NAME →

ROLL NO. →

Test No. → 02

Subject → Transportation Engg + Surveying + Geotechnical Engg + Environmental Engg.

BRANCH → CIVIL ENGINEERING.

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1 (a)

Given Design speed $V = 75 \text{ km/hr} = 20.83 \text{ m/s}$

$C = 0.55 \text{ m/s}^3$

$f = 0.35$

$t = 2.5 \text{ sec}$

descending grade $n_1 = -\frac{1}{33}$

Ascending grade $n_2 = +\frac{1}{44}$

$\therefore$ Change in grade $N = |n_1 - n_2| = \left|-\frac{1}{33} - \frac{1}{44}\right| = \frac{7}{132}$

Let L = Length of valley curve

For comfort condition →

$$L = 2\sqrt{\frac{Nv^3}{C}} = 2\sqrt{\frac{\frac{7}{132} \times (20.83)^3}{0.55}} = 59.04 \text{ m}$$

For Head light condition.

Assuming $L > SSD$ where $SSD = S = 0.278\,Vt + \frac{V^2}{254 f}$

$= 0.278 \times 75 \times 2.5 + \frac{75^2}{254 \times 0.35}$

$= 115.4 \text{ m}$

$$L = \frac{NS^2}{1.5 + 0.035S} = \frac{\frac{7}{132} \times 115.4^2}{1.5 + 0.035 \times 115.4} = 127.5 \text{ m} > 115.4 \text{ m}$$

ok.

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∴ Length of valley curve = max { 59.04 m, 127.5 m }

= 127.5 m.

L = 127.5 m

1 (b)

Given: P = 5100 kg.

$E = 3 \times 10^5$ kg/cm²

h = 18 cm

μ = 0.15

K = 6 kg/cm³

a = 15 cm

Stress at interior region $S_i = \frac{0.316P}{h^2}\left[4\log_{10}\left(\frac{l}{b}\right) + 1.069\right]$

where $l = \left[\frac{Eh^3}{12K(1-\mu^2)}\right]^{1/4}$ = Radius of relative stiffness

$= \left[\frac{3\times10^5 \times 18^3}{12 \times 6 \times (1-0.15^2)}\right]^{1/4}$

= 70.61 cm.

and $b = \sqrt{1.6a^2 + h^2} - 0.675h$ if $a < 1.724h$.

= a if $a > 1.724h$.

$1.724h = 1.724 \times 18 = 31.032\text{ cm} > a$

∴ $b = \sqrt{1.6(15)^2 + 18^2} - 0.675 \times 18 = 14$ cm.

∴ $S_i = \frac{0.316 \times 5100}{18^2}\left[4\log_{10}\left(\frac{70.61}{14}\right) + 1.069\right]$

S_i = 19.3 kg/cm²

Stress at edge region $S_e = \frac{0.572 P}{h^2}\left[4 \log_{10}\left(\frac{l}{b}\right) + 0.359\right]$

$$= \frac{0.572 \times 5100}{18^2}\left[4 \log_{10}\left(\frac{70.61}{14}\right) + 0.359\right]$$

$$\boxed{S_e = 28.54 \ kg/cm^2}$$

Stress at corner region $S_c = \frac{3P}{h^2}\left[1 - \left(\frac{a\sqrt{2}}{l}\right)^{0.6}\right]$

$$= \frac{3 \times 5100}{18^2}\left[1 - \left(\frac{15\sqrt{2}}{70.61}\right)^{0.6}\right]$$

$$\boxed{S_c = 24.27 \ kg/cm^2}$$

1 (c) Toll roads are the road which are designed with high technologies and green environment condition for the free movement of vehicles. It is constructed by public-private partnership so, a toll fee/charge is charged on vehicle owner for using the toll services during its design life.

Advantages.

i) Restriction free movement on toll road due its latest technologies and technical know how.

ii) Due to green environment condition it reduces the greenhouse gases from the environment. So, it is environment friendly.

iii) Toll roads uses is chargeable. So, the fee recieved by the toll plaza supplements the revenue of government and hence make a suitable fund for the maintenance, to toll roads and other services. Also, through all these means, it boost the economy because the infrastructure of the country developed.

iv) Due to improved road condition, the vehicle can move faster and can save a lot of time. Also passanger in vehicle feel comfortable because the toll roads are designed with suitable geometric element of roads.

Disadvantages.

i) The only disadvantage of toll road is that vehicle owner has to pay fee for using these services.

ii) Faster movement of vehicle on road may cause accidents.

1 (d) For tachemeter, Distance $D = KS + C$

$$\therefore \; 100 = 0.99\,k + C \quad \text{--- (i)}$$
$$300 = 3\,k + C \quad \text{--- (ii)}$$

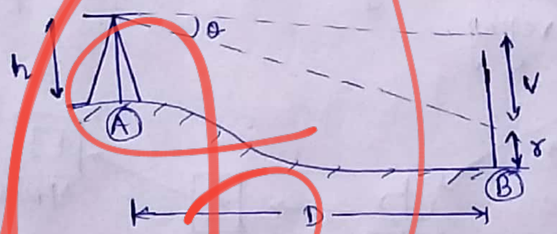
Solving (i) and (ii) we get,

Multiplying Constant $K = 99.5$
Additive Constant $C = 1.5$.

Now the given question is a case of staff vertical and inclined line of sight (depression)

$$\therefore \; D = KS\cos^2\theta + C\cos\theta \qquad \text{where } s = 2.670 - 1.000 = 1.670$$
$$= 99.5 \times 1.67 \times \cos^2 10 + 1.5\cos 10^\circ$$

$$\boxed{D = 162.632\,m}$$



$$V = KS\frac{\sin 2\theta}{2} + C\sin\theta$$
$$= 99.5 \times 1.67 \times \frac{\sin(20)}{2} + 1.5\sin 10^\circ$$
$$= 28.676\,m$$

$$\therefore \; RL_B = RL_A + h - V - r = 450.500 + 1.420 - 28.676 - 1.835$$
$$= 420.909\,m$$

$$\boxed{RL_B = 420.909\,m}$$

1(e)

(I) Elements of remote sensing -

a) Energy source → It provide electromagnetic energy to the target of interest.

b) Radiation and atmosphere → The energy emitted from the source is radiate and intract with atmosphere. The atmosphere allow the enegy to pass through it and incident on the target.

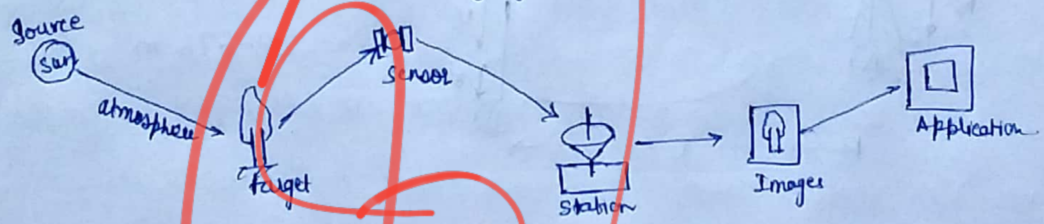
c) Interaction with target → The energy incident on the target intract with the target depending on the properties of both energy and target

d) Recording of energy by sensor → The incident as well as refracted energy from the target is recorded by the sensor

e) Transmission, reception and processing → The recorded energy by the sensor has to be transmitted to the processing station where the data are interpreted into an image.

f) Interpretation and Analysis → The image is interpreted and analysed, visually as well as digitally.

g) Application → The interpreted images are used in problem solving of surveying.



(II) Sources of error in GPS.

a) Satellite error → one nanosecond error in satellite clock cause an an error of 30 cm from the actual position of reciever.

b) GPS Jamming → It is due to disabling of civilian course aquisition code. GIS is unable to locate the actual reciever.

c) Atmospheric error → GPS signals speeds are affected by ionosphere and troposphere So, it may cause a deviation of upto 30m from the actual position of reciever.

d) Multipath error → This error is due to the successive bouncing of GPS signal on the reflecting surfaces. It causes a deviation of upto 1m from actual position of reciever.

2 (a) Width of Carriage way $W = 15m$.

Entry width $= e_1 = 10m$

Exit width $= e_2 = 10m$.

Weaving ratio $= p = \frac{b+c}{a+b+c+d}$

For NE

$a = 408$

$b = 650 + 375 = 1025$

$c = 370 + 505 = 875$

$d = 510$

$\therefore p = \frac{b+c}{a+b+c+d} = \frac{1025+875}{408+1025+875+510} = 0.674$

For E-S

$a = 250$

$b = 500 + 600 = 1100$

$c = 510 + 650 = 1160$

$d = 375$

$\therefore p = \frac{b+c}{a+b+c+d} = \frac{1100+1160}{250+1100+1160+375} = 0.783$

For S-W

$a = 420$

$b = 350 + 370 = 720$

$c = 500 + 375 = 875$

$d = 600$

$\therefore p = \frac{b+c}{a+b+c+d} = \frac{720+875}{420+720+875+600} = 0.61$

For W-N

$a = 400$

$b = 505 + 510 = 1015$

$c = 350 + 600 = 950$

$d = 370$

$\therefore p = \frac{b+c}{a+b+c+d} = \frac{1015+950}{400+1015+950+370} = 0.718$

∴ ~~Width~~

$$\therefore p = max^m \begin{cases} 0.674 \\ 0.783 \\ 0.61 \\ 0.718 \end{cases} = 0.783$$

Width of non weaving section = e_2 = max^m of entry and exit width
= 10m.

∴ Width of weaving section = $w = \frac{e_1 + e_2}{2} + 3.5$

$$= \frac{10+10}{2} + 3.5 = 13.5m.$$

Length of weaving section ≮ 4w.

∴ L = 4 × 13.5 = 54 m.

$$\therefore \text{Capacity of rotary} = C = \frac{280\,w\left(1+\frac{e}{w}\right)\left(1-\frac{p}{3}\right)}{\left(1+\frac{w}{L}\right)}$$

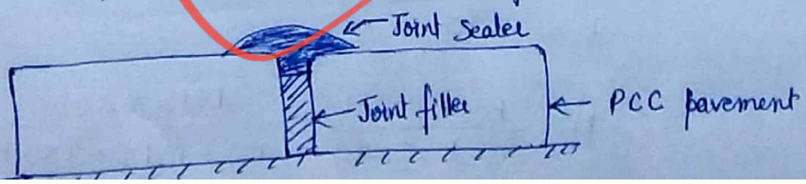
$$= \frac{280 \times 13.5 \times \left(1+\frac{10}{13.5}\right)\left(1-\frac{0.783}{3}\right)}{\left(1+\frac{13.5}{54}\right)}$$

$$= 3890 \text{ PCU/hr}.$$

∴ **Capacity ~~of~~ rotary = 3890 PCU/hr**

2 (b)

Joint in the cement concrete pavement allows water to flow into the subgrade. This causes mud pumping of subgrade in clay. Also, the stones trap in the joints causes spalling of joint edges and in extreme case blowup may take place. So, to prevent all these defects, first a filler material is filled in the joint gap called joint filler and the top of the joint is sealed with sealer material called joint sealer



Joint Filler →

The properties of Joint filler should be.

i) Compressibility → Joint filler should be compressible when the pavement will expand in the summer.

ii) Elasticity → Joint filler should regain its original shape and the pavement shrink in the winter season.

iii) Durability → Joint filler should be resistant to weather phenomena and its design life should be comparable to the PCC pavement.

The material used for Joint filler are.

i) Soft wood
ii) Impregnated fibre board
iii) Cork bounded with bitumin.

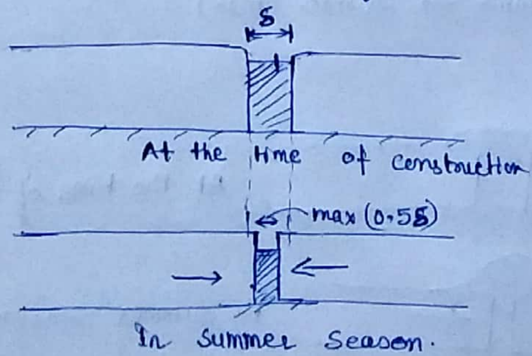
The bitumen should be properly bounded to the preformed material. The bitumen used should be 35% by weight as per IRC.

The properties required for the joint filler are –

i) Compressibility → The material should compress by more than 50% of its thickness when compressed, without lossing its weight by more than 3%.

ii) Recovery → The material used for joint ~~sealer~~ filler should regain its atleast 70% of original thickness after application and release of load after one hour at the end of third loading.

iii) Extrusion → The extrusion should not more than 6.5mm when it is tested with all its three edge restrained and compressed be 50% of its thickness.



Joint Sealer →

For the effective sealing of joint by joint sealer, the joint sealer should have following properties

i) Adhesion to concrete edges → The material used should be have good adhesion to the concrete edges so that it attached to the concrete during load movement or temperature variation.

ii) Extensibility without fracture → The joint sealer should be extensible enough that it does not fracture when the concrete pavement ~~~~ ~~slide~~ ~~up~~ slid away from each other in winter season. It is responsible for continuity of pavement

iii) Ingress of grit Resistant → Joint sealer must not allow the grit to penetrate into it. It should have an adequate penetration value.

iv) Durability → Joint sealer should not flow in hot summer sealer nor it get brittle in winter season. Its life should be long and should be protective to concrete joints.

Materials used as joint sealers are.

i) Bitumen with mineral filler.

ii) Rubber bitumen.

iii) Air blown bitumen → has a property of resistance for a wide range of temperature.

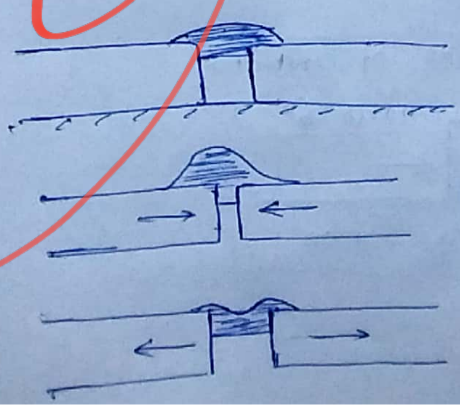
Properties required for joint sealer as per IRC are.

Softening point → 75°C

Penetration value → 15-50

Extensibility → 6mm (max)

Ingress of grit resistance → 20mm (max)



At the time of Construction

In summer season

In winter season

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2(c)

FB of AB = 71° 05′

∴ BB of AB = 71° 05′ + 180° = 251° 05′

But BB of AB = 250° 20′

∴ Error = 250° 20′ − 251° 05′ = −0° 45′

∴ Correction = + 45′

FB of BC = 110° 20′

BB of BC = 110° 20′ + 180° = 290° 20′

But BB of BC = 292° 35′

∴ Error = 292° 35′ − 290° 20′ = 2° 15′

∴ Correction = −2° 15′

FB of CD = 161° 35′

∴ BB of CB = 161° 35′ + 180° = 341° 35′

But BB of CB = 341° 45′

∴ Error = 341° 45′ − 341° 35′ = 10′

∴ Correction = −10′

FB of DE = 220° 35′

BB of DE = 220° 35′ − 180° = 40° 35′

But BB of DE = 40° 05′

∴ Error = 40° 05′ − 40° 35′ = −30′

Correction = +30′

FB of EA = 300° 50′

BB of EA = 300° 50′ − 180° = 120° 50′

But BB of EA = 121° 10′

∴ Error = 121° 10′ − 120° 50′ = 20′

Correction = −20′

Therefore, no station is free from local attraction.

Included angle has no effect of local attraction.

$\therefore \angle A = \text{FB of AB} - \text{BB of EA} \pm 360^\circ = 71^\circ 05' - 121^\circ 10' + 360^\circ = 309^\circ 55'$

$\angle B = 110^\circ 20' - 250^\circ 20' + 360^\circ = 220^\circ$

$\angle C = 161^\circ 35' - 292^\circ 35' + 360^\circ = 229^\circ$

$\angle D = 220^\circ 50' - 341^\circ 45' + 360^\circ = 239^\circ 05'$

$\angle E = 300^\circ 50' - 40^\circ 05' = 260^\circ 45'$

Sum of included angle $= 1258^\circ 45'$

Sum of the exterior angle $= (n+2) \times 180 = (5+2) \times 180 = 1260^\circ$

$\therefore$ Correction required per angle $= \dfrac{1260^\circ - 1258^\circ 45'}{5} = +15'$

Corrected Included angles →

$\therefore \angle A = 309^\circ 55' + 15' = 310^\circ 10'$

$\angle B = 220^\circ + 15' = 220^\circ 15'$

$\angle C = 229^\circ + 15' = 229^\circ 15'$

$\angle D = 239^\circ 05' + 15' = 239^\circ 20'$

$\angle E = 260^\circ 45' + 15' = 261^\circ$.

Sum of corrected included angle $= 1260^\circ$ ok.

The line which is least affected by local attraction is line CD.

$\therefore$ Correction is applied to each station C and D are $= -\dfrac{10'}{2} = -5'$

$\therefore$ Corrected FB of CD $= 161^\circ 35' - 5' = 161^\circ 30'$

Corrected BB of CD $= 161^\circ 30' + 180^\circ = 341^\circ 30'$

Corrected FB of DE $= 341^\circ 30' + 239^\circ 20' - 360^\circ = 220^\circ 50'$

Corrected BB of DE $= 220^\circ 50' - 180^\circ = 40^\circ 50'$

Corrected FB of EA $= 40^\circ 50' + 261^\circ = 301^\circ 50'$

Corrected BB of EA $= 301^\circ 50' - 180^\circ = 121^\circ 50'$

Corrected FB of AB $= 121^\circ 50' + 310^\circ 10' = 72^\circ 00'$

Corrected BB of AB $= 72^\circ 00' + 180^\circ = 252^\circ 00'$

Corrected FB of BC = $252°00' + 220°15' - 360° = 112°15'$

Corrected BB of BC = $112°15' + 180 = 292°15'$

Corrected FB of CD = $292°15' + 229°15' - 360° = 161°30'$ ok

∴ Corrected Magnetic bearings are.

Line	Fore bearing	Back bearing.
AB	72° 00'	252° 00'
BC	112° 15'	292° 15'
CD	161° 30'	341° 30'
DE	220° 50'	40° 50'
EA	301° 50'	121° 50'

5(a)

Void ratio $e = 0.52$ *Assuming point B = datum level.

specific gravity $G = 2.67$

∴ hydraulic gradient (i) = $\frac{\text{head loss}}{\text{Length of soil}} = \frac{1.5}{2} = 0.75$

1) For point B

Total stress = $\sigma_B = \gamma_w \times 0.7 + \gamma_{sat} \times 2$

where $\gamma_{sat} = \gamma_w \frac{G+e}{1+e} = 9.81 \times \frac{(2.67+0.52)}{1+0.52} = 20.59$ KN/m³

∴ $\sigma_B = 9.81 \times 0.7 + 20.59 \times 2 = 48.05$ KN/m²

Pore water pressure $u_B = \gamma_w \times (2+0.7+1.5) = 9.81 \times 4.2 = 41.2$ KN/m²

∴ Effective stress $\bar{\sigma}_B = \sigma_B - u_B = 48.05 - 41.2 = 6.85$ KN/m²

For point A,

Total stress $\sigma_A = \gamma_w \times 0.7 + \gamma_{sat} * 1$

$= 9.81 \times 0.7 + 20.59 \times 1$

$= 27.46$ kN/m²

Pore water pressure $= (1 + 0.7 + 1.5 - 0.75)\gamma_w$

$= 2.45 \times 9.81$

$= 24.03$ kN/m²

∴ Effective pressure $\bar{\sigma}_A = \sigma_A - u_A = 27.46 - 24.03 = 3.43$ kN/m²

(ii) Upward seepage force per unit volume $f_s = i\gamma_w = 0.75 \times 9.81 = 7.36$ kN/m³

5(b)

Given prosity $n = 0.4445$

thickness of clay layer $= H_0 = 2.6$ m

Liquid limit $= 41.112\%$

$(\bar{\sigma}_0) = 127$ kN/m²

$\Delta\bar{\sigma} = 46.5$ kN/m²

∴ Void ratio $e_0 = \frac{n}{1-n} = \frac{0.4445}{1+0.4445} = 0.8$

Compression Index $= C_c = 0.009(w_L - 10) = 0.009(41.112 - 10) = 0.28$

∴ Primary settlement $\Delta H = C_c \frac{H_0}{1+e_0} \log\left(\frac{\bar{\sigma}_0 + \Delta\bar{\sigma}}{\bar{\sigma}_0}\right)$

$= 0.28 \times \frac{2.6}{1+0.8} \log\left(\frac{127+46.5}{127}\right)$

$= 54.8$ mm.

Now $\frac{\Delta e}{1+e_0} = \frac{\Delta H}{H_0}$

$\Rightarrow \frac{e_0 - e_{100}}{1+e_0} = \frac{54.8 \times 10^{-3}}{2.6} \Rightarrow \frac{0.8 - e_{100}}{1+0.8} = \frac{54.8 \times 10^{-3}}{2.6} \Rightarrow e_{100} = 0.762$

Now

Secondary settlement $= \Delta H_2 = C_S \frac{H_0}{1+e_{100}} \log\left(\frac{t_2}{t_1}\right)$

where $C_S = 0.02$

$t_2 = 5$ year $= 5 \times 12 = 60$ months

$t_1 = 18$ months.

$\therefore \Delta H_2 = 0.02 \times \frac{2.6}{1+0.762} \times \log\left(\frac{60}{18}\right)$

$= 15.4$ mm.

$\therefore$ Total settlement $= 54.8 + 15.4 = 70.2$ mm.

5 (c)

$c' = 51\ kN/m^2$ $\phi' = 21°$

$\gamma = 15.7\ kN/m^3$

Lateral pressure $= \frac{1}{2} \times$ vertical pressure.

$A = 0.5$ $B = 0.9$.

$$\Delta U = B\left[\Delta\sigma_3 + A\left(\Delta\sigma_1 - \Delta\sigma_3\right)\right]$$

$$= 0.9\left[\Delta\sigma_3 + 0.5\left(2\Delta\sigma_3 - \Delta\sigma_3\right)\right]$$

$$= 0.9 \times 1.5\ \Delta\sigma_3$$

$$\Delta U = 1.35\ \Delta\sigma_3$$

Now $K_a = \frac{1 - \sin 21°}{1 + \sin 21°} = 0.472$

$\therefore$ Lateral stress when depth was 3m $= K_a \gamma Z_1 + 2C\sqrt{K_a}$

$= 0.472 \times 15.7 \times 3 + 2 \times 51 \times \sqrt{0.472}$

$= 92.31\ kN/m^2$

Lateral stress when depth is 6m $= K_a \gamma Z_2 + 2C\sqrt{K_a}$

$= 0.472 \times 15.7 \times 6 + 2 \times 51 \times \sqrt{0.472}$

$= 114.54\ kN/m^2$

$\therefore$ Change in lateral stress $\Delta\sigma_3 = 114.54 - 92.31 = 22.23\ kN/m^2$

Scanned by CamScanner

$\therefore \Delta U = 1.35 \times 22.23 = 30\ kN/m^2$

Assuming initial pore water pressure was zero.

$\therefore U = 30\ kN/m^2$

Now σ = Total stress at base $= 15.7 \times 6 = 94.2\ kN/m^2$

$\therefore \bar{\sigma}$ = Effective stress $= 94.2 - 30 = 64.2\ kN/m^2$

$\therefore$ Shear strength at the base $= \tau = c' + \bar{\sigma} \tan\phi'$

$= 51 + 64.2 \tan(21^\circ)$

$= 75.64\ kN/m^2$

$\boxed{\tau = 75.64\ kN/m^2}$

5(d)

Given

Physical stack height $h = 180m$

Inside diameter of stack $D = 0.95m$

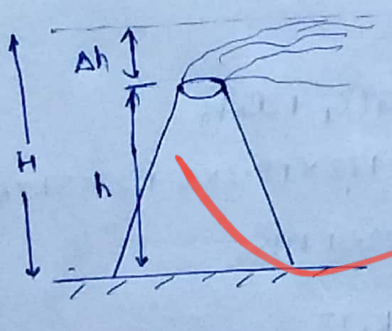
Wind velocity $u = 2.75\ m/s$

Stack gas velocity $V_s = 11.12\ m/s$

Barometric Pressure $P = 1000$ millibars

Stack gas temperature $T_s = 160^\circ C = 160 + 273 = 433\ K$

Air temperature $T_a = 20^\circ C = 20 + 273 = 293\ K$



$$\Delta h = \frac{V_s \cdot D}{u}\left[1.5 + 2.68 \times 10^{-3} PD\left(\frac{T_s - T_a}{T_s}\right)\right]$$

$$= \frac{11.12 \times 0.95}{2.75}\left[1.5 + 2.68 \times 10^{-3} \times 1000 \times 0.95 \times \left(\frac{433-293}{433}\right)\right]$$

$$= 8.924\ m.$$

$\therefore$ Effective hieght of stack $= H = \Delta h + h = 8.924 + 180 = 188.924\ m.$

$\boxed{H = 188.924\ m}$

5(e)

$$HOCl \rightleftharpoons H^+ + OCl^- \qquad K_a = 10^{-7.54} = 2.884 \times 10^{-8} \text{ mole/litres}$$

$$K_a = \frac{[H^+][OCl^-]}{[HOCl]}$$

$$pH = 7 \Rightarrow -\log[H^+] = 7 \Rightarrow [H^+] = 10^{-7} \text{ mole/litre}$$

$$\therefore 10^{-7.54} = 10^{-7} \times \frac{[OCl^-]}{[HOCl]}$$

$$\Rightarrow 10^{-0.54} = \frac{[OCl^-]}{[HOCl]}$$

$$\Rightarrow \frac{[OCl^-]}{[HOCl]} = 0.2884$$

$$\Rightarrow [OCl^-] = 0.2884\,[HOCl]$$

$$= 0.2884 \times 15 \text{ mg/l}$$

$$[OCl^-] = 4.326 \text{ mg/l}$$

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$$\therefore \% \text{ dissociation of } HOCl = \frac{4.326}{15} \times 100\% = 28.84\%$$

$$\therefore \% \text{ of HOCl not dissociated} = 100\% - 28.84\%$$

$$= 71.16\%$$

6 (a)

i) In liquid limit test, it is the moisture content at 25 no. of blows.

$$\frac{W_1 - W_L}{\log(N_1/25)} = \frac{W_1 - W_2}{\log(N_1/N_2)}$$

$$\Rightarrow \frac{40.8 - W_L}{\log(20/25)} = \frac{40.8 - 39.1}{\log(20/28)}$$

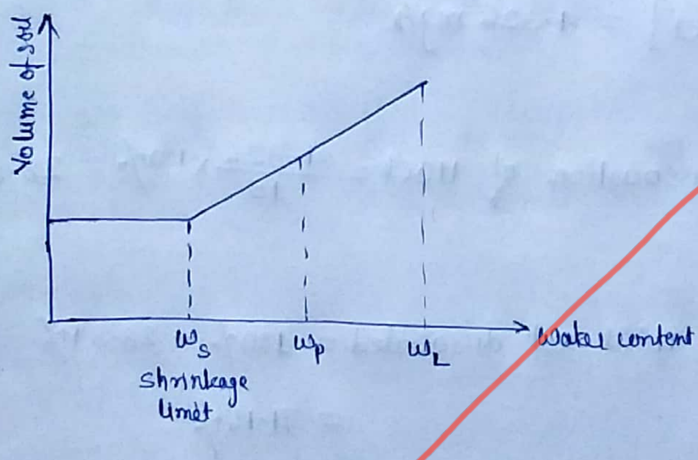
$$\Rightarrow \boxed{W_L = 39.67\%}$$ Liquid Limit

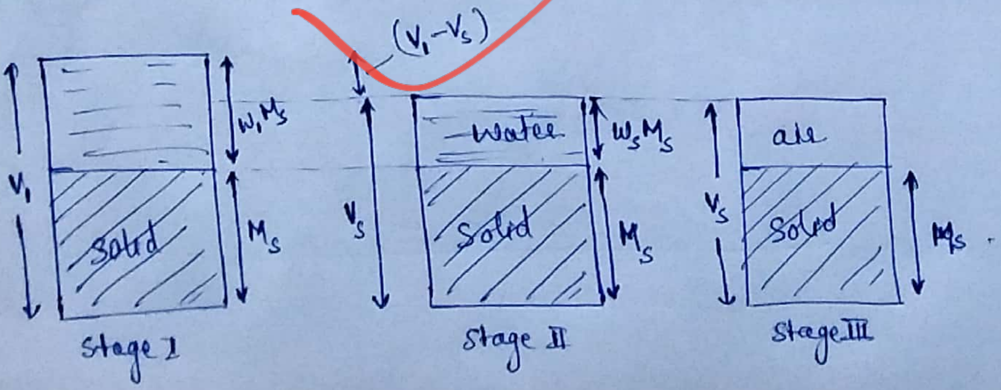
Plastic limit = $W_p = 28.5\%$

$\therefore$ Plasticity Index = $W_L - W_p = 39.67 - 28.5 = 11.17\%$

$$\boxed{I_p = 11.17\%}$$

ii) Shrinkage Limit is the maximum water content that the soil can accomodate with any increase in volume. In other word, it is the minimum water content at which any further reduction in water content does cause the change in volume of soil.





Let w_s = shrinkage limit of soil

M_s = mass of solid at shrinkage

V_s = Volume of soil at shrinkage

V_1 = initial volume of soil at moisture content w_1.

$$V_1 - V_s = \frac{W_1 M_s}{\rho_w} - \frac{w_s M_s}{\rho_w}$$

$$\Rightarrow V_1 - V_s = (W_1 - W_s)\frac{M_s}{\rho_w}.$$

$$\Rightarrow W_1 - W_s = \frac{(V_1 - V_s)\rho_w}{M_s}$$

$$\Rightarrow \boxed{w_s = w_1 - \frac{(V_1 - V_s)}{M_s}\rho_w}$$

So, if we have a soil having moisture content w_1 and volume V_1 then it is oven dried and its dry mass and volume is measured as M_s and V_s. Then by using the above formula we can get the shrinkage limit of the soil.

For the given above soil,

Soil taken for liquid limit test = 120 gm = M_s

Assuming specific gravity of soil = 2·35

$\therefore$ Volume of solids = $\frac{120}{2\cdot35 \times 1}$ = 51 cc

Assuming the volume of soil at liquid limit = 70cc

then by using above formula

$$w_s = 0\cdot3967 - \frac{(70-51)}{120} \times 1.$$

$$= 0\cdot2384$$

$$= 23\cdot84\%$$

6 (b)(i)

Corrected hydrometer reading $R_H = 25$

Volume of soil suspension $V = 1000$ cc

Specific Gravity of Solid $G = 2.75$

Effective depth $H_e = 12.13$ cm

Weight of soil mass dissolved $= W = 50$ gm.

$$N\% = \% \text{ fines} = \frac{G}{G-1} \gamma_w \frac{V}{W} \frac{R_H}{10} \%$$

$$= \frac{2.75}{2.75-1} \times 9.81 \times \frac{1000}{50 \times 9.81} \times \frac{25}{10} \%$$

$$= 78.57\%$$

Now

According to stocke's law,

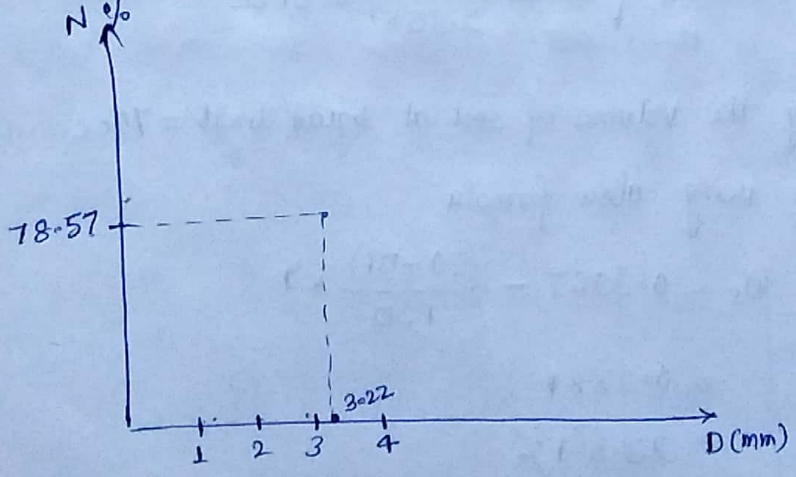
$$V_t = \frac{g}{18\nu}(G-1)d^2$$

$$\Rightarrow \frac{12.13 \times 10^{-2}}{2 \times 60} = \frac{9.81}{18 \times 0.01 \times 0.1} \times (2.75-1)\, d^2$$

$\Rightarrow$ diameter of grain $d = 3.22$ mm.

$\therefore$ Coordinates are $N\% = 78.57\%$

$d = 3.22$ mm



6 (b) (ii) Assumptions of Rankine Earth Pressure →

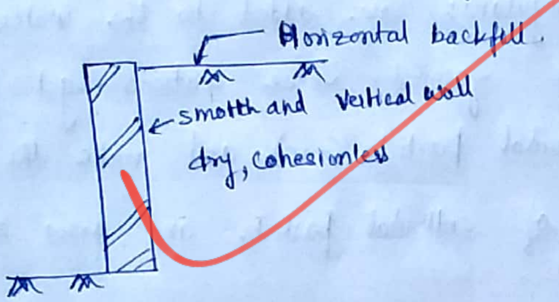
a) Soil is homogeneous, Isotropic, dry and cohesionless.

b) Backfill soil wedge is in plastic equilibrium at the time of failure.

c) Backfill soil is horizontal.

d) Back of wall is smooth and vertical.

e) failure surface is a planner surface.



Assumptions of Coulomb's theory of earth pressure →

a) soil is dry and cohesionless.

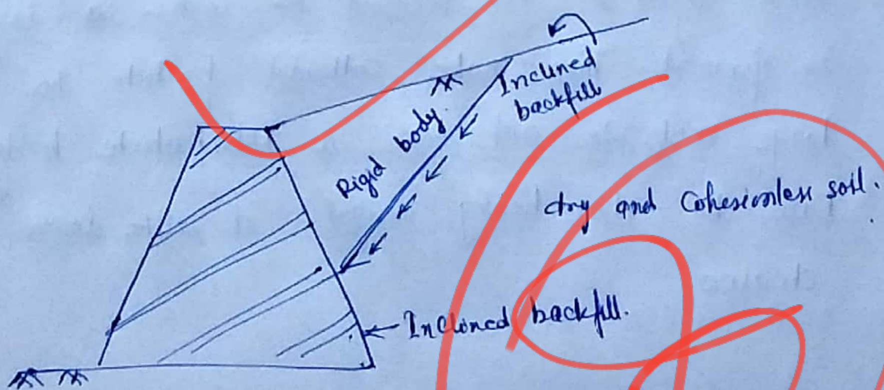
b) backfill of soil may be inclined.

c) back of wall may be inclined.

d) There is friction in the back of wall.

e) The sliding wedge are assumed to be a rigid body.

f) failure surface is a plane surface.



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6 (c) Different Mechanisms of Coagulation. →

i) Ionic layer Compression.

The large number of ions present in the water compresses the layer of positive ion toward the colloidal surface. This make the attractive force (Vanderwall force) predominates. The colloidal particle get coallese and grow in size and ultimately settle down.

ii) Adsoption and Charge Neutralisation

When the coagulants are added to the water, then the aquametallic cation (+ve) is formed. These cations get adsorbed on the surface of charged colloidal particle (−ve) and make the charge neutral. This allow free contact of colloidal particle and grow in size and ultimately settle down.

iii) Sweep Coagulation.

When alum is added to the water, it dissociate and form precipitate in the form of $Al(OH)_3$ which amorphous and gelatineous. Also, $Al(OH)_3$ precipitate is heavier so, when it settled down it swept all at colloidal partical with intself and settle down all the colloids.

iv) Inter particle bridging

When coagulants are added to water a large ~~moleg~~ molecular is formed. This make colloidal particle to attach to these large molecule and form a Interparticle bridge like structure. Due to its heavy weight, it settle down and make water clearer.

4

7(a)(i).

$P_0 = 30,000$ at $t=0$

$P_1 = 1,70,000$ at $t = 20$ yrs $= 2$ decades.

$P_2 = 3,00,000$ at $t = 40$ yrs $= 4$ decades

a)

$$\text{Saturation Population} = P_s = \frac{2P_0P_1P_2 - P_1^2(P_0+P_2)}{P_0P_2 - P_1^2}$$

$$= \frac{2\times 30,000 \times 1,70,000 \times 3,00,000 - 1,70,000^2(30,000 + 3,00,000)}{30,000 \times 3,00,000 - 1,70,000^2}$$

$$= 326000$$

b) Equation of logistic curve.

$$P = \frac{P_s}{1 + m\log_e^{-1}(nt)}$$

$$\text{where } m = \frac{P_s - P_0}{P_0} = \frac{3,26,000 - 30,000}{30,000} = 9.867$$

$$n = \frac{1}{t_1}\left[\log_e\left[\frac{P_0(P_s - P_1)}{P_1(P_s - P_0)}\right]\right]$$

$$= \frac{1}{2}\left[\log_e\left[\frac{30,000\ (326000 - 1,70,000)}{1,70,000\ (326000 - 30,000)}\right]\right]$$

$$= -1.188$$

$$\therefore P = \frac{326000}{1 + 9.867\log_e^{-1}(-1.188t)}$$

c) For next 20 yrs.

$t = 20 + 20 + 20 = 60 = 6$ decades

$$\therefore P = \frac{3,26,000}{1 + 9.867\log_e^{-1}(-1.188\times 6)} = 32340$$

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7(a)(ii) Master Plan Method or Zonal method of population forecasting →

It is a method of forecasting population in which the development of cities and town are prepared in a master plan way. In this method, the cities are divided into a number of zones based on residential area, Industrial area, commercial area etc. and the density of population (Number of people per hectare) is also fixed in each Zone. So, the growth of population is done in a very planned way. These zones are regulated by the law of corporations or local bodies. Since the population is grow in a planned way so, it is easy to forecast the future population and prepare the water supply schemes.

7(b)(i)

Noise is an excessive and disturbing sound that may affect the activity of human and animal life. It diminishes one's quality of life. Noise is harmful for human, animal as well as aquatic animal. The noise produce by submarine affect the aquatic animal and interfere its normal activity of life.

Effects of noise.

i) Immediate and acute effect is impairment of hearing.

ii) Prolonged exposure to impulsive sound affects and damage the ear drum and thus may cause permanent hearing loss.

iii) Noise may cause Cardiovascular effect on body. It may cause high blood pressure. It is very harmful for the patient suffering from brain related or heart related diseases.

iv) Noise may cause artery vascular disease and may even cause death to the person or animal.

v) Noise reduces the conciousness of a human because one can not concentrate over particular matter due high impulsive noise.

vi) Noise has very detrimental effect on animal. It may cause death of animal by altering the predators.

vii) Noise may affect the reproductive and general activity of animal so, it may cause the interference in the population of an extinct or vulnerable species.

viii) Noise produce by submarine may interefere the activity of aquatic animals. Dolphine is mostly affected by the noise. ~~and~~ Fishes are also affected and interefere in breeding.

7(b)(ii)

a) Calcium $= 72\ mg/l = \frac{72}{20}\ meq/l = 3.6\ meq/l$

Sulphate $= 136\ mg/l = \frac{136}{48}\ meq/l = 2.83\ meq/l$

Magnesium $= 54\ mg/l = \frac{54}{12}\ meq/l = 4.5\ meq/l$

chloride $= 7\ mg/l = \frac{7}{35.5}\ meq/l = 0.197\ meq/l$

Sodium $= 12\ mg/l = \frac{12}{23}\ meq/l = 0.522\ meq/l$

Bicarbonate $= 300\ mg/l = \frac{300}{61}\ meq/l = 4.92\ meq/l$

b)

Total alkalinity $= 4.92\ meq/l = 4.92 \times 50\ mg/l = 246\ mg/l$ as $CaCO_3$

Total hardness $= \left[\frac{Ca^{2+}}{20} + \frac{Mg^{2+}}{12}\right] \times 50 = [3.6 + 4.5] \times 50 = 405\ mg/l$ as $CaCO_3$

Carbonate hardness = minimum $\begin{cases} \text{Alkalinity} = 246\ mg/l. \\ \text{Total hardness} = 405\ mg/l \end{cases}$

$\therefore$ Carbonate hardness $= 246\ mg/l$. as $CaCO_3$

Non Carbonate hardness = Total hardness − Carbonate hardness

$= 405 - 246 = 159\ mg/l$ as $CaCO_3$

7(c)(1)

Assuming $\gamma_b = 12.56\ kN/m^3$ is inconsistent.

Degree of Saturation $S = \frac{wG}{e} = \frac{3.11 \times 2.75}{9} = 95.03\% < 100\%$

Assuming G is inconsistent.

$$\gamma_b = \gamma_w \frac{(1+w)\,G}{(1+e)}$$

$$\Rightarrow 12.56 = 9.81 \times \frac{(1+3.11)}{(1+9)} \times G$$

$$\Rightarrow G = 3.115$$

$$\therefore S = \frac{wG}{e} = \frac{3.11 \times 3.115}{9} = 1.076 > 1.$$

Assuming e is inconsistent

$$\gamma_b = \gamma_w \frac{G(1+w)}{(1+e)}$$

$$\Rightarrow 12.56 = 9.81 \times \frac{2.75 \times (1+3.11)}{(1+e)}$$

$$\Rightarrow e = 7.828$$

$$\therefore S = \frac{wG}{e} = \frac{3.11 \times 2.75}{7.828} = 1.093 > 1.$$

Assuming w is inconsistent.

$$\gamma_b = \gamma_w \frac{G(1+w)}{(1+e)}$$

$$\Rightarrow 12.56 = 9.81 \times \frac{2.75(1+w)}{(1+9)}$$

$$\Rightarrow w = 3.656$$

$$\therefore S = \frac{wG}{e} = \frac{3.656 \times 2.75}{9} = 1.117 > 1$$

So, here we see that only when γ_b is inconsistent the degree of saturation is less than 1. In all other case degree of saturation is more than 1

So, the value of γ_b is inconsistent.

$$\therefore \gamma_b = \gamma_w \frac{G(1+w)}{(1+e)} = 9.81 \times \frac{2.75(1+3.11)}{1+9} = 11.09 \text{ kN/m}^3.$$

$\therefore$ Correct values are $\gamma_b = 11.09$ kN/m^3

$G = 2.75$.

$e = 9$

$w = 311\%$

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7(c)(ii)

Flexible footing on sand.

Width of footing = 2 m

Load on footing = 510 kN.

Elastic modulus $E_s = 40,000$ kN/m^2

Poisson's ratio $= \mu = 0.36$.

Net pressure on foundation $= q_n = \frac{510}{2 \times 2}$ kN/m^2 = 127.5 kN/m^2

<u>For centre</u>

$I_f = 1.12$.

$$\therefore S_i = \text{Settlement} = \frac{q_n B(1-\mu^2)}{E_s} I_f$$

$$= \frac{127.5 \times 2 \times (1-0.36^2)}{40,000} \times 1.12$$

$$= 6.215 \text{ mm}$$

<u>For Corner</u>

$I_f = 0.56$.

$$\therefore S_i = \frac{q_n B(1-\mu^2)}{E_s} I_f$$

$$= \frac{127.5 \times 2 \times (1-0.36^2) \times 0.56}{40,000}$$

$$= 3.107 \text{ mm}$$

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