

SOIL STRUCTURE

Definition

"The arrangement and organization of primary and secondary particles in a soil mass is known as soil structure". (or) "The grouping and arrangement of individual soil particles is known as soil structure".

Significance of soil structure

1. Other soil properties like water movement, heat transfer, aeration, and porosity are influenced by structure.
2. The important physical changes imposed by the farmer in ploughing, cultivating, draining, liming, and manuring his land are structural.
3. Structure can be modified by cultivation and tillage operations while texture is an inherent property of soil and cannot be modified within short period of time.
4. Soil structure controls the amount of water and air present in soil. Plant roots and germinating seeds require sufficient air and oxygen for respiration.
5. Microbial activities also depend upon the supply of water and air in the soil.

Formation of soil structure

Soil particles are present as single individual grains and as aggregates *i.e.* group of particles bound together into granules or compound particles. These granules or compound particles are known as secondary particles. Particles in sandy and silty soils are present as single individual grains while in clayey soil they are present in granulated condition. The individual particles are usually solid, while the aggregates are not solid but they possess a porous or spongy character. Most soils are mixture of single grain and compound particle. Soils, which predominate with single grains are said to be structure-less, while those possess majority of secondary particles are said to be aggregate, granulated or crumb structure.

Mechanism of Aggregate Formation

The bonding of the soil particles into structural unit is called as the genesis of soil structure. The bonding between individual particles in the structural units is generally considered to be stronger than the structural units themselves.

In aggregate formation, a number of primary particles such as sand, silt and clay are brought together by the cementing or binding effect of soil colloids. The cementing materials taking part in aggregate formation are **colloidal clay, iron and aluminium hydroxides** and **decomposing organic matter**. Whatever may be the cementing material, it is ultimately the

dehydration of colloidal matter accompanied with pressure that completes the process of aggregation.

Classification

The primary particles - sand, silt and clay - usually occur grouped together in the form of aggregates.

Natural aggregates are called **peds** whereas **clod** is an artificially formed (due to ploughing, digging *etc.*) soil mass. Structure is studied in the field under natural conditions and it is described under three categories.

- 1) Type - Shape or form and arrangement pattern of peds
- 2) Class - Size of Peds
- 3) Grade - Degree of distinctness of peds

1. Types of Structure: There are four principal forms of soil structure

i) Plate-like (Platy)

In this type, the aggregates are arranged in relatively thin horizontal plates or leaflets. The horizontal axis or dimensions are larger than the vertical axis.

1. When the units/ layers are thick they are called platy
2. When they are thin then it is laminar.

Platy structure is most noticeable in the surface layers of virgin soils but may be present in the subsoil. This type is inherited from the parent material, especially by the action of water or ice.

ii) Prism-like: The vertical axis is more developed than horizontal, giving a pillar like shape.

1. Vary in length from 1- 10 cm.
2. Commonly occur in sub soil horizons of Arid and Semi arid regions.
3. When the tops are rounded, the structure is termed as columnar when the tops are flat / plane, level and clear cut - prismatic.

iii) Block like:

1. All three dimensions are about the same size.
2. The aggregates have been reduced to blocks.
3. Irregularly six faced with their three dimensions more or less equal.
4. When the faces are flat and distinct and the edges are sharp angular, the structure is named as angular blocky.
5. When the faces and edges are mainly rounded it is called sub angular blocky.

6. These types usually are confined to the sub soil and characteristics have much to do with soil drainage, aeration and root penetration.

iv) Spheroidal (Sphere like):

1. All rounded aggregates (peds) may be placed in this category.
2. Not exceeding an inch in diameter.
3. These rounded complexes usually loosely arranged and readily separated.
4. When wetted, the intervening spaces generally are not closed so readily by swelling as may be the case with a blocky structural condition.
5. Therefore in sphere-like structure, infiltration, percolation and aeration are not affected by wetting of soil.
6. The aggregates of this group are usually termed as granular which are relatively less porous.
7. When the granules are very porous, it is termed as crumb.
8. This is specific to surface soil particularly high in organic matter/ grass land soils.

2. Classes of Structure

Each primary structural type of soil is differentiated into 5 size classes depending upon the size of the individual peds.

The terms commonly used for the size classes are:

1. Very fine or very thin
2. Fine or thin
3. Medium
4. Coarse or thick
5. Very Coarse or very thick

The terms thin and thick are used for platy types, while the terms fine and coarse are used for other structural types.

3. Grades of Structure

Grades indicate the degree of distinctness of the individual peds. It is determined by the stability of the aggregates. Grade of structure is influenced by the moisture content of the soil. Grade also depends on organic matter, texture etc. Four terms commonly used to describe the grade of soil structure are:

1. **Structure-less:** There is no noticeable aggregation, such as conditions exhibited by loose sand.
2. **Weak Structure:** Poorly formed, indistinct formation of peds, which are not durable and much un-aggregated material.

3. Moderate structure: Moderately well developed peds, which are fairly durable and distinct.
4. Strong structure: Very well formed peds, which are quite durable and distinct.

Structure naming

For naming a soil structure the sequence followed is grade, class and type; for example strong coarse angular blocky, moderate thin platy, weak fine prismatic.

Factors Affecting Soil Structure

The development of structure in arable soil depends on the following factors:

1. Climate: Climate has considerable influence on the degree of aggregation as well as on the type of structure. In arid regions there is very little aggregation of primary particles. In semi arid regions, the degree of aggregation is greater.

2. Organic matter: Organic matter improves the structure of a sandy soil as well as of a clay soil. In case of a sandy soil, the sticky and slimy material produced by the decomposing organic matter and the associated microorganism cement the sand particles together to form aggregates. In case of clayey soil, it modifies the properties of clay by reducing its cohesiveness. This helps making clay more crumby.

3. Tillage: Cultivation implements break down the large clods into smaller fragments and aggregates. For obtaining good granular and crumby structure, optimum moisture content in the soil is necessary. If the moisture content is too high it will form large clods on drying. If it is too low some of the existing aggregates will be broken down.

4. Plants, Roots and Residues

1. Excretion of gelatinous organic compounds and exudates from roots serve as a link
2. Root hairs make soil particles to cling together. Grass and cereal roots Vs other roots
3. Pressure exerted by the roots also held the particles together
4. Dehydration of soil - strains the soil due to shrinkage result in cracks lead to aggregation
5. Plant tops and residues - shade the soil - prevent it from extreme and sudden temperature and moisture changes and also from rain drop impedance. Plant residues - serve as a food to microbes which are the prime aggregate builders.

5. Animals : Among the soil fauna small animals like earthworms, moles and insects etc., that burrow in the soil are the chief agents that take part in the aggregation of finer particles.

6. Microbes: Algae, fungi, actinomycetes and fungi keep the soil particles together. Fungi and actinomycetes exert mechanical binding by mycelia, Cementation by the products of decomposition and materials synthesized by bacteria.

7. Fertilizers: Fertilizer like Sodium Nitrate destroys granulation by reducing the stability of aggregates. Few fertilizers for example, CAN help in development of good structures.

8. Wetting and drying: When a dry soil is wetted, the soil colloids swell on absorbing water. On drying, shrinkage produces strains in the soil mass gives rise to cracks, which break it up into clods and granules of various sizes.

9. Exchangeable cations: Ca, Mg - Flocculating; Good structure

H, Na - Deflocculating; Poor structure

10. Inorganic cements: CaCO_3 and Sesquioxides

11. Clay and Water

Effect of Soil Structure on other Physical Properties

Porosity: Porosity of a soil is easily changed. In plate like structure, pore spaces are less where as in crumby structure pore spaces are more.

Temperature: Crumby structure provides good aeration and percolation of water in the soil. Thus these characteristics help in keeping optimum temperature in comparison to plate like structure.

Density: Bulk density varies with the total pore space present in the soil. Structure chiefly influences pore spaces Platy structure with less total pore spaces has high bulk density where as crumby structure with more total pore spaces has low bulk density.

Consistence: Consistence of soil also depends on structure. Plate-like structure exhibits strong plasticity.

Colour: Bluish and greenish colors of soil are generally due to poor drainage of soil. Platy structure normally hinders free drainage.

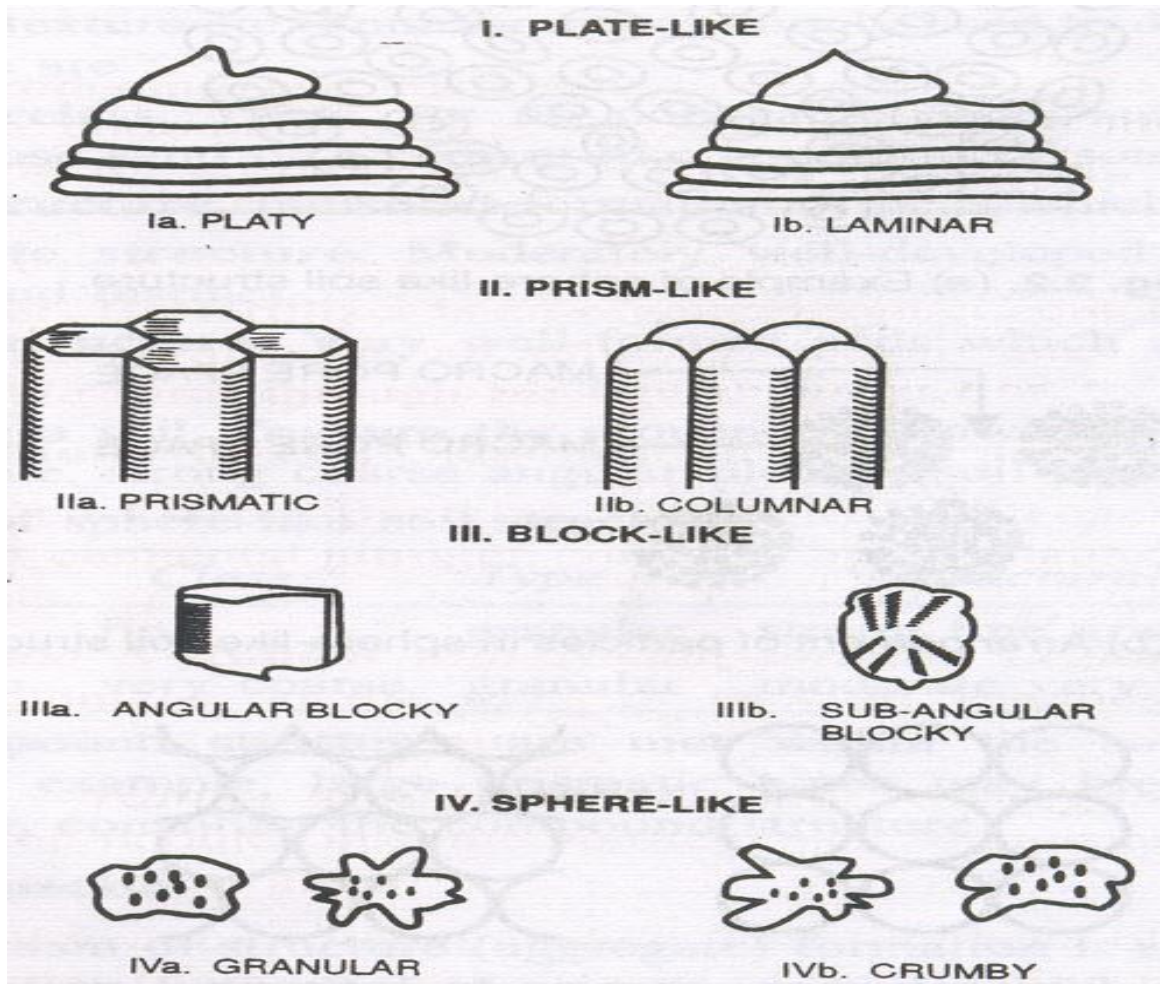
Importance of Structure

Soil structure influences rather indirectly by the formation of an array of pores of various shapes and sizes. These pores are controlling factors governing water, air and temperature in soil.

The role of soil structure in relation to plant growth

1. Soil structure influences the amount and nature of porosity.
2. Structure controls the amount of water and air present in the soil. Not only the amount of water and air dependent on soil structure, but their movement and circulation are also controlled by soil structure.
3. It affects tillage practices.
4. Structure controls runoff and erosion.

5. Platy structure normally hinders free drainage whereas sphere like structure (granular and crumby) helps in drainage.
6. Crumby and granular structure provides optimum infiltration, water holding capacity, aeration and drainage. It also provides good habitat for microorganisms and supply of nutrients.



 The image cannot currently be displayed.