RAMA UNIVERSITY

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FACULTY OF MEDICAL SCIENCES

SOIL STRUCTURE

Studying the properties of soil separates is not enough to understand the behaviour of the composite soil body, but the manner in which the various particles are packed and held together in a continuous spatial network (Soil matrix or fabric) is to be considered to understand the soil. The primary particles do not exist as such but are bound together with varying degrees of tenacity in to larger units or aggregates usually termed as Secondary Particles. These are naturally occurring semi-permanent clusters or groups of soil particles, the binding forces between which are much stronger than the forces between adjacent aggregates.

Soil Structure may be defined as 'the arrangement of primary particles (sand, silt and clay), secondary particles (aggregates) and voids (pores) in to a certain definite pattern under field conditions'. In the broad sense Soil Structure denotes: a) the size, shape and arrangement of particles and aggregates; b) the size, shape and arrangement of the voids or spaces separat ing the particles and aggregates; and c) the combination of voids and aggregates in to various types of structures.

Peds – Natural aggregates which vary in their water stability. **Clod –** It is used for a coherent mass of soil broken in to any shape by artif icial means such as by tillage. **Fragment -** It is a broken ped. **Concretion –** It is a coherent mass formed with in the soil by the precipitation of certain chemicals dissolved in percolating waters. Concretions are usually small like shotgun lead pellets.

Classification of Structure: Classification of soil structure for field description is based on i) the **type** as determined by the shape and arrangement of peds ii) the **class,** as differentiated by the size of the peds and iii) the **grade**, as determined by disti nctness and durability of peds.

TYPES: As per the geometric shape, the aggregates can be broadly divided in to two types.

1. Simple structure   2. Compound structure

1. Simple structure: In this the natural cleavage plains are absent or indistinct.

a. Single grain structure: Occur in sandy soils

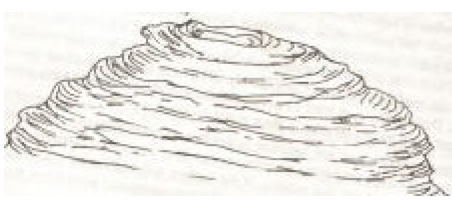
b. Massive structure: Coherent mass with high bulk density occur in soil crusts, paddy soils

c. Vesicular or honeycomb structure: Massive or loose aggregates of nodular ferruginous mass. seen in laterites.

Compound Structure: The natural cleavage plains are distinct. Described with relative length of horizontal and vertical axes and shape of peds.

Spheroid al: Small rounded peds with irregular faces and are usually separated from each other in a loosely packed arrangement. When spheroidal peds are porous, the structure is called as Crumb, while less porous peds are called granular**.** Usually granular peds are <1cm, while crumb peds are<0.5 cm in diameter. The diameter typically ranged from 1.0 t o 10.0 mm.

Granular and crumb structures are characteristic of many surface soils (A horizon) particularly those high in organic matter. They are prominent in grassland soils and soils that have been worked by earth worms. This structure is invariably subjected to management practices.



Platy Structure

Plate like: Relatively thin horizontal peds or plates characterize this structure. The thicker units are called **Platy** and thinner ones are called **Laminar**. The platy types are often inherited from parent materials,

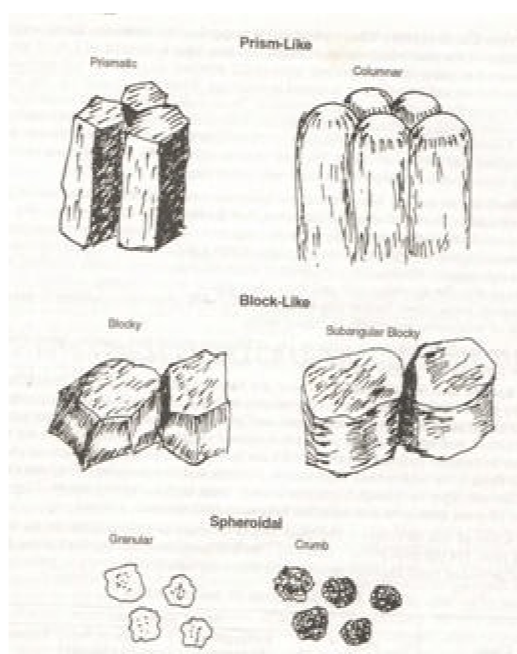


Fig. 3.1 : Types of soil structure found in mineral soils

especially those laid down by water or ice. Sometimes, compaction of clayey soils with heavy machinery can create platy structure. Found in surface layers of some virgin soils.

Block Like: Blocky peds are irregular, roughly cube-like and range from 5 to 50 mm across. The individual block are not shaped independently but are molded by the shapes of the surrounding blocks. When the edges of the blocks are sharp and rectangular faces distinct, they are called **angular blocky**, and when faces and edges are some what rounded they are referred as **sub- angular blocky**. These types are usually found in B horizons, where they promote good drainage, aeration and root penetration.

Prism – Like: These are vertically oriented pillar like peds with varying heights among different soils and may have a diameter of 150 mm or more.

In **columnar** structure pillars have distinct rounded tops, and in invariably found in sub- soils high in sodium (nitric horizon). If the tops of the pillars are relatively angular and flat horizontally, the structure is designated as **Prismatic**. These structures are associated with welling types of clay and commonly occur in sub surface horizons in arid and semi-arid regions.

- Influences soil drainage and availability of plant nutrients.

Management of soil structure: Soil structure management aims at the improvement and maintenance of soil structure, which are the major challenges in cultivated lands. The general principles relevant to structure management are :

- Tilling soils at optimum moisture conditions to ensure least destruction of soil structure.
- Suitable tillage and minimum tillage practices to minimize the loss of aggregate stabilizing organic substances.
- Covering soil surface with organic materials (mulch) to mitigate the beating action of rain and to add organics to soil.

- Incorporation of crop residues and animal manures in to soil, which upon decomposition, would stabilize soil aggregates.
- Suitable cropping systems, application of phosphatic fertilizers, inclusion of grasses and sod crops in the rotation, would enhance organic matter and favor stable aggregation.
- Green manuring and cover crops are good sources of organic matter.
- Use of synthet ic organic amendments or soil conditioners

COLE: (Coefficient of Linear Extensibility) The expansiveness of a soil can be quantified as the coefficient of linear extensibility. If the value is >0.03 it indicates that soils are black soils with considerable expandable minerals (smectite). If > 0.09 Vertisols

$$COLE = (Lm - Ld) / Ld \times 100$$

Lm = Length of bar shaped soil, when moistened to its plastic

limit Ld = Length of bar shaped soil, when air dried.

Soil crusting: Soil crusting is the phenomena associated with deterioration of soil structure, where the natural aggregates break and disperse due to impact of rain drops, followed by rapid drying due to radiant energy of the sun.

When the rain droops strike the exposed dry soil surface, there is disintegration and dispersion of the aggregates. The finer clay particles move down along with infiltrating water and clog the pores, immediately beneath the surface thereby sealing the soil surface. Later when drying starts surface tension forces pull the soil particles together, tending to form a dense and strong layer known as soil crust. Larger is the rain drop thicker may be the crust. Invariably crust thickness is about 5.0 mm.

Crust can form on all soils, excepting sands, but is severe on silty clay loams of older alluvial terraces and levees due to thin unstable structure.

Soil factors that are commonly associated with crusting are low organic matter, high silt and high exchangeable sodium.

The thickness of crust increases with increase in clay content. Montmorillonite clay forms thick and hard crust, whereas kaolinite clay form thin crust.

Soil crusting is the important factor affecting emergence and early growth of seedling and largely determines the crop stand. It is characterized by high B.D ., very low non-capillary pores, very low hydraulic conductivity, very low aeration , high penetration resistance and high run-off of water.

Soil **crust strength** can be evaluated by using **penetrometer, balloon pressure technique and modulus of rupture test.**

Management or Control of Soil Crusting:

- Surface mulches minimize formation of soil crust
- Addition of organic matter
- Close growing crops and grasses which cover the soil
- Application of SSP or gypsum
- Application of artificial conditioners
- A light tillage when the soil is still moist will break up the crust before it hardens.
- Crop rotation
- Seed line mulch technology
- Deep ploughing
- Frequent inter cultivation and light irrigation
- Crop residual recycling technology

CLASS: Based on the size of the individual peds, the primary structural types are differentiated in to five sub-classes.

Size or class	Granular (mm)	Platy (mm)	Blocky(mm)	Prismatic(mm)
Very fine or very thin	<1	<1	<5	<10
Fine or thin	1-2	1-2	5-10	10-20
Medium	2-5	2-5	1-20	20-50
Coarse or thick	5-10	5-10	20-50	50-100
Very coarse or very thick.	>10	>10	>50	>100

In case of crumb structure, less than 1.0 mm is very fine; 1-2 mm is fine and 2-5 mm is medium class. The terms thin and thick are used for platy type (very fine <1 mm and very thick >10 mm), while the terms fine and coarse are used for other structural types (very fine blocky <5 mm and very coarse blocky >50 mm)

GRADES: Grade determines the degree of distinctness and durability of individual peds .

Structure less or simple structure: When there is no observable aggregation or there is no line of cleavage indicating the presence of peds e.g. single grain, soil particles in sand dune areas and massive structure (no cleavage lines) in puddle soil from a rice field.

Weak: Poorly formed, non -durable, indistinct peds and break in to a mixture of a few entire and many broken peds and much unaggregated material.

Moderate: Moderately well developed peds which are fairly durable and distinct.

Strong: Very well formed peds, which are quite durable and distinct.

Importance of soil structure

- Influences the amount and nature of porosity in soils.

- Governs the water and air permeability in to soils.

Influences water holding capacity, soil -water relationship and growth of microorganisms.