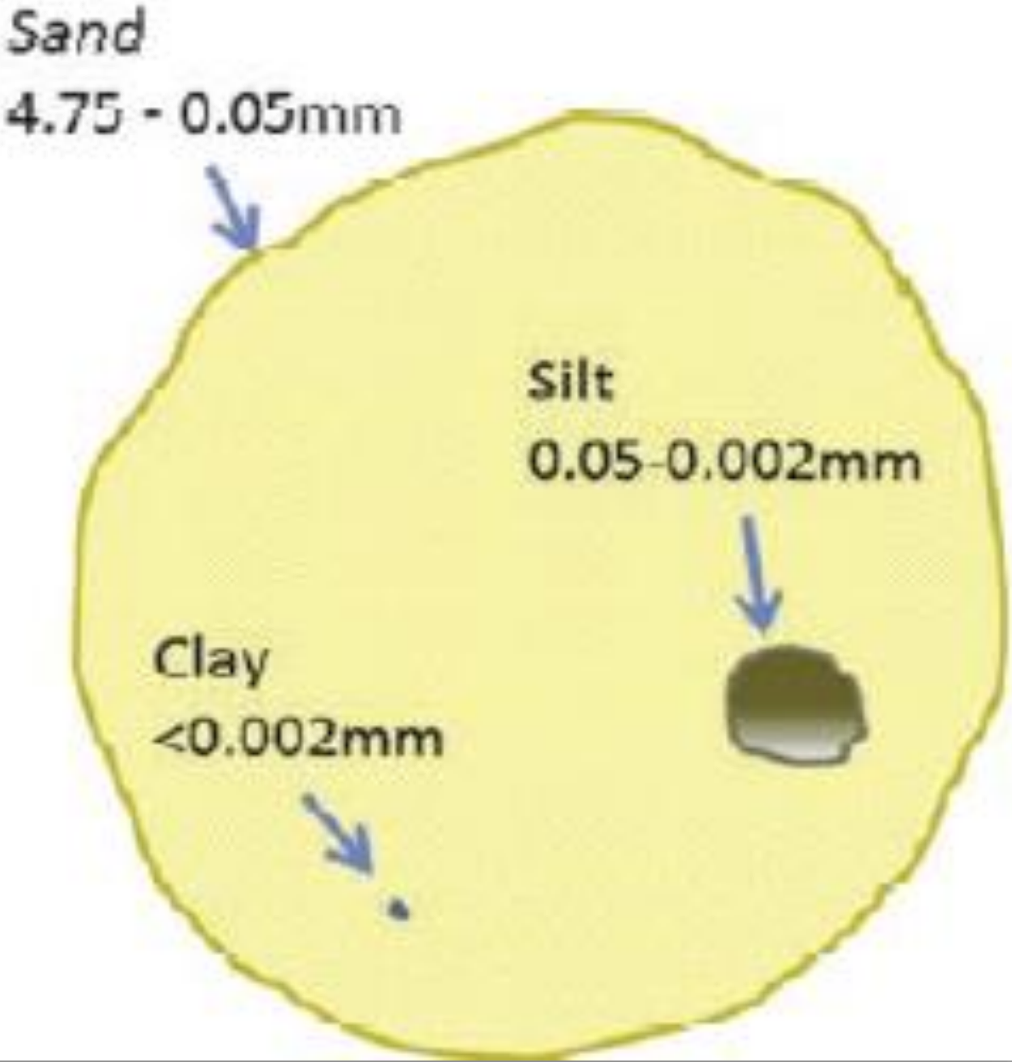
7-Ports.

8-Retaining structures.

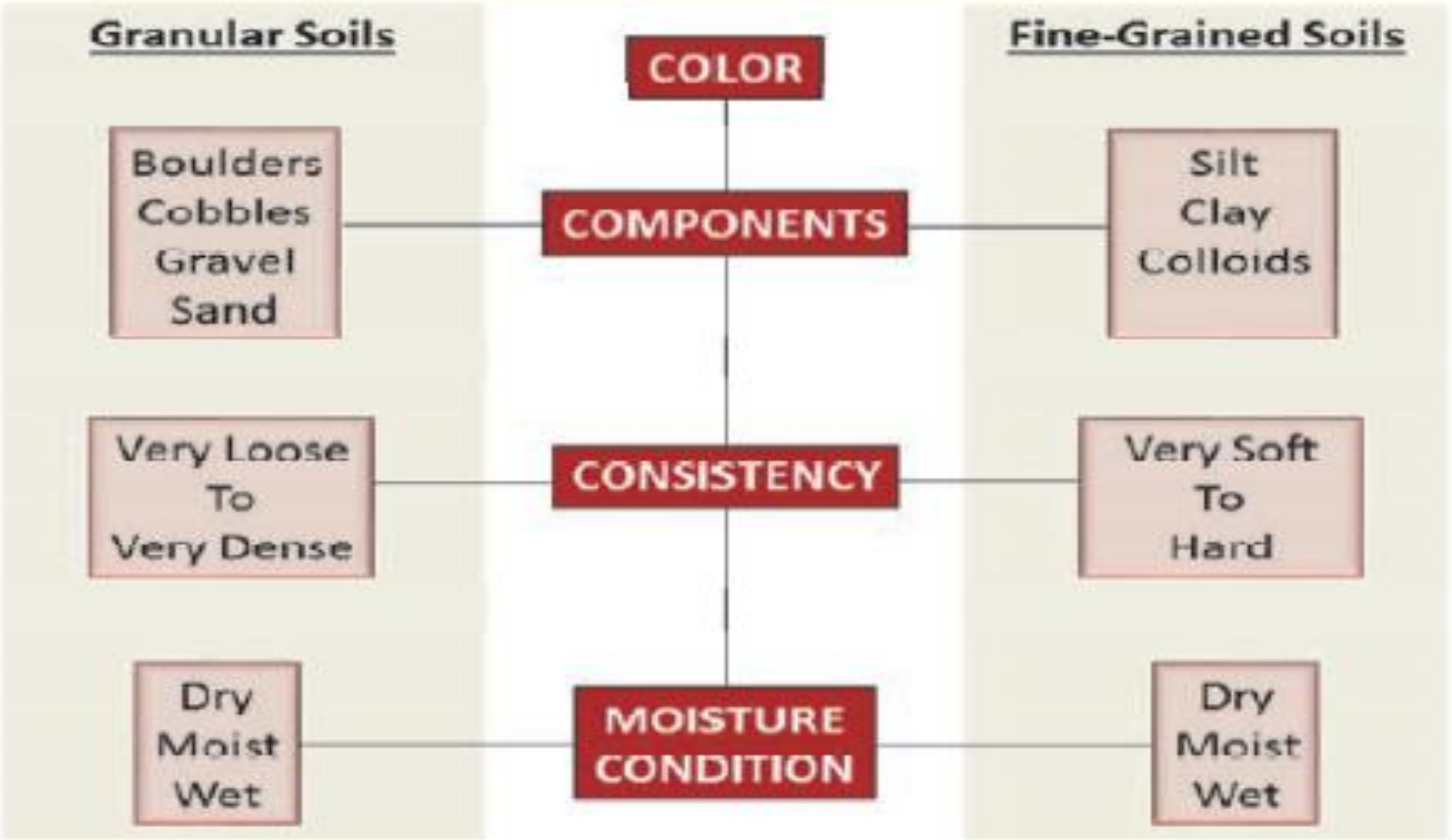
9-Slope stability.-------etc Towers such as Pisa and Evil.

Soil Types

- Granular soils (sand and gravel)
- Fine-grained soils (silts and clays)
- Organic soils (peat, organic clays and silts)



“MUD” Identification and Description



Field Identification of Soils

- Coarse grained (sand and gravel)
- Fine grained (silt and clay)
- Organic soil

Field Identification of Inorganic Fine-Grained Soils

- Sample behavior is the most common means of identifying silt and clays in the field

Shaking (Dilatancy) Test

Dry Strength Test

Thread Test

Smear Test

Select each test to learn more

Field Identification of Organic Soils

- Tips for identifying organic soils
  - Colors
  - Oxidation
  - Smell
  - Friable
  - Plasticity
  - Smear

Engineering Properties and Use of Soils

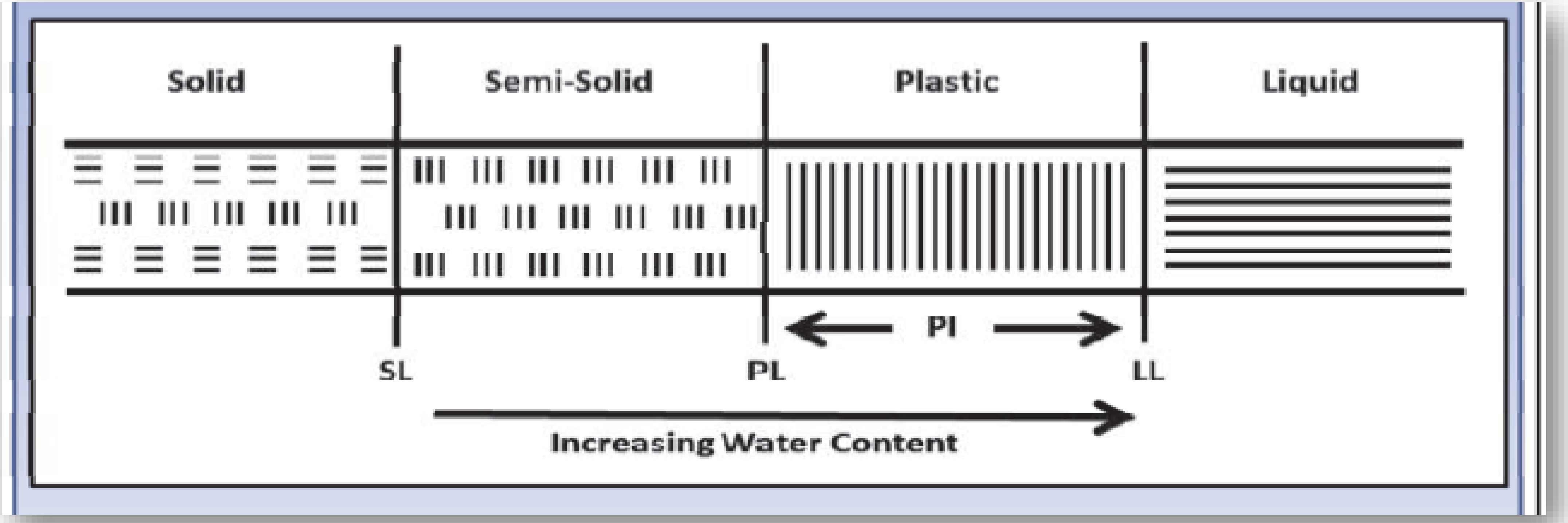
- Soil is weak relative to its weight and is variable
- Soil deposits, when treated in a consistent manner, can yield construction materials that are consistent with respect to the desired qualities of strength and durability

Engineering Use of Granular Soils

- Excellent foundation material
- Very good embankment material
- The best backfill material
  - Not frost susceptible
- Potential disadvantages
  - Difficulty dewatering
  - May be susceptible to settlement due to vibratory forces

Soil Description Examples

- Fine-grained soils
  - Soft, wet, gray, high plasticity clay with fine sand (alluvium)
    - A highly plastic clay with 15–29% fine sand
- Coarse-grained soils
  - Dense, moist, brown, silty medium to fine sand, with fine gravel to coarse sand (alluvium)
    - A medium to fine sand with more than 12% silt and more than 15% coarse sand/gravel


Solid
Semi-Solid
Plastic
Liquid
PI
SL
PL
LL
Increasing Water Content

Cohesive Soils (Clays)

- Classified based on LL and PI
- Strength largely derived from cohesion
  - Bond between clay particles
- Pure cohesive soils do not have a friction angle component to their strength

Engineering Properties of Cohesive Soils

- Often possess low shear strength
- Plastic and compressible
- Strength reduced by wetting or disturbance

Engineering Properties of Cohesive Soils

- High shrink-swell potential
- Practically impervious
- Clay slopes prone to landslides
- Poor material for backfill or embankments
  - Low permeability
  - Difficult to compact
  - Retain water coming through pavement structure (potential for swell)

Silts

- Similar to clays but exhibit no cohesion
  - Strength of silt deposits are due to friction angle and confining stress
- Engineering properties of silts
  - No cohesion
  - Relatively low shear strength
  - Relatively low permeability
  - High capillarity
  - Frost susceptibility

Engineering Properties of Silts Compared to Clays

- Silts characteristically have:
  - Better load-sustaining qualities
  - Less compressibility
  - More permeability
  - Less volume change

Organic Soils

- Peat
- Muck
- Organic silts and clays
  - Contain decayed animal and/or vegetative matter (organic matter)

Engineering Properties of Organic Soils

- Organic soils are problematic
  - Low shear strength
  - High compressibility
  - Lots of decaying plant matter
  - Create methane gas
  - Spongy structure which deteriorates rapidly
  - Acidity and other injurious characteristics to construction materials