

Principles of Soil Science Introduction



Lecture - 3 -



Calculating Soil Moisture

1- Gravimetric

– The mass of water in a given mass of soil (kg of water per kg of soil).

- $P_w =$ Percent water by weight or
- $P_w = \text{wt. water} \div \text{wt. O.D. soil}$
- $\text{Weight of water} = (\text{Wet Soil}) - (\text{O.D. Soil})$

$$P_w = \frac{(\text{Mass of wet soil} - \text{Mass of oven dry soil})}{\text{Mass of oven dry soil}} \times 100$$



2-Volumetric

The volume of water in a given volume of soil (m^3 of water per m^3 of soil).

$$P_v = \frac{(\text{Volume of Water in cm}^3)}{(\text{Volume of soil in cm}^3)} \times 100$$

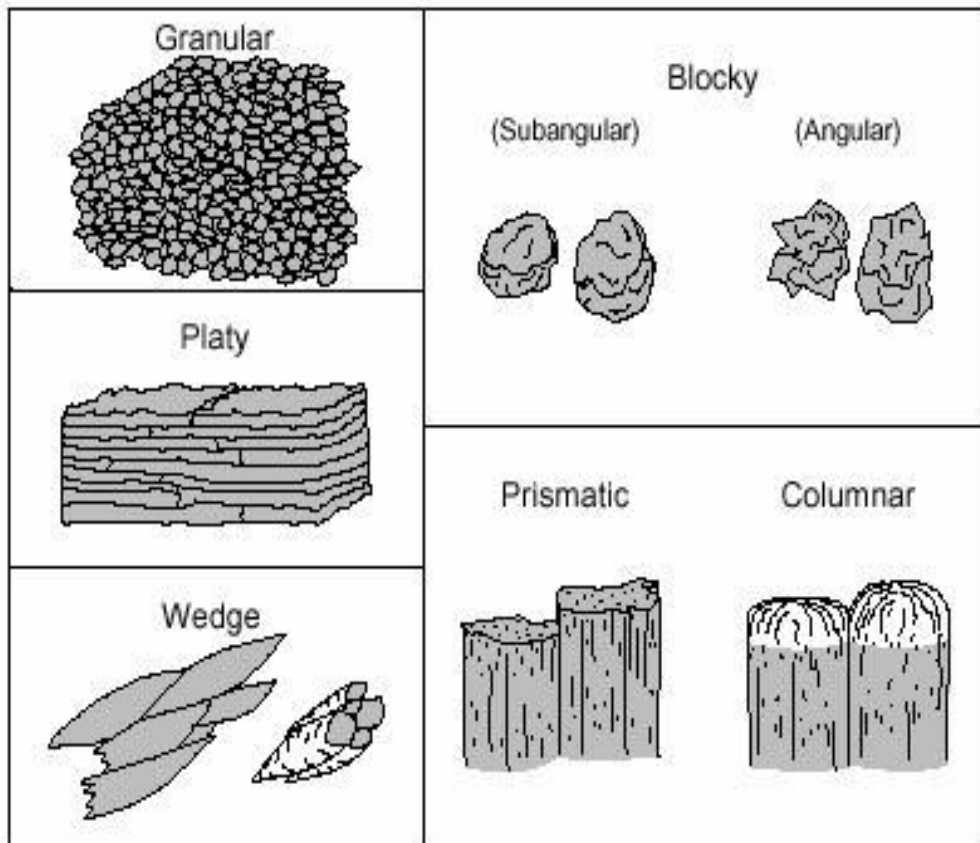
P_v = Percent volumetric

$$P_v = P_w \times \text{bulk density}$$



Structure

The clumping of the soil textural components of sand, silt and clay forms **aggregates** and the further association of those aggregates into larger units forms soil structures called **ped**s.



Examples of Soil Structure

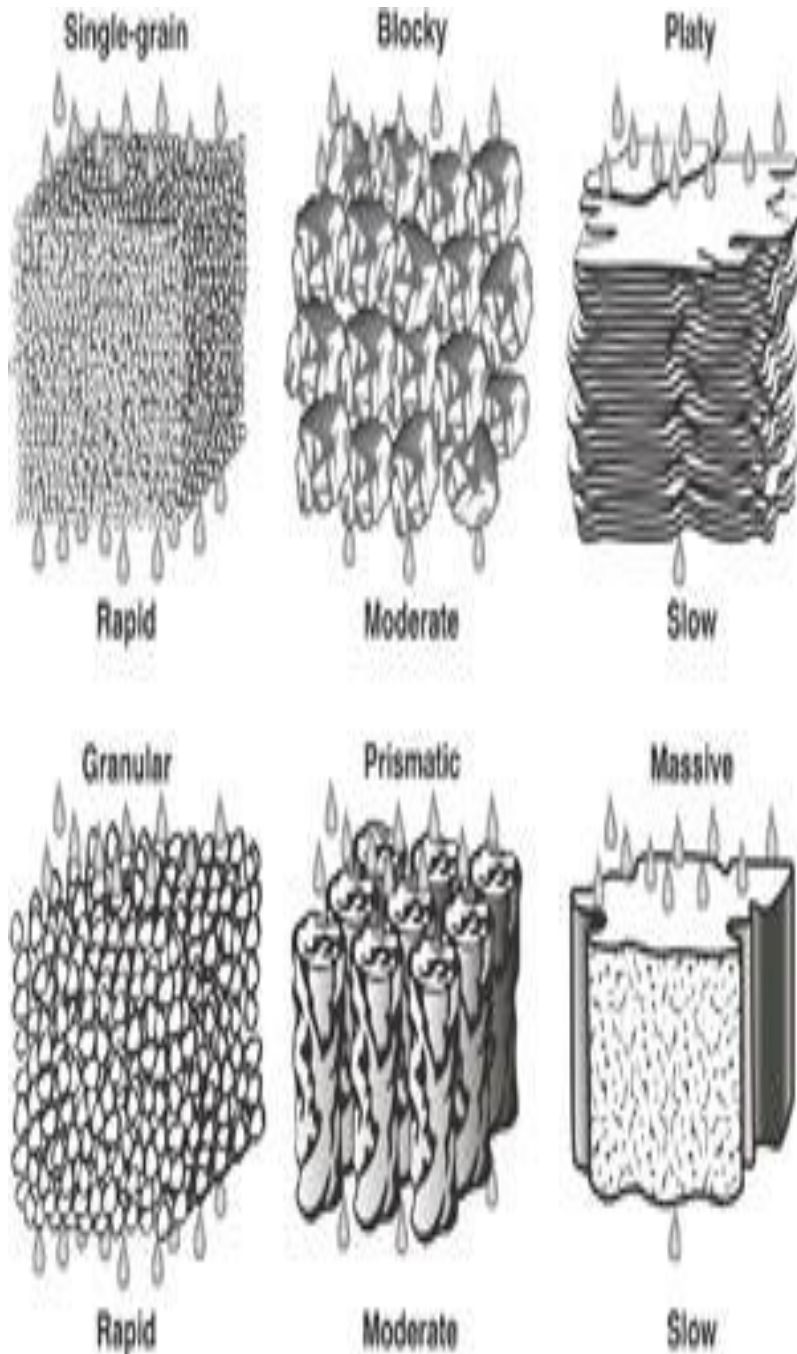
There are eight structural types commonly recognized in soil profiles:

- 1- **Granular,**
- 2- **Single grain,**
- 3- **Blocky,**
- 4- **Prismatic,**
- 5- **Columnar,**
- 6- **Platy,**
- 7- **Wedge, and**
- 8- **Massive.**

Structure

Affects permeability by influencing the path by which water can flow through the soil.

The type of structure determines the number of interconnected macro pores, which readily permit downward movement of water.



Aspects of Soil Structure

- The arrangement into aggregates of desirable shape and size
- The stability of the aggregate
- The configuration of the pores

Factors that affect...

Aggregate Stability

- Amount of clay
- Chemical elements
- Organic matter
- Biological activity

Soil Structure

- Organic matter
- Soil organisms
- Tillage
- Freezing and thawing
- Water movement

Soil Density

Density is the mass per unit volume of an object.
by the unit g.cm^{-3}

$$\text{Density} = \text{Mass} / \text{Volume}$$

Particle (Real or Actual) density

- Particle density :-

is equal to the mass of solid particles divided by the volume of solid particles.

- Particle density =
$$\frac{\text{Mass of solid particles}}{\text{Volume of solid particles.}}$$

Particle density

- It is the density of **only the mineral particles** that make up a soil; i.e., it excludes **pore space and organic material**.
- Soil particle density is typically **2.60 to 2.75 grams per cm³** and is usually unchanging for a given soil.
- Soil particle density is **lower for soils with high organic matter** content, and is **higher for soils with high Fe-oxides content**.

Soil bulk density

- **Soil bulk density**

is equal to the dry mass of the soil divided by the volume of the soil; i.e., it includes air space and organic materials of the soil volume. (**g.cm⁻³**)

Soil bulk density = Dry **mass** of the soil / **Volume** of the soil

Soil bulk density

A high bulk density is indicative of either soil compaction or high sand content.

The bulk density of cultivated loam is about 1.1 to 1.4 g/cm³

(for comparison water is 1.0 g/cm³)

***Soil bulk density is highly variable for a given soil.**

- A lower bulk density by itself does not indicate suitability.**
- For plant growth due to the influence of soil texture and structure.**
- Soil bulk density is inherently always less than the soil particle density.**

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بۇچى ھەردەم چرى ديار (الكثافة الظاهرية)

كەمترە لە چرى راستەقینە (الكثافة الحقيقية) ؟

Q/ Why the soil bulk density is less than particle density always time?

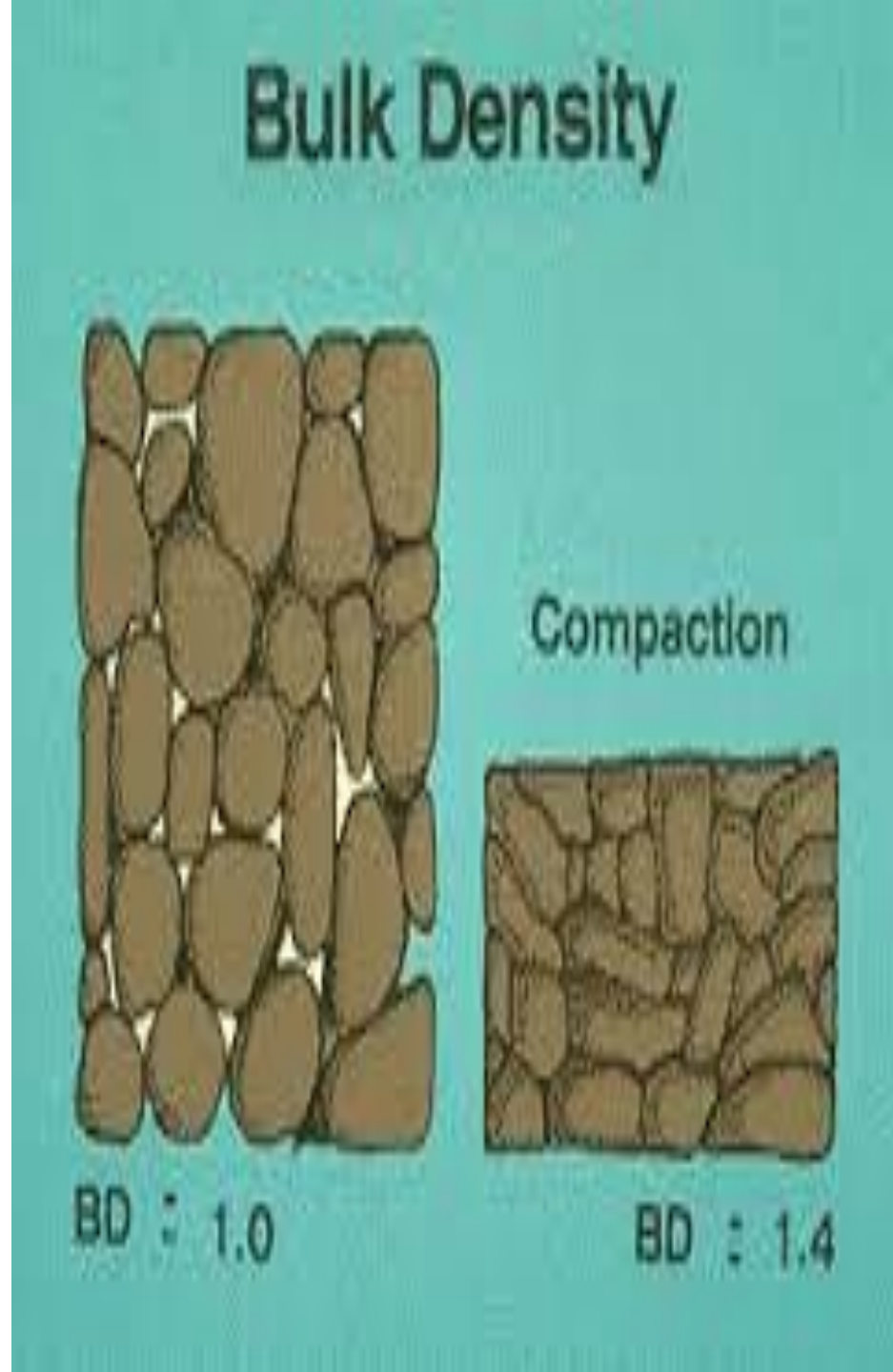
- **Bulk density**

is the mass of dry soil per unit volume, **including the air space**.

- **Bulk density**

has a major effect on the **movement of air and water in soils**.

- Soils with **high bulk densities** are often compacted.



Bulk Density

Soil compaction

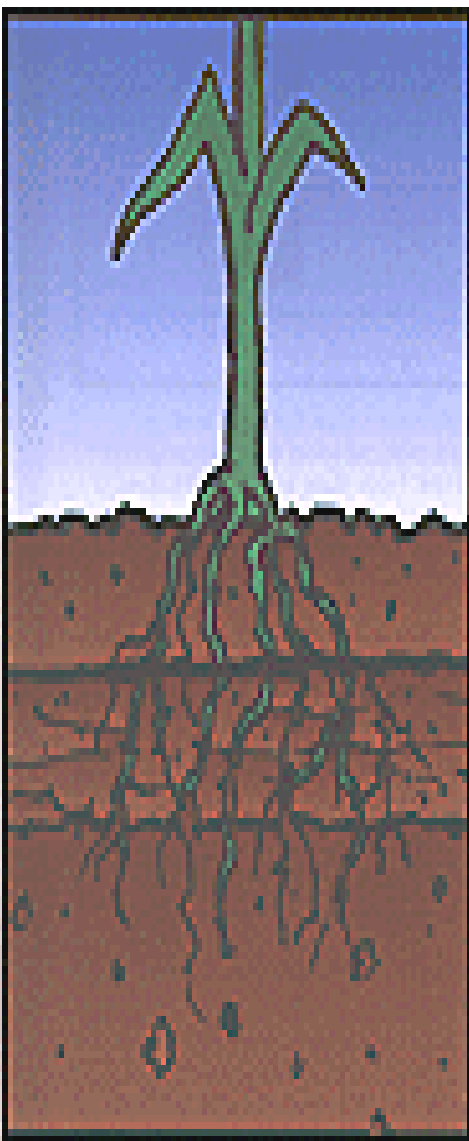
restricts rooting depth,

which reduces the uptake of

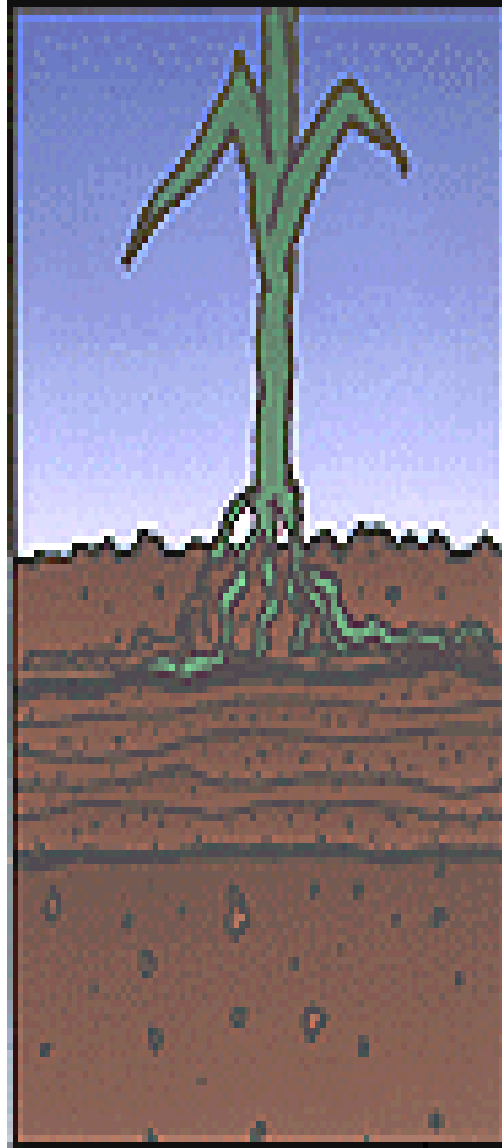
water and

nutrients by

plants.



No
Compaction

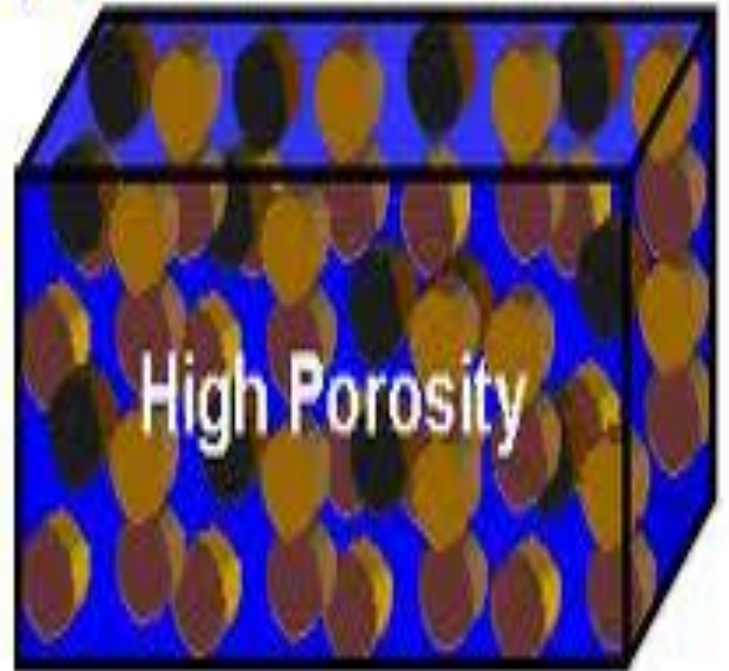
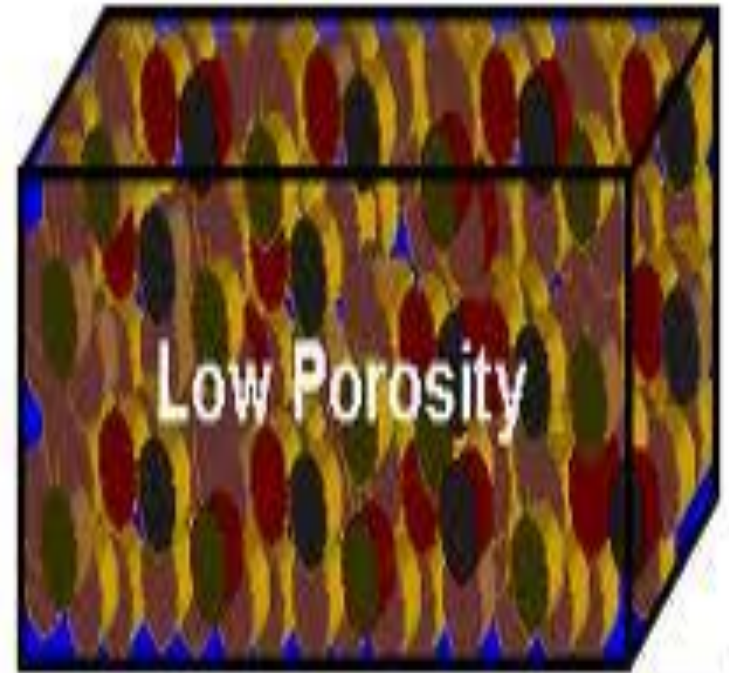


Compaction
(plow pan)

Porosity

Pore space is that part of the bulk volume that is not occupied by either **mineral** or **organic matter** but is open space occupied by either **gases** or **water**.

Ideally, the total pore space should be **50%** of the soil volume.



Calculating Porosity

- Total volume of core 98.2 g /1cm³
- Standard weight 185 g ,
- Oven dry weight 150 g , and
- 1g water equals to 1 cm³

$$\text{Porosity} = \frac{\text{Total Pore Volume}}{\text{Total Volume}}$$

Soil Color

- Indicator of different soil types
- Indicator of certain physical and chemical characteristics
- Due to humus content and chemical nature of the iron compounds present in the soil

Major Forms of Iron and Effect on Soil Color

<u>Form</u>	<u>Chemical Formula</u>	<u>Color</u>
Ferrous oxide	FeO	Gray
(Hematite)	Ferric oxide Fe ₂ O ₃	Red
(Limonite)	Hydrated ferric oxide 2Fe ₂ O ₃ · 3H ₂ O	Yellow

Soil Color

Causes of Soil Color

- Humus content
- Iron compounds in the soil .

Basic Soil Color Indications

- Indicator of different soil types.
- Indicator of certain physical and chemical characteristics.
- Due to humus content and chemical nature of the iron compounds.

Q / Write the relationship between **Organic matter** and **Bulk density** by depending on the depth of the earth? or with depth

