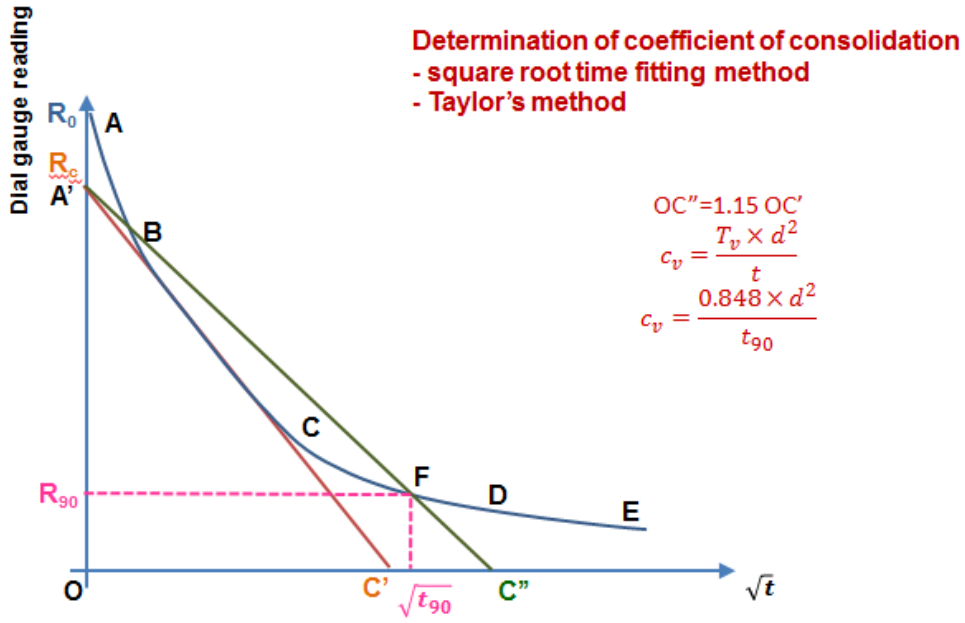
Solution - Internal Assessment Test IV –February 2022

1	(a) Elaborate the procedure to determine coefficient of consolidation using Taylor's method	[06]
	Fig -2 Explanation - 6	



1. From the oedometer test the dial reading (settlement) corresponding to a particular time is measured. From the measured data, dial reading vs square root (time) graph is drawn ie., curve ABCDE.
2. The initial straight part can be extended backwards to meet at A'. The dial gauge reading at A' corresponds to R_c.
3. Extend the straight part to meet X axis at C'.
4. Starting from Rc, draw another straight line such that its abscissa is 1.15 times the abscissa of first straight line.
5. The intersection point between the second straight line and experimental curve represents the R90 and corresponding time is determined and noted as $\sqrt{t_{90}}$. Thus, the time required (t90) for 90% consolidation is calculated.
6. The Coefficient of consolidation (cv) is determined as:

$$c_v = \frac{0.848 d^2}{t_{90}}$$

$$where\ d\ is\ the\ drainage\ path = d\ for\ single\ face\ drainage\ and$$

$$= \frac{d}{2} for\ two\ face\ drainage$$

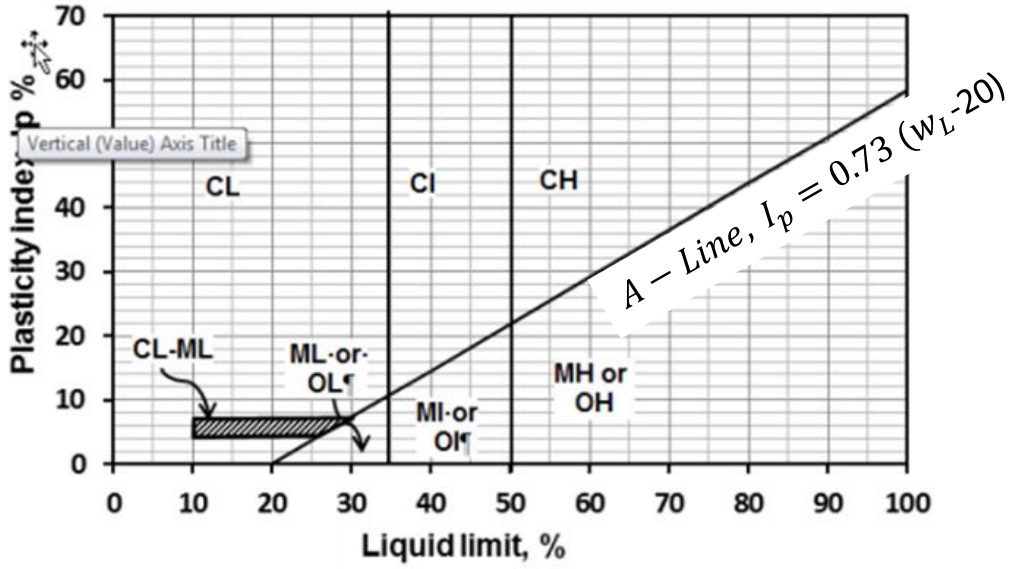
	(b) Explain IS Soil Classification system and mention the use of Plasticity Chart.	[06]
	Classification of coarse grained – 3 Classification of fine grained alongwith plasticity chart - 3	

Gravels	> 50% material is retained on 4.75 mm sieve

	GW	Fines < 5%; C_u>4; C_c is between 1 and 3	If I_p> 4 and less than 7- dual classification – GM-GC
	GP	Fines < 5%; C_u<4; C_c is not between 1 and 3	
	GM	Fines >12%; I_p< 4	If fines is between 5 and 12%, GP-GC or GW-GM
	GC	Fines >12%; I_p>7	
Sand	> 50% material is passing 4.75 mm sieve		
	SW	Fines < 5%; C_u>6; C_c is between 1 and 3	If Ip> 4 and less than 7- dual classification – SM-SC
	SP	Fines < 5%; C_u<6; C_c is not between 1 and 3	
	SM	Fines >12%; I_p< 4	If fines is between 5 and 12%, SP-SC or SW-SM
	SC	Fines >12%; I_p> 7	

The given soil is sandy soil. Since Cu>7, and Cc is between 1 and 3, the given soil is well graded. Hence, it can be classified as SW.

Fine-grained soils are those for which more than 50% of the material has particle size less than 0.075 mm. A plasticity chart is a chart with liquid limit (WL) on X-axis and plasticity index (IP) on Y-axis. According to IS classification, fine grained soils are classified into 9 groups using A-line whose equation is given as IP= 0.73 (WL- 20).

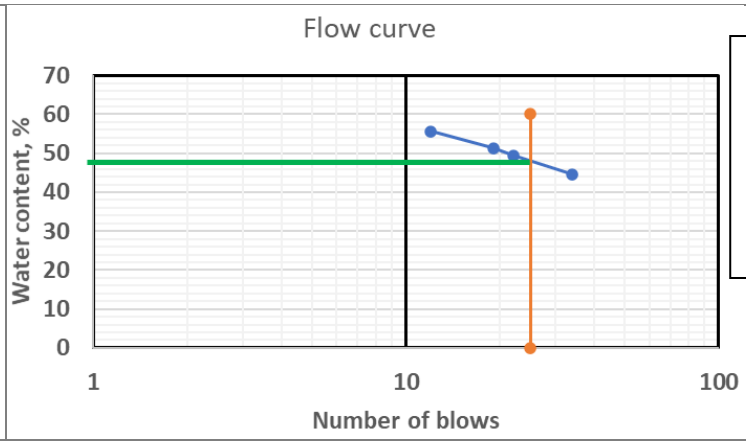


(c) The results of a liquid limit test are given below: [08]

No.of blows	34	22	19	12
Water Content (%)	44.6	49.4	51.4	55.6

If the natural water content is 27%, The plastic limit of the soil is 20%. Plot the flow curve and determine (i) Liquid limit (ii) Plasticity index (iii) Flow index (iv) Consistency index.

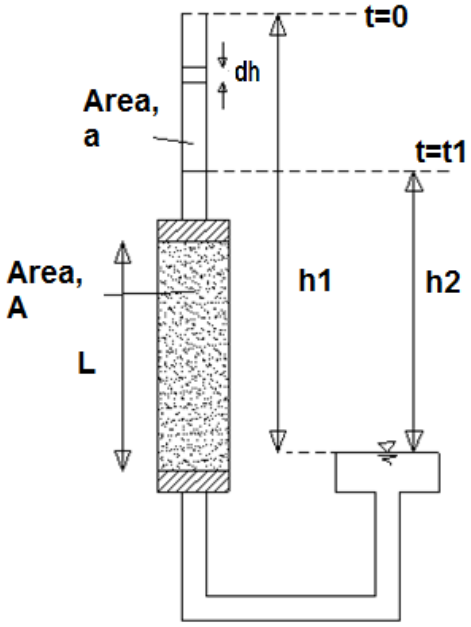
Graph – 4; 4 items – 4 marks



w_L = 48%
I_P = 48 – 20 = 28%
Flow index = (55.6-44.6))/log(34/12)
=24.32
Consistency index = (48 – 27)/28
=0.75

2 (a) Derive an expression to obtain coefficient of permeability under falling head condition. [06]

Fig. – 2
Derivation 3+ explanation of terms 1



The falling head method of determining permeability is used for soil with low discharge, especially fine grained soils. The apparatus consists of a standpipe of diameter 'a'. Soil is filled inside the permeameter to the required density. the area of soil specimen is measured as 'A' and height is measured as 'L'. the water flowing through the soil is collected in a tank and the water level in that is maintained constant. The head causing flow is measured from this water level.

$$dQ = -adh = Ak\frac{h}{L}dt$$

Integrating,

$$\int_{h1}^{h2} -adh = Ak \int_0^t dt. \frac{h}{L}$$

$$\int_{h1}^{h2} -\frac{dh}{h} = \frac{Ak}{aL}\int_0^t dt$$

$$-ln\frac{h2}{h1} = \frac{Akt}{aL}$$

$$ln\frac{h1}{h2} = \frac{Akt}{aL}$$

$$2.303.log\frac{h1}{h2} = \frac{Akt}{aL}$$

$$k = 2.303\ \frac{aL}{At}\ log\frac{h1}{h2}$$

(b) A 15 m thick isotropic clay layer overlies an impervious rock. The coefficient of consolidation of soil is 5×10^{-2} mm^2/s. Find the time required for 40% and 80% consolidation. [06]

Tv values – 3
t40 and t80 - 3

$$T_v = \frac{\pi}{4} \times 0.4^2 = 0.126$$

$$T_v = -0.9331.\log(1-u) - 0.0851 = -0.9331.\log(1-0.8) - 0.0851 = 0.567$$

$$5 \times 10^{-2} \times 10^{-6} = \frac{0.126 \times 15^2}{t_{40}} = \frac{0.567 \times 15^2}{t_{80}}$$

$$t_{40} = 567 \times 10^6 s = 17.97\ years$$

$$t_{80} = 2551.5 \times 10^6 s = 80.91\ years$$

(c) List the different types of clay minerals commonly found in soils. Briefly explain Kaolinite, Illite and Montmorillonite mineral. [08]

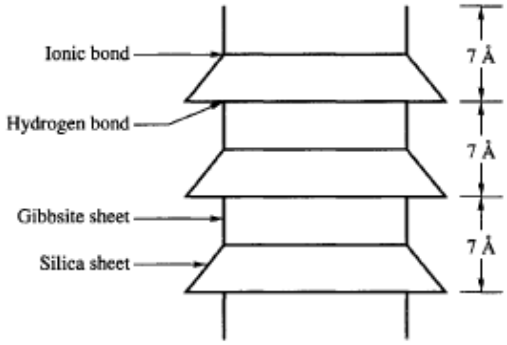
Kaolinite, Illite and Montmorillonite - 3+2+3

Kaolinite mineral

- The thickness of the layer is about 7 A° (one angstrom = 10~8 cm) thick.
- The kaolinite mineral is formed by stacking silica sheets and gibbsite sheets one above the other.
- In the kaolinite mineral there is a very small amount of isomorphous substitution.

Characteristics

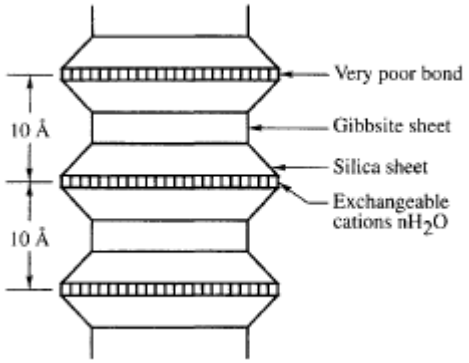
- The sheets are held to each other by hydrogen bonding.
- The mineral is therefore, stable, and water cannot enter between the sheets to expand the unit cells.



Montmorillonite mineral

- The silica and gibbsite sheets are combined in such a way that the tips of the tetrahedrons of each silica sheet and one of the hydroxyl layers of the octahedral sheet form a common layer.
- The thickness of the silica-gibbsite-silica unit is about 10 A°.
- In stacking these combined units one above the other, oxygen layers of each unit are adjacent to oxygen of the neighbouring units with a consequence that there is a very weak bond and an excellent cleavage between them.
- Water can enter between the sheets, causing them to expand significantly and thus the structure can break into 10 A° thick structural units.

- In montmorillonite, there is isomorphous substitution of magnesium and iron for aluminium.



Characteristics

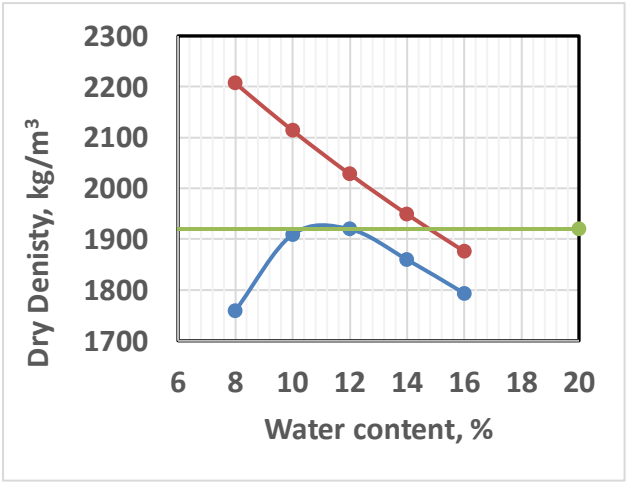
- Soils containing a considerable amount of montmorillonite minerals will exhibit high swelling and shrinkage characteristics.

3 (a) Following are the results of a Standard Proctor Test. The specific gravity of soil particles is 2.68. Plot the following and determine (i) OMC and MDD (ii) Moisture density curve (iii) Zero air voids curve (iv) What is the range of water content that can be allowed to achieve a dry unit weight of 1920 kg/m^3. [10]

Moisture Content (%)	8	10	12	14	16
Bulk density (kg/m^3)	1900	2100	2150	2120	2080

Data – 4; Curve – 2, OMC and MDD – 2. Range - 2

Moisture Content (%)	8	10	12	14	16
Bulk density (kg/m^3)	1900	2100	2150	2120	2080
Dry density (kg/m^3)	1759.259	1909.091	1919.643	1859.649	1793.103
Zero air void line	2206.851	2113.565	2027.845	1948.807	1875.7



OMC - 11 %
MDD – 1930 kg/m^3
Range - 10.2 – 12 %

Signature of CI

Signature of CCI

Signature of HoD