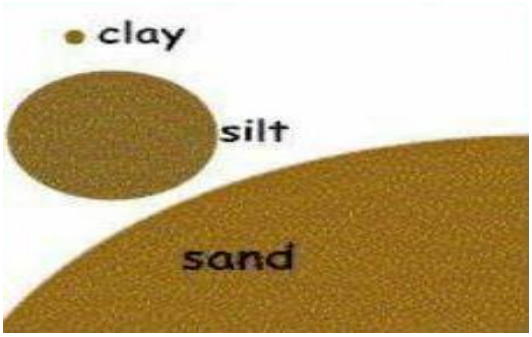
Physical properties of soils:
Determination of soil texture

A soil's texture is the relative proportions of the various size groups of individual soil grains (namely sand, silt, or clay) in a soil. Together, the three separates must add up to be 100%. The organic matter is not a part of the soil's texture. Since there are such a large number of combinations that could occur, soil scientists group similar amounts of sand, silt and clay into groups called soil textural classes.

The three soil particles are:



The importance of soil texture:

- 1. To determine the suitable growing crops.
- 2. To identify the suitable irrigation system.
- 3. To select the type of tillage implements.

SOIL CHARACTERISTICS RELATED TO TEXTUR:

Soil texture influences many soil physical properties,

1. Sandy Soils
   - Particles create large pore spaces that improve aeration. Water flows through the large pore spaces quickly (high permeability)
- Soils with a high percentage of sand are generally well-drained.
- Lack the ability to hold nutrients and are not fertile).

2. Clay Soils (-It creates very small pore spaces, (low permeability) resulting in poor aeration and poor water drainage. It has the ability to hold both nutrients and water that can be used by plants).

3. loamy soils: (Loamy soil is the mixture of sand, clay and silt. It contains more moisture, nutrients and humus compared to sandy soil and better drainage compared to clay and silt soil. It has the right water holding capacity needed for the growth of plants.

***Factor affecting soil aggregates*:**

1- Type of clay minerals. 2- Organic matter.

3- Al, Fe oxide. 4- Lime (CaCO3), Gypsum.

5- Cations (Ca, Mg, K)

The principle depends on separation of soil particle from another or separation of soil aggregates without rupturing the soil particles by the following processes.

1- Remove of salts: It is by washing the soil with distilled water.
2- Remove of organic matter. It is by addition of hydrogen peroxide 30% (H_2O_2), which causes oxidation of organic matter.
3- Addition of Calgon (sodium hexameta phosphate) which causes desperation of soil particles from another, by replacing of calcium and magnesium by sodium on the surface of soil particles.

Methods for determination of soil texture

- (Field Determination) Feel method or ribbon method:
- Lab. Methods or sedimentation method:

1-Field Determination of Soil Texture

Characteristic Feel of the Soil particle

1. **Sand:**

- Gritty feel
- Particles can be seen with the naked eye
- Hand sampling: No residue left on hand

- If the soil is not 'sticky' enough, it could not be to form a ball or ribbons

2. Silt:

- Dry: Powdery smooth feel, flour-like

- Wet: Creamy slick, slippery feel
- No sticky or plastic or malleability
- Particles can be seen with a hand lens or microscope
- Hand sampling: Coats hand, able to brush off.

3. Clay:

- Wet: Sticky, plastic feel
- Dry: extremely smooth, powdery feel
- Particles can be seen with an electron microscope
- Easily formed into long ribbons

2- **Laboratory Method or (Sedimentation Method)**

Methods of determination:

1- Hydrometer. 2- Pipette. 3- Sieve. 4-Centerfuge.

Two common methods of particle size distribution are:-

a. The pipette method

b. Hydrometer methods.

In both, the coarser fractions are measured by sieving, and the finer from sedimentation rates based on Stokes' law. Stokes' law states that the amount that a particle sinks depends upon the density of the particle, denser (larger) particles sink more than less dense (smaller) particles when suspended in a liquid. Sheldrake and Wang, indicate that Stokes'_law describes small spherical particles of density, P_S, and radius, r, settling through a liquid of density, P_L, and viscosity, η, at a rate of.

$$V = \frac{2r^2 g\,(\rho s - \rho f)}{9\eta}$$

V= Velocity of fall	cm/sec
g= Acceleration of gravity	980 cm/sec^2
P_s = Density of particles	2.65 gm/cm^3
P_f = Density of liquid	1.0 gm/cm^3
r = Radius of the particle	cm
η = Absolute viscosity of the liquid	0.01 g/cm.sec (poise)

Soil textural class

- Soil textural classes are based on the relative proportions of the various soil separates (sand, silt, and clay).
- You may determine the textural class of the soil by referring to the textural triangle.
- There are 12 different soil textural classes.

USDA Soil Texture Classes

1. Sand (S)
2. Loamy sand (LS)
3. Sandy loam (SL)
7. Sandy clay loam (SCL)
8. Clay loam (CL)
9. Silty clay loam (SiCL)

4. Loam (L) 10. Sandy clay (SC)

5. Silt loam (SiL) 11. Silty clay (SiC)

6. Silt (Si) 12. Clay (C)

Rarely do soils consist entirely of a single separate, but instead are a mixture. Textural classes are based on different combinations of sand, silt, and clay. The term loam refers to soils having a moderate amount of sand, silt, and clay. Thus, loamy soils have textural properties intermediate to the properties of the individual separates. A sandy loam soil has a soil texture somewhat coarser than a loam and a loamy sand soil has a texture somewhat finer than a sand. Those textural classes with the term sand in the name are often modified to indicate the fineness of the sand. A very coarse sand, for example, will have different properties than a very fine sand.

Soil texture describes the size distribution of individual soil particles. Specifically, **texture is defined as the relative distribution of various sized particles**.

However, texture is generally used to reference the proportions of sand, silt, and clay. The particle sizes in each of these three **soils separates** ranges between specific limits. The distinctions among the size groups are more or less arbitrary. They have been arrived at after many trials in developing classes that can be used consistently, conveniently, and best describe the nature of the separates. The scheme we will use in this course is that adopted by the **United States Department of Agriculture (USDA)**. Another scheme of soil separate classification is used by the **International Society of Soil Science (ISSS)**.

There are two organization of soil classified which expressed in

Soil particles	Particle diameter (mm)	

	USDA	**ISSS**
Sand	2.0-0.05	2.0-0.02
Silt	0.05-0.002	0.02-0.002
Clay	less than 0.002	less than 0.002

U.S.D.A		ISSS	
Particles	diameter(mm)	Particles	Diameter(mm)
Very coarse sand	2 – 1 mm	coarse sand	2 – 0.2 mm
coarse sand	1 – 0.5 mm	fine sand	0.2- 0.02mm
Medium sand	0.5 – 0.25mm	Silt	0.02- 0.002mm
Fine sand	0.25- 0.1 mm	Clay	< 0.002 mm
Very fine sand	0.1 – 0.05mm		
Silt	0.05- 0.002mm		
Clay	<0.002 mm		

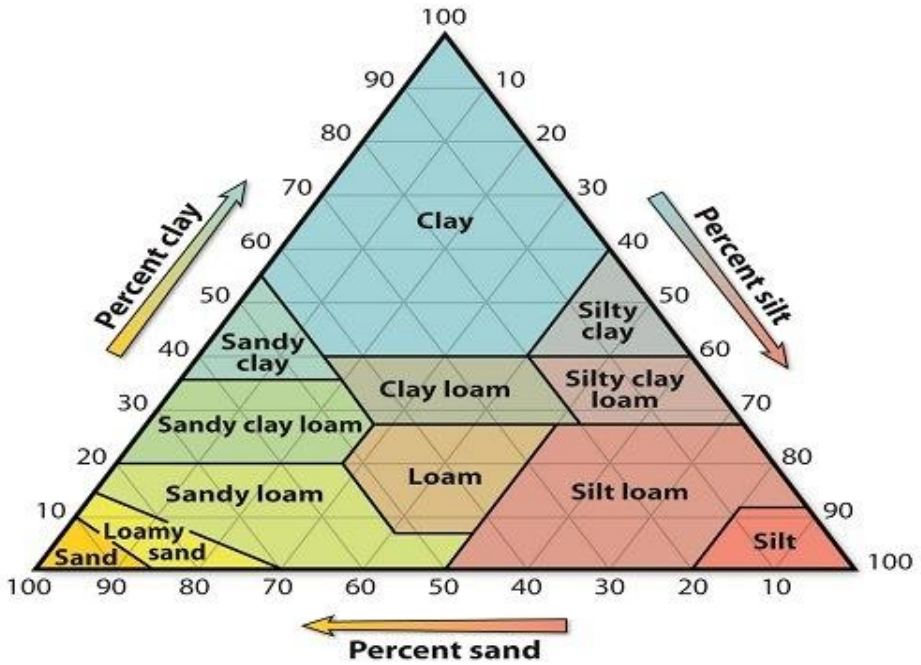
Texture triangle

- The percentage units (0-100%) of sand, silt, and clay are listed along the sides of the triangle.

- clay (across) →

- silt (down) ↓

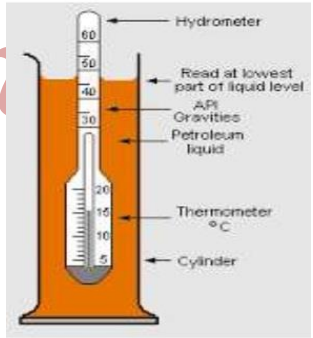
- Sand (up) ↑



HYDROMETER PROCEDURE

Apparatus and materials:

1.Glass cylinders, 1000-mL graduated cylinder
2. Thermometer, Fahrenheit
3.Hydrometer
4. Electric mixer
5.Balance sensitive
6.Plunger
7.Stopwatch



1. Weigh 50 g of soil transfer in to a beaker.
2. Remove of organic matter. It is by addition of hydrogen peroxide 30% (H_2O_2), which causes oxidation of organic matter.
3. Addition of Calgon (sodium hexameta phosphate) which causes desperation of soil particles from another, by replacing of calcium and magnesium by sodium on

the surface of soil particles or transfer the suspension to shaker bottles and shake overnight on an end-over-end shaker.

4. Stir the suspension with electrical stirrer for 10 min.
5. Transfer the suspension to a cylinder and add distilled water to bring the volume to 1000 ml.
6. Insert the plunger and move it up and down to mix contents thoroughly.
7. Lower the hydrometer carefully into the suspension and take readings after 40 s (R40 s).
8. Remove the hydrometer carefully after the 40 s reading, rinse it, and wipe it dry
9. Reinsert the hydrometer carefully and take another reading after 2 h (R2 h).

Calculate% sand, silt, and clay, and determine the soil textural class.

- The data may read at 20 ^{o}C if the temperature more or less than 20 ^{0}C the reading may Minus or plus with 0.3 to any one centigrade. Calculate the amount of sand, silt, and clay to determine the name of soil texture class.

the temperature more than 20 ^{o}C correct the read of hydrometer

5 = 20 – 25

Read of hydrometer 25 increase to read of hydrometer

5*0.3 =1.5

1.5+25=26.5

If the temperature less than 20 ^{o}C correct the read of hydrometer

=18-20=2

2*0.3=0.6

To correct Read of hydrometer decrease to read of hydrometer

25-0.6=24.4

CALCULATIONS

(Silt +Clay)%= (final correct H.R.40 sec. / O.d.s) * 100

Clay % = (final correct H.R. 2 hr. / O.d.s) * 100

Silt % = (Silt + Clay) % - Clay %

Sand % = 100 – (Silt + Clay) %

Determined the soil texture by using texture triangle.

Q/Determine the soil texture class by using of soil texture triangle, if you have the following information:

1. Hydrometer reading at 40 sec.is 37.2 at 17°C
2. Hydrometer reading at 2h is 12 at 25 °C
3. Mass of air dry soil 420 g and Pww = 4.76%.

Note// neglect the blank reading of hydrometer.

Solution:

20-17=3 3*0.3=0.9

37.2-0.9= 36.3 final correct H.R after 40 sec .

25-20=5 5*0.3=1.5

12+1.5= 13.5 final correct H.R after 2hr.

(Silt +Clay)%= (final correct H.R.40 sec./ o.d.s) * 100

= (36.3/400.92)* 100

Oven dry soil= air dry soil/1+% M

= 420/1+0.0476= 400.92 g

= 420/1+0.0476

= 400.92 g

=9.05 %

Clay % = (final correct H.R. 2 hr. / o.d.s) * 100

= (13.5/400.92)* 100

=3.37 %

Silt % = (Silt + Clay) % - Clay %

= 9.05-3.37

= 5.68 %

Sand % = 100 – (Silt + Clay) %

=(100 – 9.05)%

= 90.95 %

Sand+Silt+Clay=90.95+5.68+3.37=100%

Determined the soil texture by using texture triangle.