Properties of Soils :-

Properties of Soil

- Index properties
  - * Size
  - * Shape
  - * S. Gravity
  - * Minerological Characteristics
  - → Soil Grain properties
  - → Soil agg properties
  - → Water content
  - → Insitu density
  - → Relative density
  - → Consistency / Atterberg Limits
- Engg properties
  1. permeability
  2. Compressibility
  3. Shear Strength

Shape :-

Bulky grains → Angular, Sub Angular, Well Rounded

L = W = D

Flaky grains (T) <

Elongation grains (L) >

Bulky grains gives more strength.

Specific gravity :-

$$\text{Specific Gravity (G)} = \frac{\text{Wt of Solids}}{\text{Wt of eq. vol of water}}$$

Specific gravity should be obtained max and min temparature of 27°c / 4°c

$$G_{27^\circ c/4^\circ c} = G_{t^\circ} * \frac{\text{Specific gravity of water at } t^\circ c}{\text{Specific gravity of water at } 27^\circ c/4^\circ C}$$

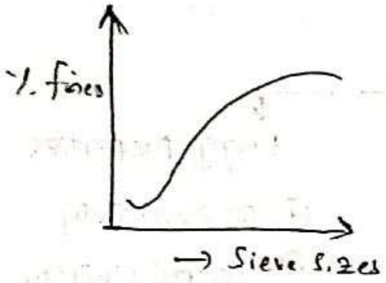
Size :-

Size

- Sieve Analysis > 75 μ
  - Dry Sieve → Non Cohesion less soils
  - Wet Sieve → Cohesive soils
- Sedimentation Analysis < 75 μ
  - Pippete method
  - Hydrometer method

* If < 0.2 μ particles doesn't done sieve analysis
* In coarse grain – 80 mm, 40 mm, 20 mm, 10 mm, 4.75 mm Gravel.
* Sand – 4.75 mm, 2 mm, 1 mm, 600 μ, 425 μ, 212 μ, 150 μ, 75 μ

Sieve No	retained wt	% of Retained	Cumulative % of Retained	Cumulative % Passing = 100 − Cumlative % Retained
	Ex:- 400	$\left(\frac{400}{1000}\right) \times 100$		

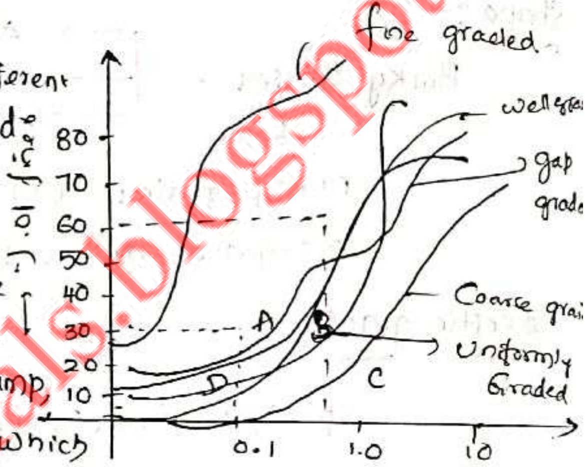


Wet sieve Analysis :- When taken soil has 5% of wet conditi[on] Then wet sieve analysis is done.

Grading of soils :-

Distribution of particles of different sizes in a soil mass is called "grading".

The grading of soils can be determined from particle size distribution curve.



A curve with a bump i.e; 'A' curve represents soil in which some of the intermediate size particles are missing such as soil is "Gap Graded" (or) "Skip graded soil".

Flat "S" curve i.e; curve "B" represent a soil which contains a particles of different sizes in good proportion such soil is called "well graded soil".

Steep curve "c" indicates a soil containing the particles of almost the same size, ie; uniformly Graded soil.

A curve situated higher up and to th[e] left indicates a relatively fine grained soil. A curve situated right indicate coarse grained soil.

The uniformity of the soil is expressed by "Uniformity Co-efficient"

$$\text{Co-efficient of Uniformity } "C_u" = \frac{D_{60}}{D_{10}}$$

The shape of the particle size curve is represented by "Co-efficent of curvature".

$$\text{Co-efficient of Curvature } "C_c" = \frac{D_{30}^2}{D_{60} \times D_{10}}$$

If "C_u" is ≥ 6 then it is "Well Graded"

If "C_u" is ≥ 4 then they are "Gravel"

If "$1 < C_c < 3$" then they are "well graded sand other wi
poorly graded sand"

For uniformly graded soils $C_c = 1$ and $C_u = 1$

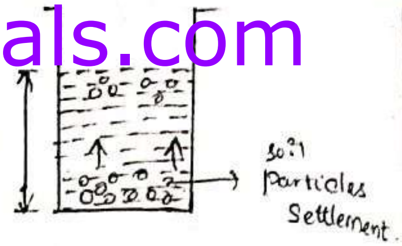
Gap grading of soil cannot be detected by "C_u" only. The value of C_c also required to detect it.

Uses of particle size distribution curve :-

* The plot b/w sieve sizes and % of fine is known as grain size distribution curve (or) grain size distribution curve (or) particle size distribution curve.
* It is gives ideal about type of soil and gradation of soil.
* It is extremely used for coarse grained soil to classify the soil sample.
* The co-efficient of permiability of coarse gr

Sedimentation Analysis:-

* It is based on "stokes Law."



Drag force $F_D = 6\pi n r v$

where n = dynamic viscosity

r = radius

v = velocity (terminal velocity)

Terminal velocity $(v) = \frac{1}{18} \times \frac{g D^2 (G-1) \rho_w}{\eta} \rightarrow ①$

D = diameter of soil grains

G = specific gravity of material

g = Acceleration due to gravity

ρ_w = density of water.

then velocity $(v) = \frac{He}{60t} \rightarrow ②$ (cm) (t = time taken) (min)

from ① & ②

$$\frac{He}{60t} = \frac{1}{18} \times \frac{g D^2 (G-1)\rho_w}{\eta}$$

$$\therefore D = \sqrt{\frac{18 He * \eta}{60 \times g (G-1)\rho_w t}}$$

$$D = M\sqrt{\frac{He}{t}}$$

where $M = \sqrt{\frac{0.3 \times \eta}{\cancel{60} \times g (G-1)\rho_w}}$

Sedimentation Analysis:-

Two methods for Analysis

Hydrometer method	Pippette method

~~Pipette~~ Hydrometer method

50 gms → oven dried soil.

(33 gms of sodium hexameta phosphate
+
7 gms of sodium Carbonate)

Mix with
1 Litre of water.

(Take 100 ml solution) + (3/4 distilled water)
↓
(Mechanical stirrering)
↓
75μ (Seive Analysis)

Pippette ~~Hydrometer~~ method.

* Pippete volume

* Sedimentation tube

shake 30 sec

* Note down the time and note down particle Settlement.

* $m_D = m_D' - m$

m_D = actual mass of solids sample (ml)

m_D' = mass of ~~the~~ solids 10 ml as obtained from sample m = Mass of dispersing Agent per ml of suspension

% of finer :- $N = \frac{m_D}{m_s} * 100$ $(m_D = m_D' - m)$

m_D = mass of the particle for ml of suspension

m_s = " " " " " " at the beginning of sedimentation.

N = % of finer

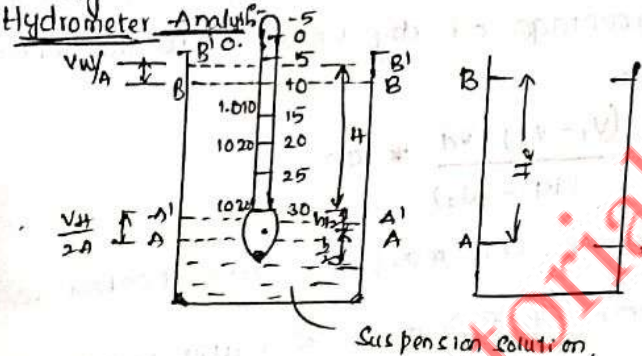
Merits

* It is suitable for fine grained soils it gives very accurate results

Demerits

* Quite expensive and delicate
* It requires sensitive weighing balance.
* For quick particle analysis hydrometer method is more convinient.

Hydrometer Analysis



→ "Hydrometer Analysis"

He = effective height

He =

Hydrometer heigth (R_h) = (sp. gravity − 1) * 1000 (for left side readings)

$$He = H + \frac{h}{2} - \frac{V_H}{2A}$$

$$\therefore He = H + \frac{1}{2}\left[h - \frac{V_H}{A}\right]$$

V_H = volume of the hydrometer.

Corrections for Hydrometer :-

① meniscus correction → $R_h = R_h \pm C_m$

② Temparature correction → $T > 2°C$ $AR < CR$ $(\pm C_T)$

③ Dispersion agent correction

④ combined correction.

$\therefore R_h = R_h' + C_m \pm C_T - C_d$ (or) $R_h = R_h' \pm C$

Shrinkage limit :- It is defined as the maximum water content at which a reduction of water content will not cause a decrease in the volume of the soil mass

* It is the smallest water content at which soil is saturated.

$$w_s = ((m_1 - m_s) - (v_1 - v_2))\rho_w / m_s$$

$$w_s = w_1 - (v_1 - v_2)\rho_w / m_s .$$

Shrinkage parameters :-

Shrinkage index :- Numerical difference b/w liquid limit and Shrinkage limit.

$$I_s = w_L - w_s .$$

Shrinkage Ratio :- It is defined as the ratio of a given volume change expressed as a percentage of dry volume, to the corresponding change in water.

$$SR = \frac{(v_1 - v_2)/v_d}{(w_1 - w_2)} * 100$$

where v_1 = volume of soil mass @ water content w_1

v_2 = volume of soil mass @ water content w_2

v_d = volume of dry soil.

when v_2 is at shrinkage limit

$$SR = \frac{(v_1 - v_d)/v_d}{(w_1 - w_s)} * 100$$

Volumetric shrinkage :- change in volume expressed as a percentage of dry volume when the water content is reduced from given value to shrinkage limit.

$$V_s = \frac{(v_1 - v_d)}{v_d} * 100$$

$$V_s = SR\,(w_1 - w_s)$$

Linear shrinkage :- change in length ~~volume~~ ~~expressed~~ as ~~a percentage of dry volume when the water~~ divided by initial length when the water content is reduced to shrinkage limit expressed as % and report to whole number

$$LS = \frac{(\text{Initial length} - \text{final length})}{\text{Initial length}} * 100$$