USN

Internal Assessment Test 1 – April 2019

Sub:	Basic Geotechnical Engineering					Sub Code:	17CV45	Branch:	CIVIL
Date:	20/4/2019	Duration:	90 mins	Max Marks:	50	Sem / Sec:	4B		OBE

PART A (ANY 5) & PART B (COMPULSORY)

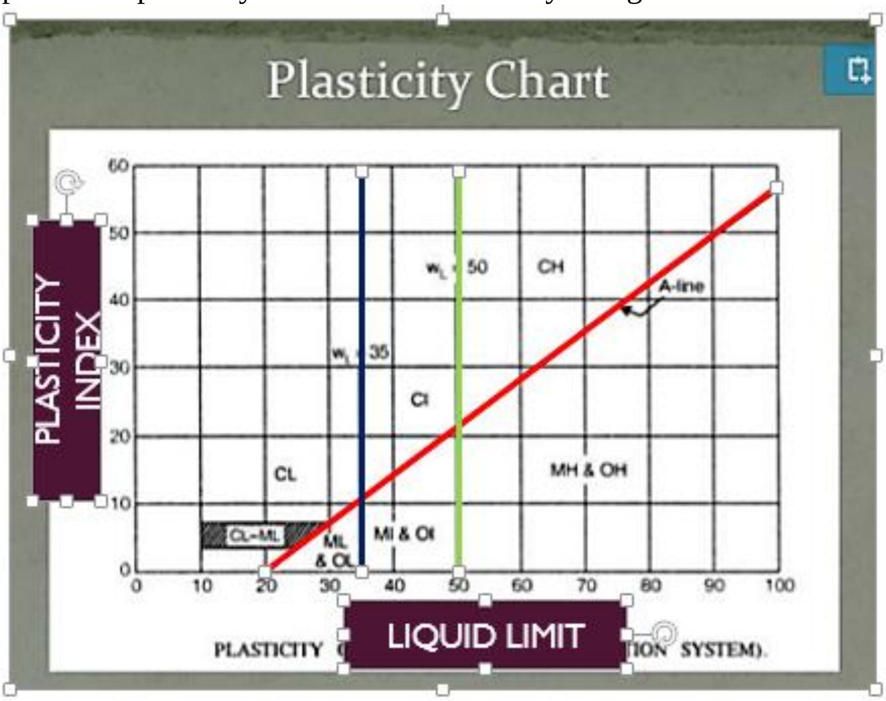
PART A (ANY 5)

MARKS | CO | RBT

1 What are the differences between standard proctor test and modified proctor test. [6] CO1 L2

	STANDARD	MODIFIED
Hammer weight (kg)	2.6	4.89
Drop height (m)	0.310	0.45
No of soil layers	3	5
No. of blows per layer	25	25
Energy per blow	2.6*9.81*0.310 J = 7.90 J	4.89*9.81*0.450 =21.58 J
Compactive effort	Energy per blow *25*3 J = 592 J	Energy per blow *25*5 J =2698 J
Compactive effort per m^3 kJ/m^3	Compactive effort/volume of mould in m^3 592J/m^3	Compactive effort/volume of mould in m^3 2698 J/m^3

2 Briefly explain how plasticity chart is used to classify fine grained soils. [6]



- Plasticity chart is a chart with plasticity index (IP) as Y-axis and Liquid limit (LL) as X-axis to classify a fine grained soil.

- The chart is divided in to different regions by A line (IP = 0.73 (LL-20)), LL =50% and LL =35%.

LL>50% and Ip below A line	MH or OH -
LL>50% and Ip above A line	CH
50% < LL < 35 % , IP below A line	MI or OI
50% < LL < 35 % , IP above A line	CI
LL<35% , below A line	ML or OL
LL<35%, above A line	CL
4< Ip <7, above A line	CL-ML

MH – Highly compressible silt

OH – Highly compressible organic soil

CH – Highly compressible clay

MI – silt of intermediate compressibility

OI – organic soil of intermediate compressibility

CI – clay of intermediate compressibility

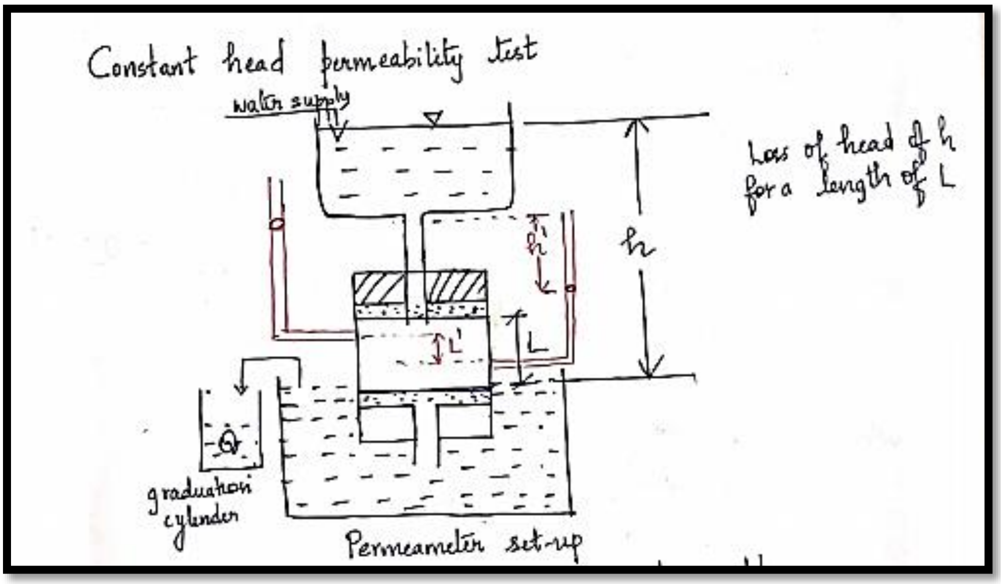
ML – silt of low compressibility

OL – organic soil of low compressibility

CL – clay of low compressibility

ML-CL combined properties of silt and clay with low compressibility

3 Explain briefly constant head test and derive an equation for coefficient of permeability. [6]



1. Assemble saturated soil in 1000 ml mould.
2. Porous stones should be placed at the top as well as the bottom.
3. The top and bottom of the sample should be connected to water tanks as shown.
4. Note the head causing flow, the difference in hydraulic head at the top and bottom. as "h"
5. Note the length of the specimen as L.
6. Measure the time (t) and quantity of water collected (Q)

Precautions

1. The soil should be saturated.
2. Porous stones should be clean and de-aired.
3. Experiment should be started once steady state of flow is reached.
4. Throughout the experiment the rate of inflow of water should be equal to rate of outflow of water ie The head difference is always kept constant.

Deriving "k" from the test.

Discharge, $q = k\,i\,A$

where i = hydraulic gradient = $\frac{h}{L}$; $h \rightarrow$ head causing flow

A = cross-section area of the specimen.

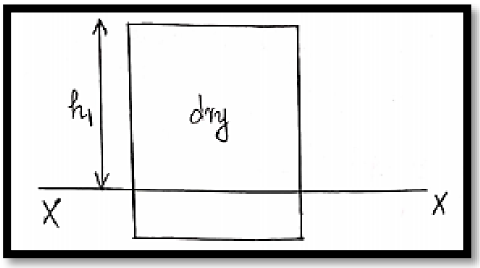
$$\therefore\ q = k \frac{h}{L} \cdot A = \frac{Q}{t}$$

where $Q \rightarrow$ volume of water collected in graduation cylinder in time "t".

$$\therefore\ \boxed{k = \frac{q \cdot L}{A h}} = \frac{\frac{Q}{t} \cdot L}{A h}$$

4	Explain the concept of effective stress, pore water pressure and total stress.	[6]

Concept of total stress



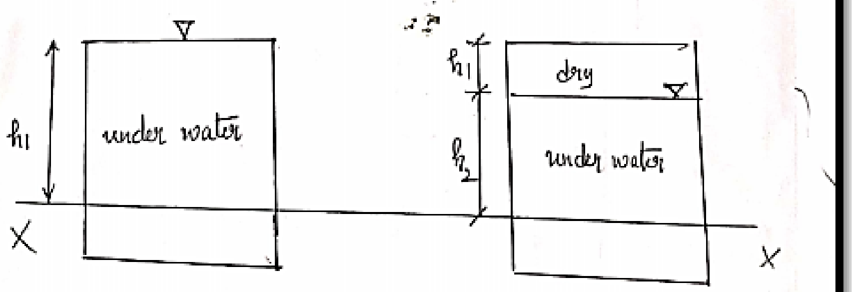
$\sigma_{xx} = \gamma_d h_1$ Total stress is total weight above a section divided by total area A.

Here the soil is dry hence the total weight is the weight of soil which is dry.

$$\frac{\text{Total weight of soil above X-X}}{\text{cross-section area (A)}} = \text{unit weight of soil} \times h_1$$

$$= \gamma_d \times h_1$$

The unit of total stress is KN/m^2 or KPa



$\sigma_{xx} = \gamma_{sat} \times h_1$ $\qquad$ $\sigma_{xx} = \gamma_d h_1 + \gamma_{sat} h_2$

Note : γ_{sat} → total unit weight of soil + water

CONCEPT OF PORE WATER PRESSURE

Total stress = pore water pressure + effective stress

Pore water pressure is also known as neutral stress. It acts on all sides of a solid particle.

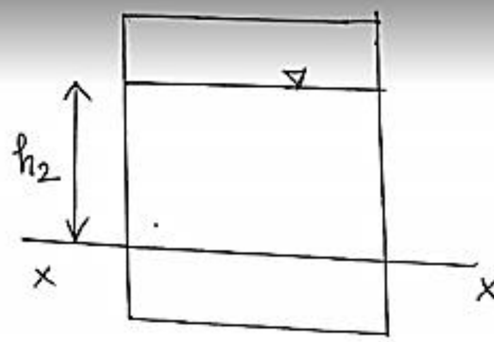
$$u = \frac{\text{Weight of water}}{A - A_s}$$

where A: area of cross-section of the soil.

A_s: grain contact area

$A - A_s$: area of contact of soil – grain contact area.

Pore water pressure $= u = \gamma_w h_2$ = (unit weight of water) $\times h_2$



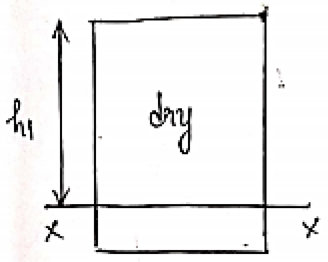
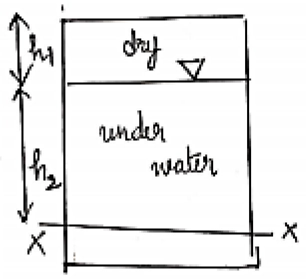
If the soil is dry pore water pressure = 0

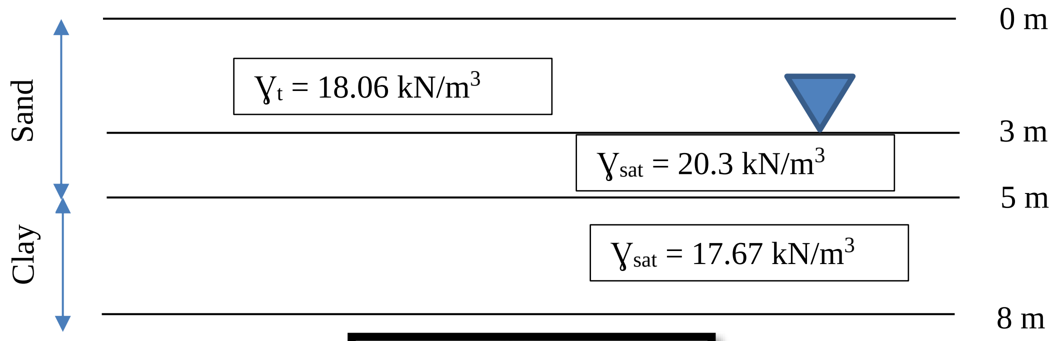
Pore water pressure can be measured by a piezometer

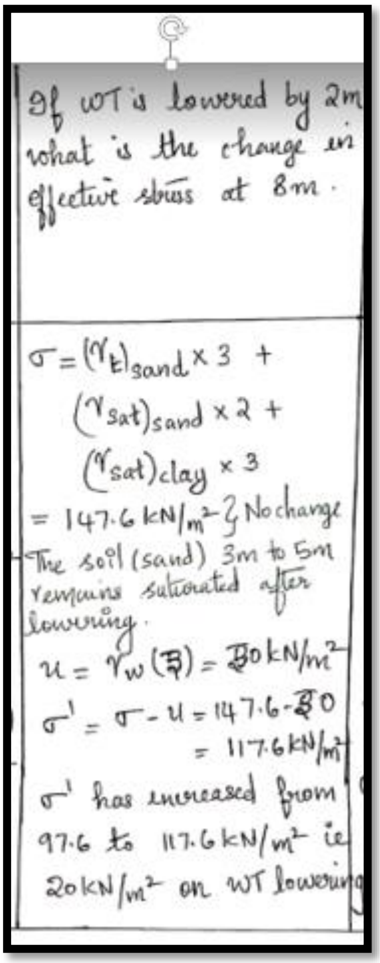
CONCEPT OF EFFECTIVE STRESS

$$\sigma' = \frac{\text{Weight of soil skeleton}}{\text{total cross-sectional area }(A)}$$

$$\sigma' = \sigma - u$$

	 $\sigma' = \gamma_d h_1 = \sigma$  $\sigma' = [\gamma_d h_1 + \gamma_{sat} h_2] - [\gamma_w \cdot h_2]$ $\sigma \quad - \quad u$ $\sigma' = \gamma_d h_1 + h_2(\gamma_{sat} - \gamma_w)$ $\sigma' = \gamma_d h_1 + \gamma_{sub} \cdot h_2$ Effective stress is the difference of total stress and pore water pressure. It cannot be measured directly like total stress or pore water pressure. It can only be computed from σ and u. The mechanical behaviour of soil is linked to effective stress rather than total stress. An increase in effective stress can cause reduction in void ratio, decrease of compressibility and an increase of shear strength.			
5	If the effective stress for the given subsoil conditions at 8 m is 97.8 kN/m^2. Find out the change in effective stress if water table is lowered by 2m.	[6]		





If WT is lowered by 2m what is the change in effective stress at 8m.

$\sigma = (\gamma_t)_{sand} \times 3 + (\gamma_{sat})_{sand} \times 2 + (\gamma_{sat})_{clay} \times 3$

$= 147.6\ kN/m^2$ } No change

The soil (sand) 3m to 5m remains saturated after lowering.

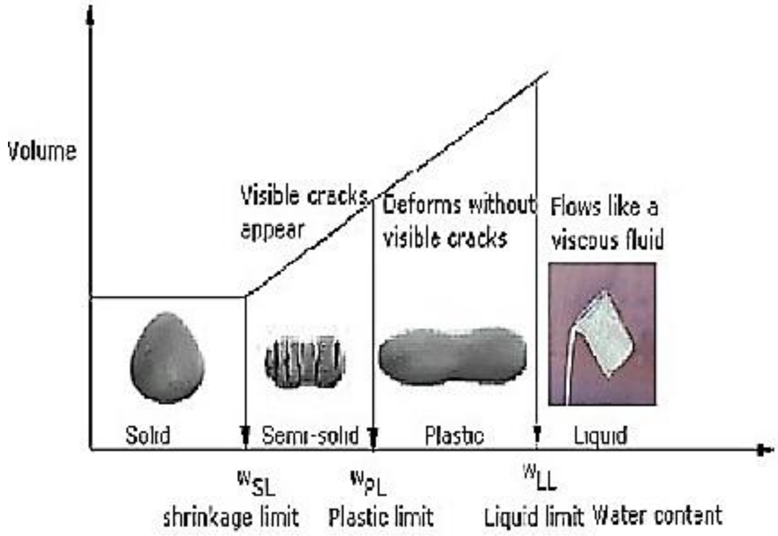
$u = \gamma_w (3) = 30\ kN/m^2$

$\sigma' = \sigma - u = 147.6 - 30 = 117.6\ kN/m^2$

σ' has increased from 97.6 to 117.6 kN/m^2 ie 20 kN/m^2 on WT lowering

6. What is consistency of a soil. List and define the three consistency limits. [6]

Consistency of a fine grained soil is the degree of firmness of a soil indicated by terms as soft, firm or hard. Consistency limits or Atterberg's limits are water contents at which soil changes its state from one to another.



There are 3 consistency limits-

Liquid limit – The water content above which the soil behaves like a fluid with no shear strength.

Plastic limit – The water content till which the soil can be moulded without cracks. Below plastic limit soil becomes a semi-solid.

Shrinkage limit – The minimum water content at which the soil remains fully saturated. Below shrinkage limit there is no volume reduction even if water content reduces.

7. In a falling head permeability test the length and area of cross-section are 0.17 m and $21.8 \times 10^{-4} m^2$ respectively. Calculate the time required for the head to drop from 0.25 m to 0.10 m. The cross-sectional area of the stand pipe is 2×10^{-4} m^2. The sample has three layers having permeabilities $3 \times 10^{-5} m/s$ for 0.07 m, 4×10^{-5}m/s for 0.05m and $6 \times 10^{-5} m/s$ for 0.05 m. The flow is taking perpendicular to the bedding plane. [6]

$$k = \frac{H_1+H_2+H_3}{\frac{H_1}{k_1}+\frac{H_2}{k_2}+\frac{H_3}{k_3}} = \frac{0.07+0.05+0.05}{\frac{0.07}{3\times10^{-5}}+\frac{0.05}{4\times10^{-5}}+\frac{0.05}{6\times10^{-5}}} =$$

$$k = \frac{2.303 \times aLlog\frac{h_1}{h_2}}{At}$$

$$t =$$

PART B (Compulsory)

8. The observations of a standard proctor test is given below- [10] CO1 L3

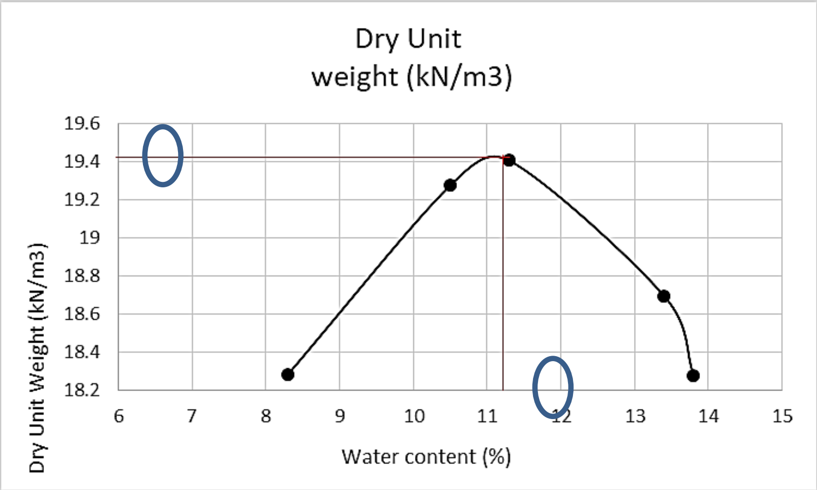
Water Content	Bulk unit Weight (kN/m^3)
8.3	19.8
10.5	21.3
11.3	21.6
13.4	21.2
13.8	20.8

i. Determine the Optimum moisture content and maximum dry density.
ii. Plot the 80% saturation line.
iii. Determine the void ratio and degree of saturation at optimum condition.
iv. If the relative compaction to be achieved on field is 95% find the range of water content that can be used on field.

Solution

i. OMC = 11.3 % & MDD = 19.4 kN/m3

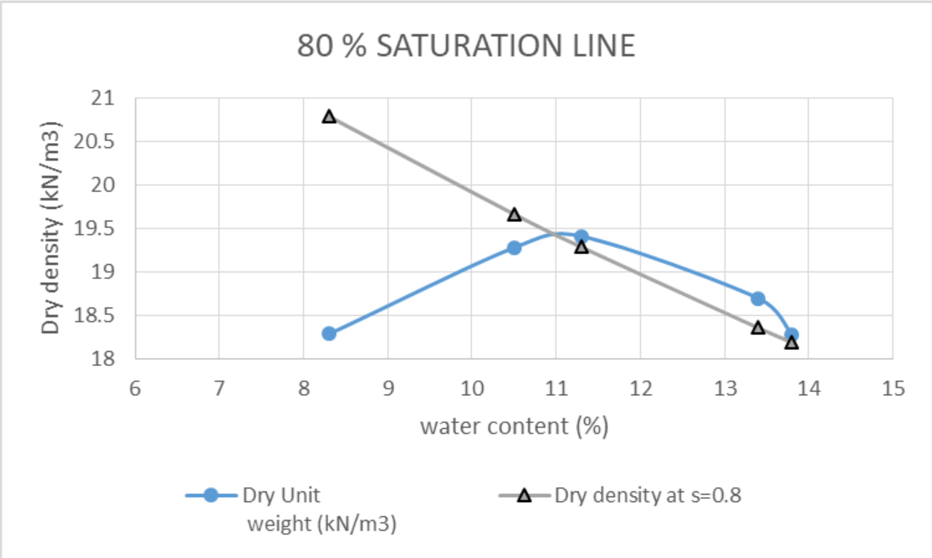
Water content w (%)	Bulk unit weight (γ_t) (kN/m3)	Water content in decimals (w)	Dry Unit weight (γ_d) (kN/m3)
Given	Given	$\frac{w(\%)}{100}$	$\gamma_d = \frac{\gamma_t}{1+w}$
8.3	19.8	0.083	18.28255
10.5	21.3	0.105	19.27602
11.3	21.6	0.113	19.40701
13.4	21.2	0.134	18.69489
13.8	20.8	0.138	18.27768



ii. 80 % saturation line

Water content (%)	Bulk unit weight (kN/m3)	Water content in decimals	Dry Unit weight (kN/m3)	Dry density at s=0.8
Given	Given	$\frac{w(\%)}{100}$	$\gamma_d = \frac{\gamma_t}{1+w}$	$(\gamma_d)@\, s = 0.8 = \frac{G_s \gamma_w}{1 + \frac{wG_s}{s = 0.8}}$
8.3	19.8	0.083	18.28255	20.78533
10.5	21.3	0.105	19.27602	19.66149

11.3	21.6	0.113	19.40701	19.28237
13.4	21.2	0.134	18.69489	18.35339
13.8	20.8	0.138	18.27768	18.1865



iii. Void ratio and degree of saturation at OMC.

Dry density at OMC = MDD = 19.4 kN/m^3
OMC = w = 11.3 %

$$\gamma_d = \frac{\gamma_w G_s}{1+e}$$

$$19.4 = \frac{10 \times 2.65}{1+e}$$

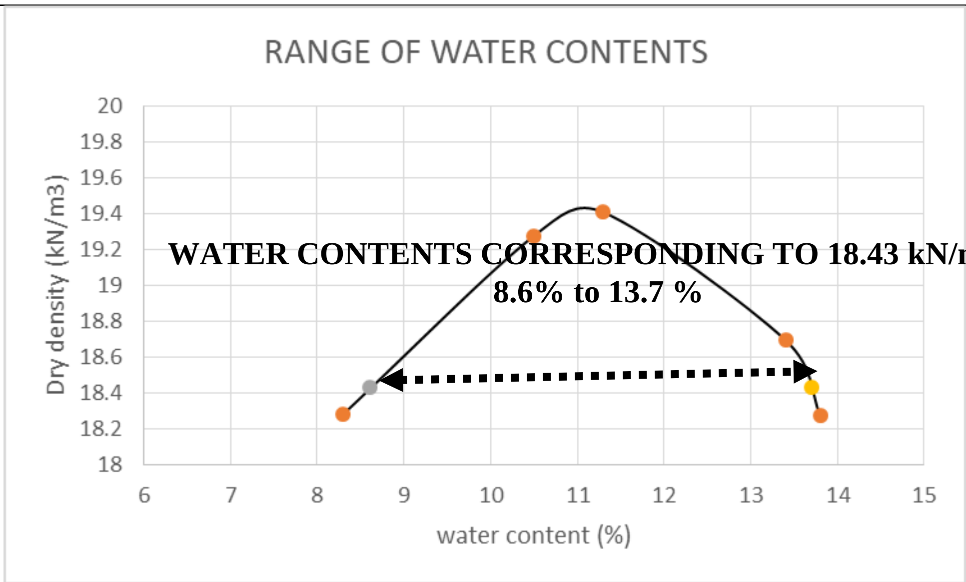
$$e = 0.37$$

$$wG_s = se$$

$$0.113 \times 2.65 = s \times 0.37$$

S = 0.81

Hence void ratio at OMC = 0.37 and the degree of saturation is 0.81



iv. Relative compaction = 95 %

$$Relative\ Compaction = \frac{Maximum\ dry\ density\ achieved\ on\ field}{Maximum\ dry\ density\ achieved\ in\ lab}$$

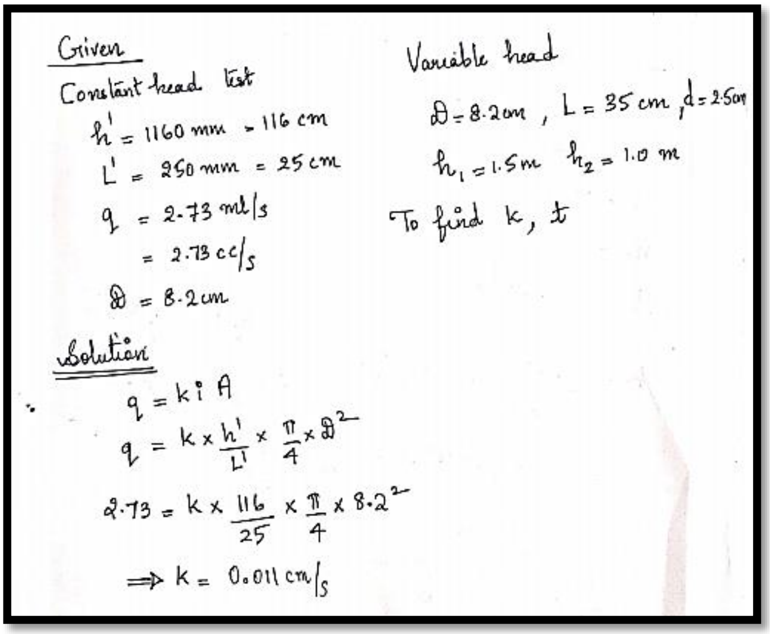
9. A permeameter of diameter 82 mm contains a sample of soil of length 350 mm. It can be used for either constant head test or falling head test permeability test. The stand pipe used for falling head has a diameter of 250 mm. The rate of flow was 2.73 ml/s. [10]

i. Find the coefficient of permeability of soil.

ii. If a falling head permeability was then conducted, how much time it will take for the head to drop from 1.5 m to 1 m.

iii. If the soil specimen is oven dried to give a dried weight of 2900 g, find the seepage velocity.

PART 1



Given

Constant head test

$h' = 1160$ mm $= 116$ cm

$L' = 250$ mm $= 25$ cm

$q = 2.73$ ml/s $= 2.73$ cc/s

$D = 8.2$ cm

Variable head

$D = 8.2$ cm, $L = 35$ cm, $d = 2.50$ m

$h_1 = 1.5$ m $h_2 = 1.0$ m

To find k, t

Solution

$q = k\,i\,A$

$q = k \times \frac{h'}{L'} \times \frac{\pi}{4} \times D^2$

$2.73 = k \times \frac{116}{25} \times \frac{\pi}{4} \times 8.2^2$

$\Rightarrow k = 0.011$ cm/s

PART 2

To find time of fall from 1.5m to 1.0 m

$$k = \frac{2.3\,aL}{A\,t}\log_{10}\left(h_1/h_2\right)$$

$$k = \frac{2.3 \times \frac{\pi}{4} \times 2.5^2 \times 35}{\frac{\pi}{4} \times 8.2^2 \times t} \times \log_{10}\frac{1.5}{1}$$

$$\Rightarrow t = 119.9$$

$$\simeq 120\,s$$

PART 3

The oven dried mass = dry mass = M_d = 2900 g

The dry density = $\rho_d = \frac{M_d}{V} = \frac{Dry\ mass}{Volume\ of\ specimen} = \frac{2900}{\frac{\pi}{4}\times 8.2^2 \times 35} = 1.56\ g/cc$

$$\rho_d = \frac{\rho_w \times G_s}{1+e} = \frac{1\times 2.65}{1+e} = 1.56$$

$$e = 0.69$$

$$n = \frac{e}{1+e} = \frac{0.69}{1+0.69} = 0.41$$

Discharge velocity, v

$$v = ki$$

$$v = 0.011 \times \frac{h'}{L'} = 0.011 \times \frac{116}{25} = 0.05\ \text{cm/s}$$

Seepage velocity, v_s

$$v_s = \frac{v}{n} = \frac{0.05}{0.41} = 0.122\ cm/s$$

Signature of CI | Signature of CCI | Signature of HOD