RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

SOIL CONSISTENCE

Soil consistenc e is a dynamic physical property of soils, which varies with the variation of soil moisture and applied stress. It implies that the knowledge about soil water and its attraction for soil materials is a prerequisite, to know about soil consistency.

Soil consistency is defined as the manifestation of the physical forces of cohesion and adhesion acting within the soil at various moisture constants. These manifestations include the behaviour toward gravity, pressure, thrust and pull; the tendency of soil mass to adhere to foreign bodies or substances; the sensations, which are evidenced as feel by the fingers of the observer.

Cohesion refers to the attraction of substances of like characteristics such as that of one water molecule to another. Adhesion is the attraction of unlike materials i.e., attraction of water molecule for the s oil particle.

Soil consistency depends on the texture, nature and amount of inorganic and organic colloids, structure and moisture content etc., With decreasing moisture content, the soils loose their stickiness and plasticity and become friable and soft and finally when dry become hard and coherent.

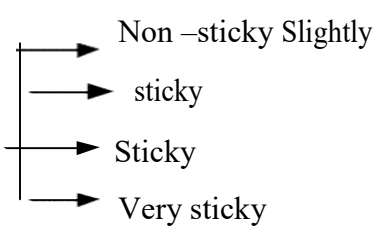
Consistency is expressed based on moisture levels like wet, moist and dry

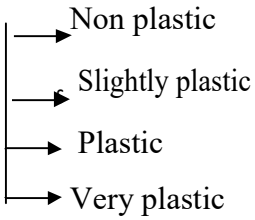
Wet soils: Soils are saturated with water.

Stickness (property of stickiness or adherence to various objects)

and Capacity of soil to be molded)

Plasticity (property of toughness





Moist soils: Moist consistency is determined, at a moisture content approximately mid way between air-dry and field capacity. It is very important as it describes the condition of soils, when they are tilled in the field.

Loose (non-coherent)

Very friable (soil material crushed under very gentle pressure; coheres when pressed together

Friable (soil material crushed easily under gentle pressure)

Firm (soil material crushes under moderate pressure between thumb and forefinger, resistance is distinctly noticeable)

Very firm (soil barley crushable between thumb and forefinger)

Extremely firm (soil can not be crushed between thumb and fore finger)

Dry soils: Rigidity, brittleness, maximum resistance to pressure, tendency to crush to a powder and inability of a crushed material to cohere again when pressed together, characterize Consistency of soils in dry soils.

Loose (non coherent)

Soft (soil mass is very weakly coherent, breaks easily to powder)

Slightly hard (easily broken between thumb and forefinger)

Hard (Moderately resistant to pressure, can be broken in the hands without difficulty but is barely brea kable between thumb and forefinger) Very hard (can be broken in the hands only with difficulty) Extremely hard (can not be broken in the hands)

Atterberg's consistency limits: Atterberg's limits are used to relate soil water content limits and various states of soil consistency. The state of consistence between solid and liquid range is divided into a number of distinct stages.. Water content limits have been imposed for various states of consistence. These limits are called Atterberg's limits.

Shrinkage limit Plastic limit Liquid limit

W=0 WSL WPL WLL W 100%

¦? Solid state? ¦? Semi solid state ? ¦? Plastic state? ¦? liquid state ? ¦

Liquid limit (W_{LL}) : It is the water content at which soils is practically liquid but possesses a small shearing strength. This is also termed as upper plastic limit. At this poin t the water film becomes so thick that cohesion is decreased and soil mass flows under an applied force. It is the water content above, which a mixture of soil and water flows as a viscous liquid and below which the material is plastic.

Plastic limit (W_{PL}) : It is the minimum water content at which a soil is plastic and the soil threads start to crumble. This is also known as lower plastic limit. At this point sufficient water is available like a film around each particle, lead to sliding of particles one over other with maximum cohesion. The number of water film around particles and total water adsorbed is regulated by nature and quantity of colloidal material present in the soil.

Shrinkage limit : It is the water content of soil at which soil transf orms from the semi- solid state to the solid state. The shrinkage limit is attained at that water content at which the volume of soil remains constant regardless of drying. As drying proceeds a meniscus begins to form at the surface and react against soil grains producing a compression effect between the grains due to surface tension. When water tension is maximum further recession of mensci would cause no increase in stress and shrinkage. This water content is called shrinkage limit.

Soil plasticity : It is the pliability or capacity of the soil to be molded. It is one range of consistence of soil. Plasticity is defined as the property which enables a clay / soil to take -up water, to form a mass that can be deformed in to any desirable shape and to maint ain the shape after the deformation pressure is removed.

Plasticity results from plate like nature of clay particles and the combined binding /

lubricating effect of adsorbed water. With the adsorption of water, thin films are formed around the particles. With applied pressure or force the particles slide over each other and are held in that condition by the tension of moisture films even after the pressure is removed. Any soil can exhibit plasticity, if it contains more than 15% clay.

Plastic limits or Indices of plasticity : Plasticity exhibited over a range of moisture contents are referred as plastic limits. There are three indices called the lower plastic limit or simply the plastic limit; the upper plastic limit or liquid limit and the plasticity in dex.

Plastic limit is the lowest moisture content at which a soil can be deformed without cracking. It is the upper limit of moisture content for tillage operation for most crops except rice. Tilling at moisture content above plastic limit, results in smearing and puddling of soil. The upper plastic limit or liquid limit is the moisture content at which soil ceases to be plastic. It becomes semi fluid and tends to flow like a liquid under an applied force.

The difference in moisture content between up per and lower plastic limits is the range over which a soil remains plastic is called plasticity index. Soils with high plasticity indices are difficult to plough.

Factors effecting plastic limits

- High clay content in soil, offers more surface area, thereby increases plasticity number.

2:1 expanding type clay colloids i.e., montmorillonite increases the plasticity index or number. The difference in moisture content between up per and lower plastic limits is the range over which a soil remains plastic is called plasticity index. Soils with high plasticity indices are difficult to plough.

Factors effecting plastic limits

- High clay content in soil, offers more surface area, thereby increases plasticity number
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- Sodium saturated montmorillonite has the highest plastic limit as compared to K, Ca and Mg saturated montmorillonite clay.

- Higher the hydration energy of adsorbed cation, higher is the plastic number.

Organic matter decreases the plastic number of a given clay soil. Hydration of organic matter must be complete before sufficient water is available for film.