

**SAMANTA CHANDRASEKHAR INSTITUTE OF TECHNOLOGY &  
MANAGEMENT, SEMILIGUDA**

**1<sup>ST</sup> INTERNAL EXAMINATION  
Diploma 3<sup>rd</sup> Semester (Civil)  
Subject: Geotechnical engineering**

Time:1 hr 30 minutes

Total Marks:20

*(Figures to the right hand side indicates marks)*

**PART-A**

Q1. Answer any five from the questions:  
(2x5=10marks)

- (a) What is retaining structure, draw a neat sketch of its retain structure?
- (b) What is geologic cycle? How soil is from.
- (c) Derive the inter relationship between void ratio and porosity?
- (d) What is density index? Write the formula for  $I_D$ ?
- (e) Describe a method of determination of water content in the laboratory?
- (f) Explain soil as a three-phase system with sketch?

**PART-B**

Q2. Answer the following questions:  
(5x2=10)

- (a) A soil sample in its undistributed state found to have a volume of 108 cm<sup>2</sup> and mass of 204 g after oven drying the mass got reduced to 165 g compute (i) Water content (ii) Void ratio (iii) porosity (iv) Dry density

Take  $G=2.7$  (hint  $e = \frac{G\gamma_w}{\gamma_d} - 1$ )

- (b) What is particle size distribution? What are the two stages of particle size analysis?
- (c) What is wet mechanical analysis ? Derive the expression for terminal velocity of stroke's law ?



**SAMANTA CHANDRASEKHAR INSTITUTE  
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SEMILIGUDA - 764 036

Internal-1 Examination 3rd Semester/Class  
 Name Ashutosh Dash Branch CIVIL  
 Roll No. Registration No. F20030001004  
 Subject Geotechnical Date 20-12-2021  
 No. of Addl. Sheets used \_\_\_\_\_

19  
20
 Manisha Mishra  
 22/12/2021

Manisha Mishra  
 Signature of the Invigilator  
 20/12/2021

**USE BOTH SIDE OF PAPER**

MARKS OBTAINED

<u>Question No.</u>	<u>Marks</u>	<u>Question No.</u>	<u>Marks</u>
1. 1(a)	2marks	6. 2(a)	5marks
2. 1(b)	2marks	7. 2(b)	4marks
3. 1(c)	2marks	8.	
4. 1(d)	2marks	9.	
5. 1(f)	2marks	10.	
Total : .			

Manisha Mishra  
 Signature of the Examiner

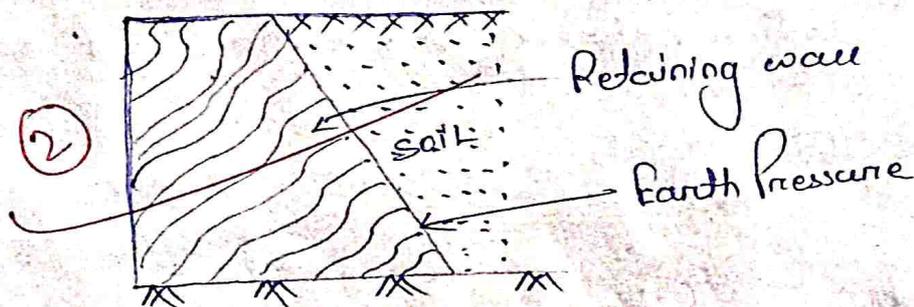
Date 22/12/2021

## ① (a) Retaining structure:

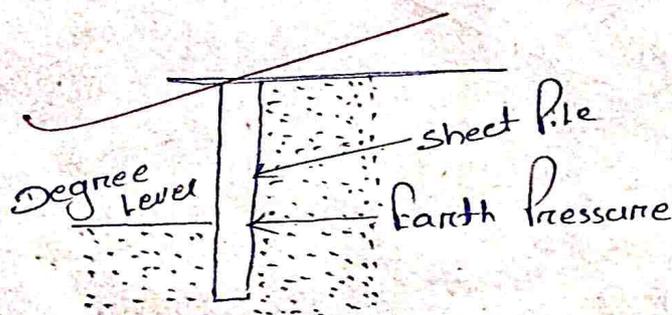
→ when sufficient slope is not available for a mass of soil to spread or from a safe slope, a structure is required to retain to the soil.

→ An earth retaining structure is also required to keep the soil at different level on its either sides.

## (b) Retaining structure wall



## (b) Sheet pile

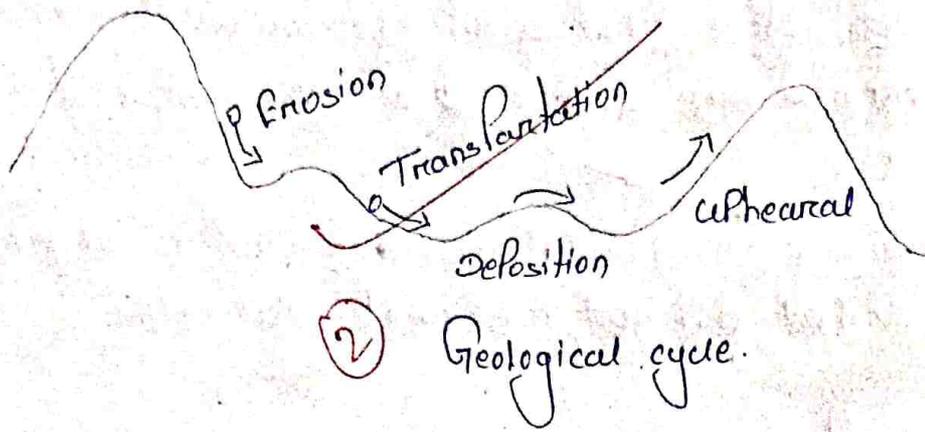


## ① (b) Geological cycle

→ soil are formed by weathering of rock due to the mechanical disintegration or chemical decomposition.

when rock surface gets exposed to atmosphere for appreciable time, it disintegrate or decomposes into small particle and thus the soil are formed.

→ soil may be considered as an incidental material obtained from the geological cycle which goes on continuously in nature.



(c) ~~void~~ Inter-relation between Void ratio and Porosity.

$$n = \frac{V_v}{V}$$

$$\frac{1}{n} = \frac{V}{V_v}$$

$$\frac{1}{n} = \frac{V_v + V_s}{V_v}$$

$$\frac{1}{n} = 1 + \frac{V_s}{V_v}$$

$$(e = \frac{V_v}{V_s})$$

$$\frac{1}{n} = 1 + \frac{1}{e} \quad \text{--- (1)}$$

$$n = \frac{e}{1+e}$$

From eqn 1

$$\frac{1}{e} = \frac{1}{n} - 1 = \frac{1-n}{n}$$

$$e = \frac{n}{1-n}$$

(d) Density Index!

Is the term density index IP or relative density or degree of density is used to express the degree to completion of natural cohesionless soil deposits.

The density index is defined as the ratio of the difference of the void ratio of the soil in its loosest state  $e_{max}$  and its natural void ratio  $e'$  to the diff between the void ratio in the loosest and densest states

$$ID = \frac{e_{max} - e}{e_{max} - e_{min}}$$

$e_{max}$  = Void ratio in the loosest state.

$e_{min}$  = Void ratio in the densest state.

$e$  = Natural void ratio of the deposit



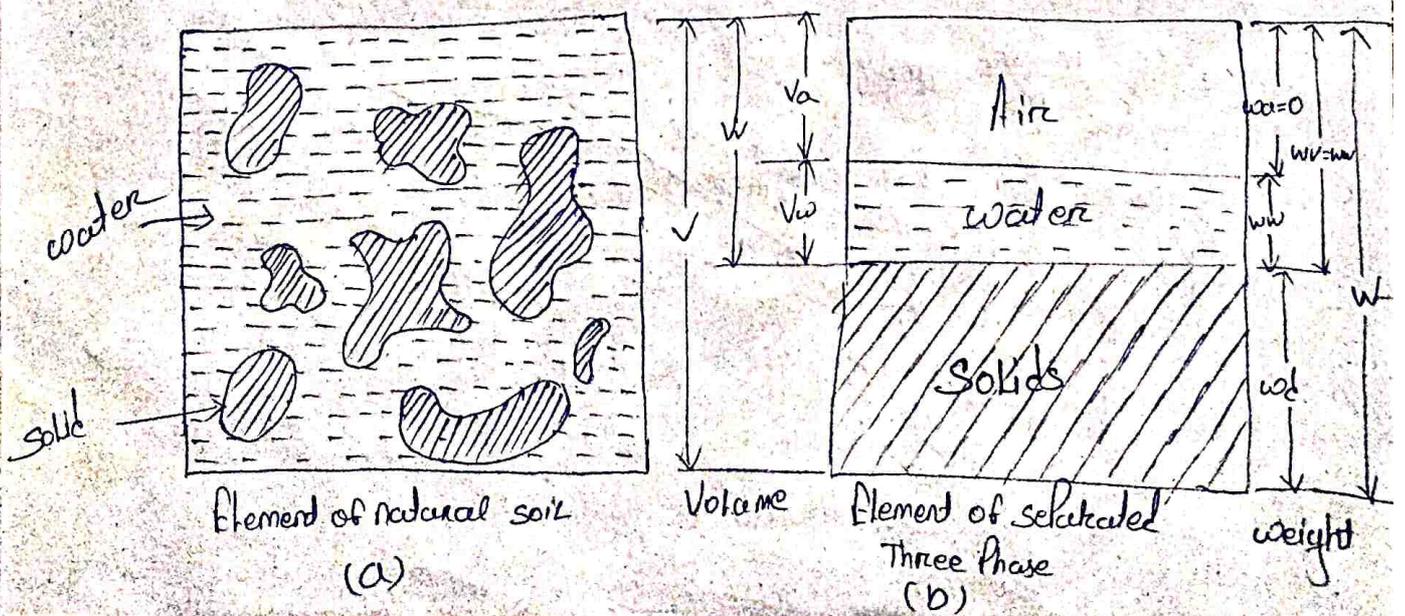
Q1) soil as a three phase system!

→ A soil as a three phase system consisting of a soil particle, water and air. The void space bet<sup>n</sup> the soil grains is filled partly with water & partly with air.

→ In case of dry soil mass of the void ratio are filled with air only.

→ In case of perfectly saturated soil voids are filled completely with water.

→ In general the soil has three constituents which do not occupy separate spaces but are blended together forming a complex material the properties of which depends on the relative large of ~~three~~ these constituent their arrangement and a variety of other factor.



The total volume. = 'V'

Volume of air = 'V<sub>a</sub>'

Volume of water = V<sub>w</sub>

Volume of solids = V<sub>s</sub>

The volume of voids V<sub>v</sub>

Fig. 6

weight of fig 6 2

The weight of air is considered to be negligible  
Hence the weight of total voids = weight of water w,

$$W = W_v + W_s$$

Q2

given data

$$V = 108 \text{ cm}^3$$

$$m = 204 \text{ gm}$$

$$m_d = 165 \text{ gm}$$

(i) water content = W

$$W = \frac{W_w}{W_s} \times 100\%$$

$$= \frac{m - m_d}{m_s} \times 100\%$$

$$W = \frac{204 - 165}{165} \times 100\%$$

$$= 23.63 \%$$

(i) dry density

$$= \gamma_d = \frac{W_s}{V}$$

$$= \frac{165}{108}$$

$$= 1.527$$

(ii) Void ratio

$$e = \frac{G \gamma_w}{\gamma_d}$$

$$= \frac{2.7 \times (1)}{1.527} - 1 = 1.768 - 1$$

$$= 0.768$$

(iii) Porosity

$$n = \frac{e}{1+e}$$

$$= \frac{0.786}{1+0.786}$$

$$= 0.434$$

(5)

(c) In the weight mechanical analysis or sedimentation analysis the soil fraction, finer than 75 micron size is kept in suspension in a liquid medium. The analysis is based on Stokes law according to which the velocity at which grains settle out of suspension, all other factors being equal is dependent upon the shape, weight and size of the grain. However in the usual analysis it is assumed that the soil particles are spherical and have the same specific gravity. With this assumption, the coarse particle settle more quickly than the finer ones. If  $V$  is the terminal velocity of sinking of a spherical particle it is given by

$$v = \frac{1}{18} \cdot \frac{g d^2 (\rho_s - \rho_w)}{\eta}$$

## Stokes Law

Soil particle finer than 75  $\mu$ m size content is determined by sedimentation analysis. The analysis is based on Stokes' Law which gives the terminal velocity of a small sphere settling in a fluid of infinite extent. When a small sphere settles in a fluid of infinite extent, its velocity first increases under the action of gravity, but the drag force comes into action & retards the velocity. After an initial adjustment period, steady conditions are attained & velocity becomes constant. The velocity attained is known as terminal velocity.

$F_d$  = drag force

$u$  = buoyancy

$$W = \frac{4}{3} \pi r^3 \rho_s = \frac{4}{3} \pi r^3 (\rho_s g)$$

$$u = \frac{4}{3} \pi r^3 \rho_w = \frac{4}{3} \pi r^3 (\rho_w g)$$

From equilibrium forces in vertical direction.

$$W = u + F_d$$

or

$$\frac{4}{3} \pi r^3 \rho_s = \frac{4}{3} \pi r^3 \rho_w + 6\pi \eta r v$$

or

$$\frac{4}{3} \pi r^3 g \rho_s = \frac{4}{3} \pi r^3 g \rho_w + 6\pi \eta r v$$

or

$$v = \frac{2}{9} \cdot \frac{r^2}{\eta} \cdot (\rho_s - \rho_w) g$$

$$\Rightarrow v = \frac{1}{18} \cdot \frac{g d^2 (\rho_s - \rho_w)}{\eta}$$

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**2<sup>nd</sup> INTERNAL EXAMINATION  
Diploma 3<sup>rd</sup> Semester (Civil)  
Subject: Geotechnical engineering**

Time:1 hr 30 minutes

Total Marks:20

*Figures to the right hand side indicates marks)*

**PART-A**

**Q1. Answer the following questions.  
=10)**

**(2X5)**

- (a) What is density index ? Explain briefly with formula ?
- (b) Define degree of saturation with suitable formula ?
- (c) Differentiate between shallow foundation and deep foundation ?
- (d) How suspension is prepared for sedimentation analysis ?
- (e) Explain determination of specific gravity by density bottle method with formula ?

**PART-B**

**Q2. Answer the following questions .**

**(5X2=10)**

- (a) Explain soil as three phase system with diagram ?
- (b) Explain pipette method with suitable diagram? Explain the merits and demerits of pipette method ?
- (c) Derive stroke's law for settling velocity ?



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2nd Internal Examination 3rd Semester/Class

Name Ashutosh Dash Branch CIVIL

Roll No. \_\_\_\_\_ Registration No F2003000 1004

Subject GRD TECH Date 19-02-2022

No. of Addl. Sheets used \_\_\_\_\_

19  
20

Manisha Mishra  
21/02/2022

B  
Signature of the Invigilator  
19/02/2022

**USE BOTH SIDE OF PAPER**

**MARKS OBTAINED**

<u>Question No.</u>	<u>Marks</u>
1. <u>1(a)</u>	<u>2marks</u>
2. <u>1(b)</u>	<u>2marks</u>
3. <u>1(c)</u>	<u>2marks</u>
4. <u>1(d)</u>	<u>2marks</u>
5. <u>1(e)</u>	<u>1mark</u>

<u>Question No.</u>	<u>Marks</u>
6. <u>2(a)</u>	<u>5marks</u>
7. <u>2(c)</u>	<u>5marks</u>
8. _____	_____
9. _____	_____
10. _____	_____
Total : _____	

Manisha  
Signature of the Examiner

Date 21/02/2022

① The density index is defined as the ratio of the difference of the voids ratio of the soil in its loosest state  $e_{max}$  and its natural void ratio  $e'$  to the diff between the void ratio in the loosest and densest state is

$$ID = \frac{e_{max} - e}{e_{max} - e_{min}} \quad (2)$$

where  $e_{max}$  = void ratio in the loosest state.

$e_{min}$  = void ratio in the densest state.

$e$  = natural void ratio of the deposit.

① (b) Degree of saturation ( $S$ ) is the ratio of volume of water to the volume of voids

$$S = \frac{V_w}{V_v} \quad (2)$$

① (c) shallow foundation

Foundation which is placed near the surface of the earth or transfers the load at shallow depth is called the shallow foundation

→ A shallow foundation is cheaper

deep foundation

Foundation which is placed at a greater depth or transfers the load to deep strata is called the deep foundation.

→ Deep foundations are generally more expensive than shallow foundation.

① In the sedimentation analysis only those particles are finer than 75 micron.

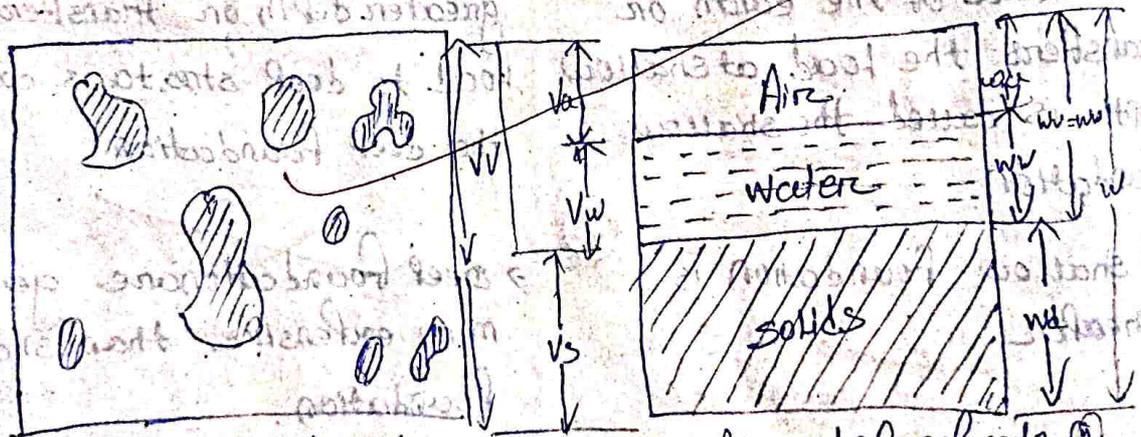
→ According to Stokes law the velocity at which grain settle out suspension all other factors equal is dependent upon shape weight & size of grain.

② soil as a 3 phase system

A soil as a 3 phase system consisting of a soil particle (called soil grain) water and air. The void space bet<sup>n</sup> the soil grains is filled partly with water & partly with air.

- In case of a perfectly saturated soil voids are filled with air only.
- In case of a perfectly saturated soil voids are filled completely with water.
- In general the soil has three phases constituents which do not occupy separate spaces but are blended together forming a complex material the properties of which depends upon the relative large of these constituent their arrangement and a variety of other factors.

→ For calculation purposes it is always is more convenient to show this constituent occupy separate spaces.



① Element of natural soil

② Element of separate in to three phase

As shown in figure

- ① The total volume =  $V_v$  of the soil mass consist of
  - Volume of air =  $V_a$
  - Volume of water =  $V_w$
  - Volume of solid =  $V_s$
  - The volume of void  $V_v$  is there fore equal to volume of air plus the volume of water.

① Show the weight in Figure (b)

→ The weight of air is considered to be negligible. Hence the weight of total voids = weight of water  $w_w$ . The weight of solid is represented by  $w_d$  (or  $w_s$ ) which is evidently equal to the dry weight of the soil sample. The total weight  $w$  of the moist sample is therefore

$$W = W_w + W_d$$

② Soil particles finer than 75  $\mu$ m size can't be sieved. The particular size distribution of such soil can be determined by sedimentation analysis. The analysis is based on Stokes Law, which gives the terminal velocity of a small sphere settling in a fluid of infinite extent. When a small sphere settles in a fluid, its velocity first increases under the action of gravity, but the drag force comes into action and retards the velocity. After an initial adjustment period, steady conditions are attained and the velocity becomes constant. The velocity attained is known as terminal velocity.

The drag force  $F_D$  experienced by a sphere of radius  $r$  when it falls through a fluid of viscosity  $\mu$  is given by

$$F_D = 6\pi\mu r v \quad \text{--- (a)}$$

The two other forces acting on the sphere are the weight of the sphere and the buoyant force (b)

$$W = \frac{4}{3}\pi r^3 \rho_s g$$

$$= \frac{4}{3}\pi r^3 (\rho_s g) \quad \text{--- (b)}$$

$\rho_s$  is the unit weight of the material of sphere

$$U = \frac{4}{3}\pi r^3 \rho_w = \frac{4}{3}\pi r^3 (\rho_w g) \quad \text{--- (c)}$$

From equilibrium of forces in vertical direction

$$W = U + F_D$$

$$\Rightarrow \frac{4}{3} \pi r^3 v_s = \frac{4}{3} \pi r^3 v_w + 6\pi r \eta v_r$$

$$\Rightarrow \frac{4}{3} \pi r^3 g \rho_s = \frac{4}{3} \pi r^3 g \rho_w + 6\pi r \eta v_r$$

$$v = \frac{2}{9} \cdot \frac{r^2}{\eta} \cdot (\rho_s - \rho_w) g$$

$$v = \frac{1}{18} \cdot \frac{g \cdot D^2 (\rho_s - \rho_w)}{\eta} \quad (5)$$

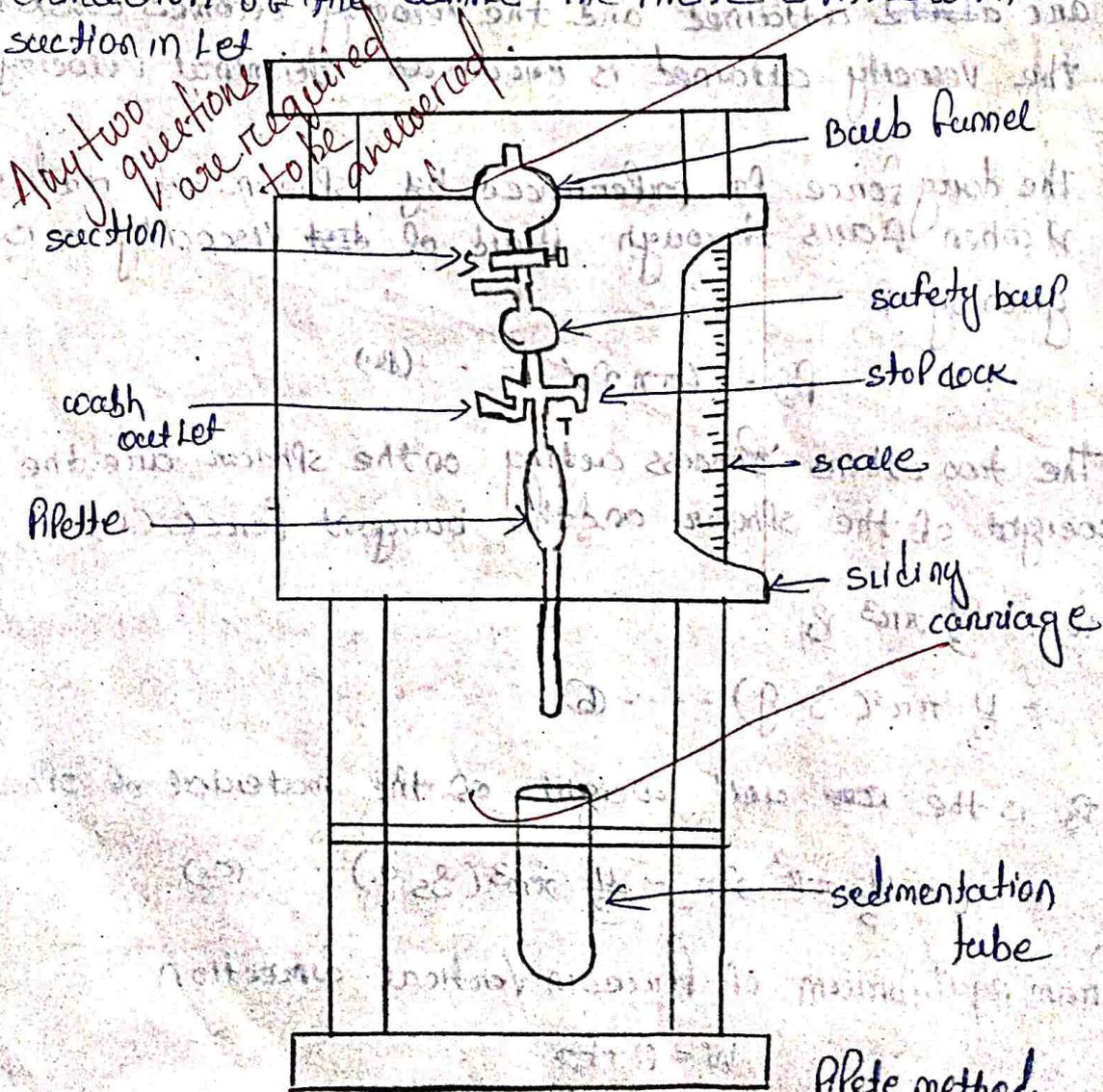
$$v = \frac{1}{18} \cdot \frac{g \cdot D^2 (\rho_s - \rho_w)}{\eta}$$

$\eta$  - eta.

(2b)

### PIPETTE METHOD

In this method some of soil suspension is required. The procedure for preparation of 1000 ml of suspension has been discussed in sect 3.5. All the quantities required for 100 ml of suspension are halved to get a 500 ml of suspension. The suspension is taken in a sedimentation tube. Fig 3.3 shows a 10 ml capacity pipette used for extraction of the sample. The pipette is fitted with a section in let.



merits and demerits of pycnometer method:

The pycnometer method is a standard laboratory method for the particle size analysis of fine-grained soils. It is a very accurate method. However, the apparatus is quite delicate and expensive. It requires a very sensitive weighing balance. For quick particle size analysis the hydrometer method described in the following section is more convenient.

①

② The specific gravity of solid particles can be determined in laboratory using density bottle method filled with a stopper having a hole.

$$G = \frac{M_d}{M_d - (M_3 - M_4)}$$

①

$$G = \frac{M_2 - M_4}{(M_2 - M_4)(M_3 - M_4)}$$

$M_1$  = mass of bottle

$M_2$  = mass of bottle + dry soil

$M_3$  = mass of bottle + soil + water

$M_4$  = mass of bottle filled with water.

$M_d$  = dry mass of soil =  $(M_2 - M_1)$