1. Reynold's number, $Re = \dfrac{VR}{\nu}$

$R \rightarrow$ Hydraulic radius, $R = A/P$

$\nu \rightarrow$ Kinematic viscocity

$$500 \leq Re \leq 12500$$

laminar Transitional turbulent

2. Froude number, $Fr = \dfrac{V}{\sqrt{gD}}$; $D = A/T$

Celerity, $c = \sqrt{gD}$

$Fr > 1$: super critical

$Fr < 1$: Subcritical

$Fr = 1$: Critical

3. Manning Formulae: $Q = \frac{1}{n} A R^{2/3} S^{1/2}$, $n = 0.047 \times d_{50}^{1/6}$

$\downarrow$ mm?

Chezy's Formulae: $Q = CAR^{1/2} S^{1/2}$

$C = \frac{1}{n} R^{1/6}$

4. Lacey's theory: $V = \left(\dfrac{Qf^2}{140}\right)^{1/6}$, $f = 1.76\sqrt{d}$

$A = Q/V$

$$R = \frac{5}{2} \times \frac{V^2}{f}$$

$P = 4.75\sqrt{Q} \rightarrow$ cumec

$$S = \frac{f^{5/3}}{3340\, Q^{1/6}}$$

Lacey's normal scour depth, $= 0.473\left(\dfrac{Q}{f}\right)^{1/3}$

5. Friction loss in pipe (Turbulent flow):

$$h_L = 4f \times \frac{L}{D} \times \frac{V^2}{2g}$$

6. Darcy-Weisbach formulae:

$$V = \sqrt{\frac{8g}{f}}\, R^{1/2} S_f^{1/2}$$

7. Cross sectional mean velocity:

$$U^* = \sqrt{gRS_0}$$

- Hydrolically smooth surface, $\frac{K_s U^*}{\nu} \le 5$

$$\frac{U}{U^*} = 5.75 \log\left(\frac{3.64\, U^* R}{\nu}\right)$$

$\nu \rightarrow$ viscosity

- " Rough ", $\frac{K_s U^*}{\nu} \ge 70$

$$\frac{U}{U^*} = 5.75 \log\left(\frac{12.2 R}{\nu}\right)$$

- Transition

$$\frac{U}{U^*} = 5.75 \log\left(\frac{12.2 R}{k_s + 3.35\, \nu/U^*}\right)$$

8. Critical depth:

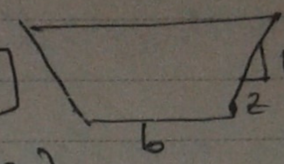
Wide channel, $h_c = \sqrt[3]{\frac{\alpha q^2}{g}}$, $U_c = q/h_c$

Rectangular channel, $\boxed{h_c = \sqrt[3]{\frac{\alpha Q^2}{g b^2}}}$, $U_c = Q/A_c$ $= Q/bh_c$

$$\boxed{q = Q/b}$$

9. Lined channel:

$= y[b + y(\cot\theta + \theta)]$



$A = by + y^2(\cot\theta + \theta)$ $\cot\theta = H/V$

$P = b + 2y(\cot\theta + \theta)$

10. Hydralic jump:

Initial & sequent depth, $\frac{y_2}{y_1} = \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right)$

Length of jump, $\frac{L}{y_1} = 9.75(F_1 - 1)^{1.01}$

Energy loss, $\Delta E_{Total} = \frac{(y_1 - y_2)^3}{4y_1y_2}$

$[E = y + v^2/2g]$

Kinetic Energy loss,

$\Delta E_{K.E} = \frac{1}{2g}(v_1^2 - v_2^2)$

Height of jump, $h_j = y_2 - y_1$

Relative height of jump, $\frac{h_j}{E_1} = \frac{\sqrt{1+8F_1^2} - 3}{F_1^2 + 2}$

11. Irrigation,

Delta, $\Delta\,(m) = \frac{8.64B}{D}$

$B \rightarrow$ days

$D \rightarrow$ Duty, ha/cumec

① $\boxed{1\,ha = 10{,}000\,m^2}$

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3. Math → Ques Sol^{m} (HL-onko)

1. Math → QS (madam - I.00)

WRE 311

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(5)

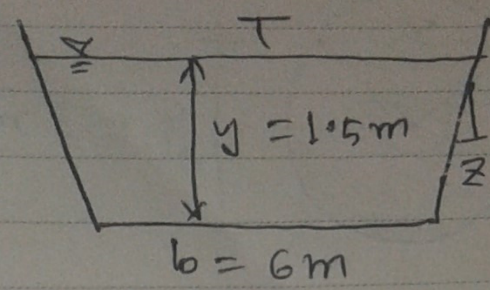
$Q = \frac{1}{n} A R^{2/3} S^{1/2}$ $R = \frac{A}{P}$

$50 = \frac{1}{0.013} \times 2 \times y \times \left(\frac{2y}{2+2y}\right)^{2/3} \left(\frac{1}{1000}\right)^{1/2}$

$\therefore y = 10.897$ ft

BSRM

1.a



$V = 2.3$ m/s

$z = 2$

$\nu = 1 \times 10^{-6}$

Soln:

$$\boxed{\begin{aligned} A &= (b+yz)y \\ P &= b + 2y\sqrt{1+z^2} \\ T &= b + 2yz \end{aligned}}\quad \begin{aligned} &= 13.5 \text{ m}^2 \\ &= 12.71 \text{ m} \\ &= 12 \end{aligned}$$

$R = A/P = 1.06$ m

$D = A/T = 1.13$ m

$Q = AV = 31.05$ m^3/sec

$Re = \dfrac{VR}{\nu} = 2438000 > 12500$

$Fr = \dfrac{V}{\sqrt{gD}} = 0.69 < 1$

subcritical turbulent

$c = \sqrt{gD}$

speed of faster water $= V + c$

" slower " $= V - c$

— Masud M Rahman

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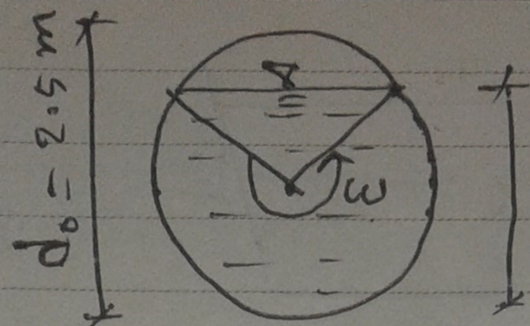
1.(b)



$V = 3\,m/s$

$\nu = 10^{-6}$

Sol^n: $\omega = 2\cos^{-1}\left(1 - \frac{2y}{d_0}\right) = 2.74$ rad

$A = (\omega - \sin\omega) \times \frac{d_0^2}{8} = 1.84\ m^2$

$P = \omega \cdot \frac{d_0}{2} = 3.43\ m$

$R = A/P = 0.54\ m$

$D = A/T = 0.75\,m \quad , T = d_0 \sin(\omega/2)$

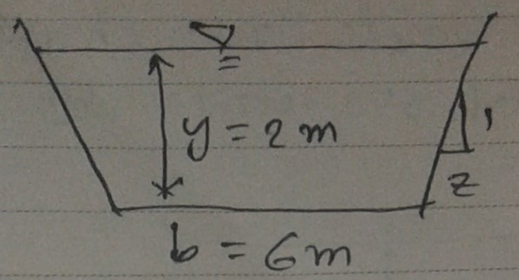
$Q = AV = 5.52\ m^3/sec$

$Re = \frac{VR}{\nu} = 1620000 > 12500$

$Fr = \frac{V}{\sqrt{gD}} = 1.11 > 1$

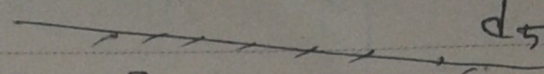
supercritical turbulent

3.a



$z = 2$

$Q = ?$



$S_0 = 0.1\%$

$d_{50} = 1.5$ mm
$= 1.5 \times 10^{-3}$ m

$Q = \frac{1}{n} A R^{2/3} S_0^{1/2}$

$= 48.04$ m³/s

$A = (b + yz)y = 20$ m²

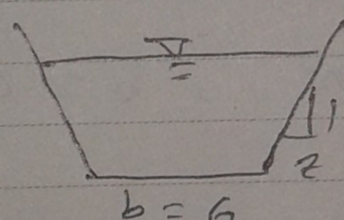
$P = b + 2y\sqrt{1+z^2} = 14.94$

$R = A/P = 1.34$ m

$n = 0.047 \times (d_{50})^{1/6}$

$= 0.016$

3.b



$z = 2$, $n = 0.025$

$S_0 = 0.001$, $Q = 14$ m³/s

$y_n = ?$, $V_n = ?$

$A = (6 + 2y)y$

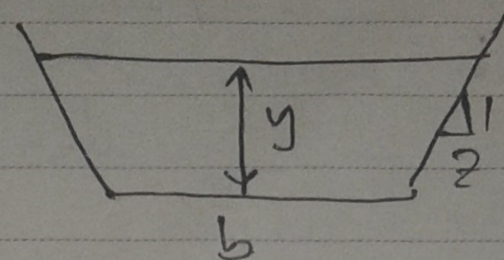
$P = 6 + 2y\sqrt{1+2^2} = 6 + 2y\sqrt{5}$

$Q = \frac{1}{n} A R^{2/3} S_0^{1/2}$

$14 = \frac{1}{0.025} \times (6+2y)y \times \left[\frac{(6+2y)y}{6+2y\sqrt{5}}\right]^{2/3} \times (0.001)^{1/2}$

$\therefore y = 1.32$ m

Q.a Design a concrete lined channel to carry a discharge of 350 cumecs by a slope of 1 in 5000.



$z =$

$n = 0.014$

$V = 2\ m/sec$

Sol^n:

$Q > 50$ cumec, Trapezoidal

$A = 175$

$R = 2.786$

$P = 62.82$

$y = 3.106\ m$, $b = 49.85\ m$

7.a A rectangular channel is 6m wide & laid on a slope of 0.25%. The channel is made of concrete ($k_s = 2$ mm) and carries water at a depth of 0.50 m. Mean velocity? $\nu = 10^{-6}$

Sol^n: $U^* = \sqrt{gRS_0} = \sqrt{g \frac{A}{P} S_0}$

$= \sqrt{9 \times \frac{6 \times 0.5}{6 + 2 \times 0.5} \times 0.25/100}$

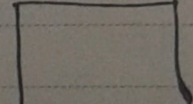
$= 0.1025$ m/s

$\frac{k_s U^*}{\nu} = \frac{2 \times 10^{-3} \times 0.1025}{10^{-6}} = 250 > 70$

Rough, $\frac{U}{U^*} = 5.75 \log \frac{12.2R}{k_s}$

$U = 2.014$ m/s (Ans:)

8.a Compute critical depth & velocity.



b = 6m

$Q = 20\ m^3/s$

$q = 1.12$

Sol^n: $h_c = \sqrt[3]{\frac{\alpha Q^2}{g \cdot b^2}} = 1.08$ m

$V_c = Q/A_c = Q/6 \times h_c = 3.08$ m/s

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10.a Rectangular, $y_1 = 1.8m$, $v_1 = 24 m/s$

$$f_1 = \frac{v}{\sqrt{gD}}$$

$$= \frac{24}{\sqrt{g \times 1.8}} = 5.71 > 1$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left(\sqrt{8f_1^2+1} - 1\right) = 7.59$$

$$y_2 = 13.67 \text{ m}$$

$$h_j = y_2 - y_1 = 11.87 \text{ m}$$

$$L/y_1 = 9.75(f_1 - 1)^{1.01} = 46.64$$

$$\therefore L = 83.95 \text{ m}$$

$$\Delta E_T = \frac{(y_2 - y_1)^3}{4 y_1 y_2} = 16.99 \text{ m}$$

$$E_1 = y_1 + \frac{v_1^2}{2g} = 31.16 \text{ m}$$

$$\text{Efficiency} = \frac{E_1 - \Delta E}{E_1} = 45.47\%$$

BSRM

4/a Design a regime channel to carry a discharge of 50 cumecs. Assume silt factor as 1.0. Use Lacey's theory for design.

Soln: $V = \left(\frac{Qf^2}{140}\right)^{1/6}$

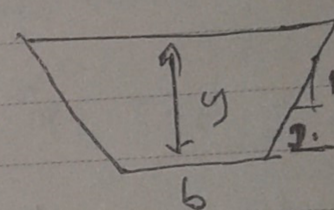
$= 0.842 \text{ m/s}$

$R = \frac{5}{2}\frac{v^2}{f} = 1.774 \text{ m}$

$A = Q/V = 59.38 \text{ m}^2$

$R = A/P$

$\therefore P = 33.47$



$59.38 = (b + 2y)y$ — (i)

& $33.47 = b + 2y\sqrt{1+2^2} = b + 4.472y$

$\Rightarrow b = 33.47 - 4.472y$ — (ii)

(i),(ii) $\Rightarrow$ $y = 2.0998 \text{ m}$

& $b = 24.08 \text{ m}$

$S = \frac{f^{5/3}}{3340\, Q^{1/6}} = 1 \text{ in } 6411$

$ax + by + c = 0$

12a. The peak of a flood hydrograph due to 3 hr duration isolated storm in catchment is 270 m^3/s. The total depth of rainfall is 5.9 cm. Assume average infiltration loss of 0.3 cm/hr and a constant base flow of 20 m^3/s. (i) Estimate the peak of 3h unit hydrograph of this catchment, if the area of the catchment is 567 km^2. (ii) Determine the base width of 3h unit hydrograph by assuming it to be triangular in shape. [K.sub 203]

Soln:

(i) Depth of rainfall $= 5.9$ cm

Loss $= 0.3 \times 3 = 0.9$ cm

Rainfall excess $= 5$ cm

peak of DRH $= 270 - 20 = 250\ m^3/s$

peak of 3-h unit hydrograph $= \frac{250}{5}$

$= 50\ m^3/s$

(ii) B = Base width

Vol^m represented by area of UH = Vol^m of 1 cm depth over the catchment

$\therefore$ Area of UH = Area of catchment × 1 cm

$\frac{1}{2} \times B \times 50 \times 60 \times 60 = 567 \times 10^6 \times \frac{1}{100}$

$\therefore B = 63$ hours (Ans:)

Discharge, $Q = 5800$ m³/s, Hydraulic mean depth is 58 m & mean regime velocity 10.5 m/s. Calculate the scour depth using Lacey's silt factor.

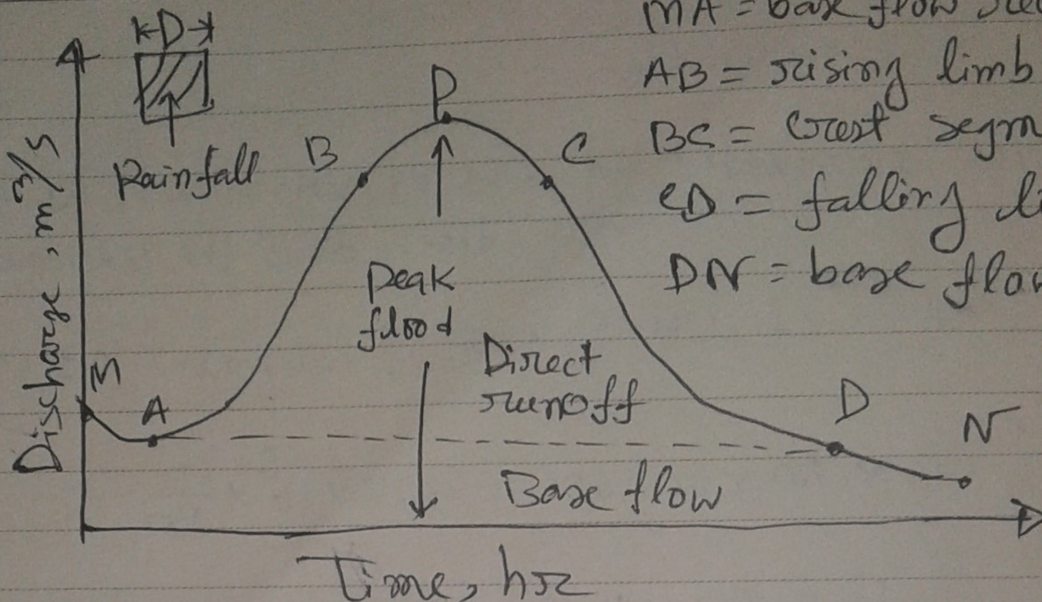
Soln: $R = \frac{5}{2}\left(\frac{v^2}{f}\right)$ $v = \left(\frac{Qf^2}{140}\right)^{1/6}$

$\cancel{58} = \frac{5}{2}\left(\frac{10.5^2}{f}\right)$ $f = 56.87$

$\therefore f = \cancel{4.7}52$ $Q = 58050$ m³/sec

Scour depth $= 0.473\left(Q/f\right)^{1/3} = 4.76$ m

$= 5.\cancel{855}$ m (Ans:)



Hydrograph components

MA = base flow recession

AB = rising limb

BC = crest segment

CD = falling limb

DN = base flow recession

fig: Elements of flood Hydrograph

Open channel flow:

- It must have a free surface. A free surface is subjected to atmospheric pressure.

- The physical condition of open channel varies more widely. The cross section of open channel may be of any shape (from circular to the irregular forms of naturals streams.

Pipe flow: • No free surface. It exerts no direct atmospheric pressure but hydraulic pressure only.

- Generally round in shape

Classification of flow

(i) steady & unsteady flow

(ii) Uniform & Non-uniform flow

(iii) Gradually & rapidly varied flow

(iv) spatially varied flow

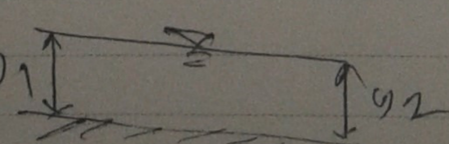
Steady flow: Depth of flow does not change or it can be assumed to be constant during the time interval under consideration

$$\frac{\partial y}{\partial t} = \frac{\partial u}{\partial t} = \frac{\partial Q}{\partial t} = 0$$

- Occure when no rainfall occurs

Unsteady flow: Depth of flow changes w.r.t time

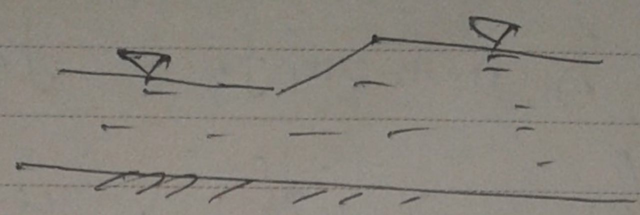
Uniform flow: Depth of flow is same at every section of the channel



$y_1 = y_2$

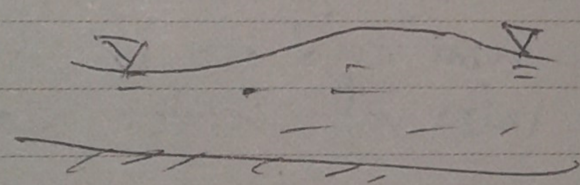
Non uniform flow: $y_1 \neq y_2$

Rapidly varied flow: Depth of flow changes abruptly over a comparatively short distance.



RVF

Gradually varied flow: Flow is gradually varied, if the depth changes gradually over a long distance.

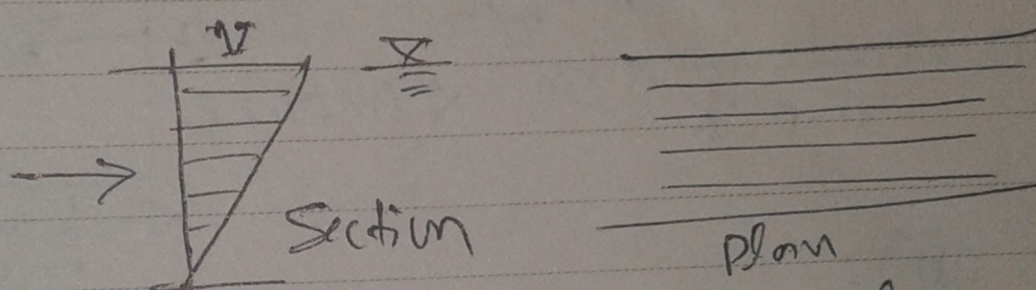


GVF

Spatially varied / discontinuous flow: The flow is spatially varied when water enters and/or leaves the channel along the course of flow. It is found channel side weirs, feeding channels in irrigation system.

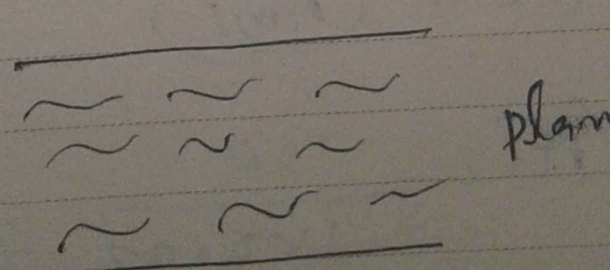
Laminar flow: occurs when a fluid flows in parallel layers, with no disruption between the layers. At low velocities, the fluid tends to flow without lateral mixing

- velocity is high at open surface.
- No velocity at the bottom layer of channel.



Turbulent flow: The viscous forces are very weak relative to the inertia forces.

- The water particles are in more irregular paths.
- Velocity is very high relative to laminar



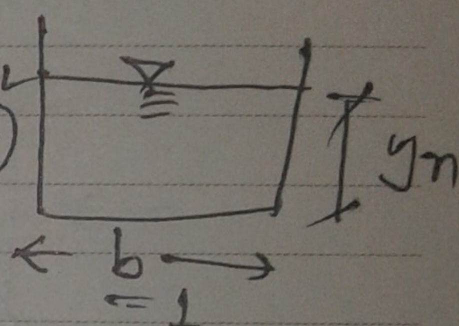
Transitional flow: $500 \le Re \le 12500$

Discharge of a wide river 30 m^3/sec, $n = 0.026$, $s = 0.0028$, Determine velocity & normal depth.

$$Q = \frac{1}{n} A R^{2/3} S_0^{1/2}$$

$A = b \times y_n$

$$30 = \frac{1}{0.026} \times \overbrace{y_n}^{b \times y_n} \times y_n^{2/3} \times (0.0028)^{1/2}$$



∴ $\cancel{y_n} =$

$$30 = \frac{1}{0.026} \times y_n^{\frac{5}{3}} \times (0.0028)^{1/2}$$

$q = Q/b$

For wide channel Hydraulic radius, $R = y_n$

∴ $y_n = 5.02\ m$ (Ans:)

$$V_n = Q/A = \frac{30}{1 \times 5.02} = 5.98\ m/s$$

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Rainfall intensity of a catchment area is 2.4 m/yr & Run-off coefficient 0.7. Find the min^m catchment area for the daily water demand is 15 lpcd for 7 people.

Soln:

$$Q = CiA$$

$C = 0.7$

$i = 2.4 \, m/yr$

$Q = 15 \times 7$ litre/day

$= 15 \times 7 \times 365$ litre/yr

$= 15 \times 7 \times 365 \times 10^{-3} \, m^3/yr$

$$15 \times 7 \times 365 \times 10^{-3} = 0.7 \times 2.4 \times A$$

$\therefore A = 22.81 \, m^2$ (Ans:)

The area of irrigation is 400 ha. The duty is 200 ha/cumec. Find the design discharge at the canal take off.

Sol: $\cancel{\Delta = \frac{8.64B}{D}}$

$\cancel{= 8.60}$

$$Q = \frac{400 \text{ ha}}{200 \text{ ha/cumec}} = 2 \text{ cumec}$$

Geotechnical

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Silt & Clay < #200 (75 μm)

1. Grain size distribution:

Coeff. of uniformity, $C_u = \frac{D_{60}}{D_{10}}$ Eff. size = D_{10} → particle size corre. to 10% finer.

$\frac{3}{2}''$, $\frac{3}{4}''$, $\frac{3}{8}''$, #4, #8, #16, #30, #50, #100

Coeff. of curvature, $C_z = \frac{(D_{30})^2}{D_{60} \times D_{10}}$

$$FM = \frac{\Sigma \text{ Cumulative \% Retained } (3/8 \text{ in to } \#100)}{100}$$

$$\boxed{FM = \frac{\Sigma F_i M_i}{\Sigma n_i}}$$

2. Atterberg's limit test:

Liquid limit (LL) = WC corresponding to 25 blow

Flow Index, $I_f = \frac{W_1 - W_2}{\log(n_2/n_1)}$

Plasticity Index, $I_P = LL - PL$

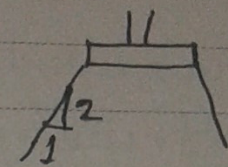
Liquidity Index, $I_L = \frac{W_n - W_P}{I_P}$

Toughness Index, $I_T = I_P / I_F$

Activity, $A_c = \frac{I_P}{\% \text{ of clay particle } (< 0.002 \text{ mm})}$

Consistency Index, $I_c = \frac{W_L - W}{I_P}$

3. Consolidation:



$C_s \approx \frac{1}{5}$ to $\frac{1}{10} \times C_c$

NCC:

$$S_c = \frac{C_c H}{1+e_0} \log \frac{P_0' + \Delta P'}{P_0'} \; ; \quad C_c = 0.009(LL-10) \longleftarrow \text{Undisturbed}$$

$$= 0.007(LL-10) \longleftarrow \text{Disturbed}$$

$$C_c = \frac{e_1 - e_2}{\log(P_1/P_2)}$$

OCC:

✓ Case-I: $P_0' + \Delta P' \le P_c'$, $S_c = \frac{C_s H}{1+e_0} \log \frac{P_0' + \Delta P'}{P_0'}$

✓ Case-II: $P_0' + \Delta P' > P_c'$, $S_c = \frac{C_s H}{1+e_0} \log \frac{P_c'}{P_0'} + \frac{C_c H}{1+e_0} \log \frac{P_0' + \Delta P'}{P_c'}$

4. Direct shear:

$$\tau = c + \sigma \tan\phi$$

$\sigma \rightarrow$ Normal stress $= P_v/A$

$\tau \rightarrow$ shear stress $= P_n/A$

5. Bearing capacity:

Strip footing, $q_{ult} = cN_c + 0.5\gamma B N_\gamma + qN_q$

Square footing, $q_{ult} = 1.3cN_c + 0.4\gamma B N_\gamma + qN_q$
$(1 + 0.2B/L)$

Circular footing, $q_{ult} = 1.3cN_c + 0.3\gamma B N_\gamma + qN_q$

$$q = \gamma D_f$$

6. Pile capacity :

Clay: $Q_s = \alpha \times C_u \times A_{surf}$

$\alpha \rightarrow$ Individual $= 0.56$

Group $=$

$Q_b = 9c \times A_b$

Sand: $Q_s = K \times \sigma_v' \times \tan\delta \times A_{surf}$

$\delta \rightarrow \delta = \phi$

$K \rightarrow 1 \sim 1.5$

$Q_b = \gamma D_f \times N_q \times A_b$

$N_q \rightarrow 100$

7. Unconfined compression test :

Unconfined compressive strength, $q_u = \frac{P}{A_{Cor}}$

Undrain shear strength, $C = q_u/2$

8. Specific gravity :

$$SG = \frac{G_T \times W_s}{W_s + W_2 - W_1}$$

$W_1 \rightarrow$ Bottle + water + soil

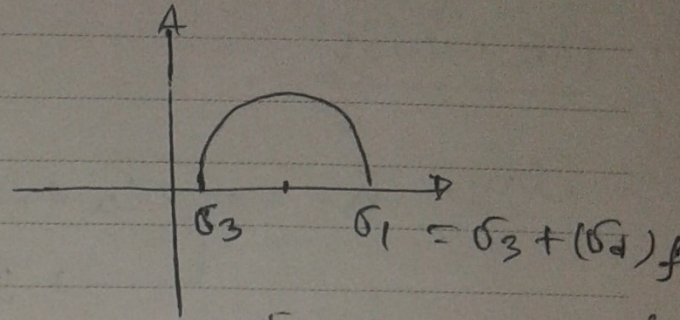
$W_2 \rightarrow$ Bottle + water

BSRM
innovating safety

9. **Triaxial test :**

$$\sin\phi = \frac{\sigma_1 - \sigma_3}{\sigma_1 + \sigma_3}$$

$$\theta = 45^\circ + \phi/2$$



σ_1 = Major principle stress

$$\sigma_n = \frac{\sigma_1 + \sigma_3}{2} + \left(\frac{\sigma_1 - \sigma_3}{2}\right)\cos 2\theta$$

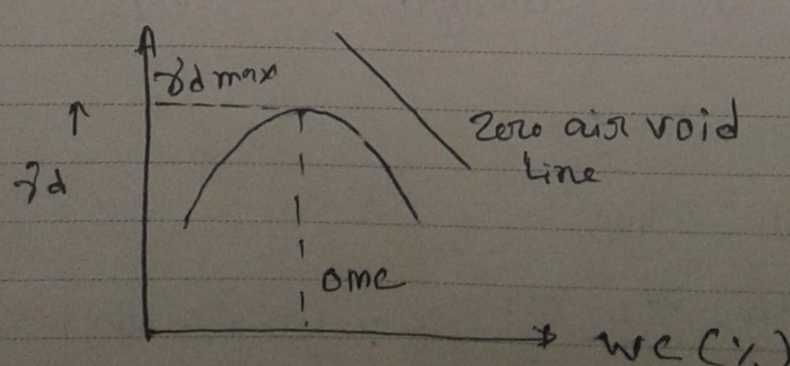
$$\tau_n = \left(\frac{\sigma_1 - \sigma_3}{2}\right)\sin 2\theta$$

10. **Compaction of soil :**

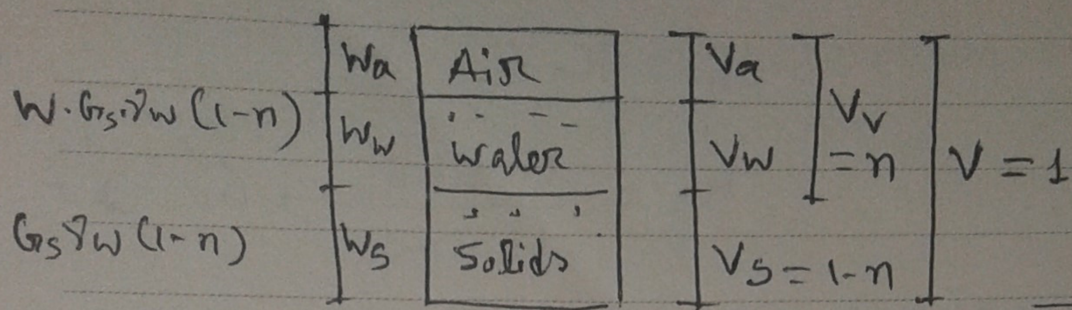
✓ Relative compaction $= \dfrac{\gamma_d\,(\text{field})}{\gamma_d\,(\text{max})}$

✓ Relative density, $D_r = \dfrac{e_{max} - e}{e_{max} - e_{min}}$

✓ Sensitivity $= \dfrac{q_u\,(\text{undisturbed})}{q_u\,(\text{Remoulded})}$



11. Soil water Relationship:



$$\rho_d = \frac{\rho}{1+w}$$

Moisture content, $w = W_w/W_s$

Void ratio, $e = V_v/V_s$

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

porosity, $n = V_v/V$

Dry unit wt, $\gamma_d = \frac{W_s}{V} = G_s\gamma_w(1-n)$

Moist Unit wt, $\gamma = \frac{W_s+W_w}{V} = G_s\gamma_w(1-n)(1+w)$

Saturated Unit wt, $\gamma_{sat} = [G_s(1-n)+n]\gamma_w$

Degree of saturation, $S = \frac{V_w}{V_v} = \frac{wG_s}{e} = \frac{W_w/\gamma_w}{V_v}$

Relative density, $D_r = \frac{e_{max}-e}{e_{max}-e_{min}}$

Density Index, $I_d = \frac{\rho_{max}-\rho}{\rho_{max}-\rho_{min}}$

12. permeability:

Constant head, $K = \frac{QL}{hAt}$

Falling head, $K = 2.3\,\frac{aL}{At}\,\log(h_0/h_1)$

13. **Retaining wall:** Rankine,

Active pressure, $\sigma_a' = K_a \sigma_o'$

$$K_a = \frac{1-\sin\phi'}{1+\sin\phi}, \quad \sigma_o' = \gamma z$$

Active Force, $P_a = \frac{1}{2} \times \sigma_a' \times z$

$$K_p = \frac{1+\sin\phi'}{1-\sin\phi'}$$

14. Depth of Unsupported excavation,

$$H_c = \frac{4c}{\gamma\sqrt{K_a}}, \quad K_a = \frac{1-\sin\phi}{1+\sin\phi}$$

15. Angularity Number, $AN = 67 - \frac{100 \times W}{C \cdot G_s}$ → W: wt. of Agg; C: wt of water to fill cylinder

[Transport]

16. **Raft foundation:**

0.4?

$$q_{ult} = C_u \times N_c \times \left(1 + 0.2\frac{D_f}{B}\right)\left(1 + 0.2\frac{B}{L}\right)$$

14.A Surcharge load:

$$\sigma_a' = K_a \sigma_o' - 2c'\sqrt{K_a}$$

$$\sigma_p' = K_p \sigma_o' + 2c'\sqrt{K_p}$$

14a. The unconfined compressive strength of soil 10 KSF. Determine the depth of excavation that can be made without lateral support ?

Soln: Depth $= \frac{4c}{\gamma} \tan(45 + \phi/2)$

$$= \frac{4 \times 10^{\times 1000}}{120} \tan(45^\circ + 0/2)$$

$$= 333.33 \text{ ft } (!!)$$

* $H_c = \frac{\cancel{4}^{4} c}{\gamma \sqrt{K_a}}$, $K_a = \frac{1 - \sin\phi}{1 + \sin\phi} = 1$

$$= \frac{\cancel{4}^{2} \times 10 \times 1000}{120 \sqrt{1}}$$

$$= \frac{333.33}{\cancel{4}} \text{ ft}$$

Soln: $\boxed{\sigma'_a = K_a \sigma'_0 - 2c\sqrt{K_a}}$

$$0 = 1 \times \gamma \times h - 2c \times \sqrt{1}$$

$$\therefore h_t = \frac{2 \times 10}{0.12} = 166.67 \text{ ft}$$

$h_c = 2 \times h_t = \boxed{333.33}$

15(1): Calculate the angularity number (AN) of aggregate if relative density of aggregate = 2.8
mass of water required to fill the cylinder = 2500 gms. mass of cylinder filled with compacted aggregate = 5150 gm
mass of cylinder = 1100 gms

Sol^n: $AN = 67 - \frac{W}{C \cdot G_s}$

$= 67 - \frac{(5150 - 1100)}{2500 \times 2.8}$

$= 59.42$

Transport

Raft foundation:

$q_a = q_b - \gamma D_f$

$F = \dfrac{cN_c}{q_b - \gamma D_f}$ [cN]

$q_b - \gamma D_f \rightarrow \dfrac{\text{Load}}{\text{Area}}$ from structure

$q_a = q_b - \gamma D_f = \dfrac{cN_c}{F}$

$q_a \rightarrow$ Allow soil pressure

$q_{ult} = cN_c \left(1 + 0.2 \dfrac{D_f}{B}\right)\left(1 + 0.2 \dfrac{B}{L}\right)$

$$\boxed{F.S = \dfrac{5.14c\left(1 + \dfrac{0.195B}{L}\right)\left(1 + 0.4 \dfrac{D_f}{B}\right)}{\dfrac{Q}{A} - \gamma D_f}}$$ [Bowles 6.21]

$$\boxed{q_{net(u)} = 5.14 c_u \left(1 + \dfrac{0.195B}{L}\right)\left(1 + 0.4 \dfrac{D_f}{B}\right)}$$

[Bowles 6.10]

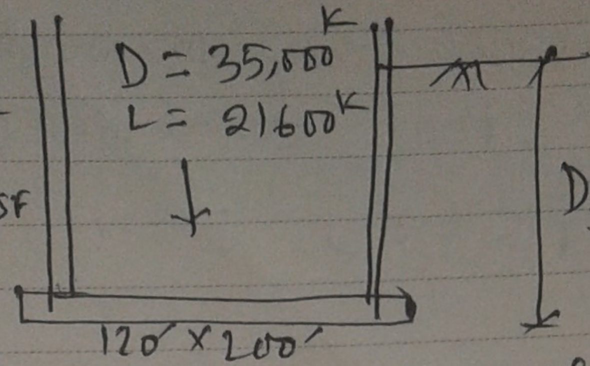
CN

16 (i)

$c = q_u/2$

$\gamma = 115$ pcf

$q_u = 0.3$ TSF



(a) Calculate D_f for full compensation

(b) Calculate D_f for $F = 3$.

(a) $q_b = \gamma D_f$

$$\frac{35{,}000 + 21{,}600}{120 \times 200} = \frac{115 \times D_f}{1000}$$

$\therefore D_f = 20.5'$

(b) $$F = \frac{c N_c}{q_b - \gamma D_f}$$

$3 = 0.15 \times$

16(ii) Find allowable soil pressure of a soil having $N_c = 7$, Raft foundation ($10 \times 10\ m^2$) $D_f = 5m$, $FS = 2$, $c = 40\ kN/m^2$

Soln:

$$q_{ult} = cN_c\left(1+0.2\frac{D_f}{B}\right)\left(1+0.2\frac{B}{L}\right)$$

$$= 40 \times 7\left(1+0.2\times\frac{5}{10}\right)(1+0.2\times1)$$

$$= 369.6\ kN/m^2$$

$$q_{allow} = \frac{q_{ult}}{FS} = 184.8\ kN/m^2$$

Alt:

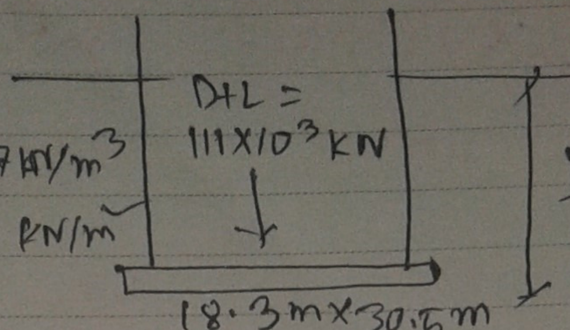
$$F = \frac{cN_c}{(q_b - \gamma D_f) = q_{all}}$$

$$\therefore q_a = \frac{cN_c}{F}$$

$$= 140\ kN/m^2$$

16(iii)

Bowles 6.3



$\gamma = 18.87\ kN/m^3$

$c_u = 134\ kN/m^2$

$D_f = 1.52\ m$

$F.S = ?$

Sol^n: $$F.S = \frac{5.14\, c_u \left(1 + 0.195\frac{B}{L}\right)\left(1 + 0.4\frac{D_f}{B}\right)}{\frac{Q}{A} - \gamma D_f}$$

$$= 4.67$$ (Ans:)

ERL-2017 (13)

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Sieve (#)	% Retained	Cum % Retained
#16 (1.2mm)	25	25
#30 (0.6mm)	25	50
- (0.425mm)	25	75
#50 (0.3mm)	25	100
#100 (0.15mm)	0	100

$$\text{fm} = \frac{25 + 50 + 100 + 100}{100}$$

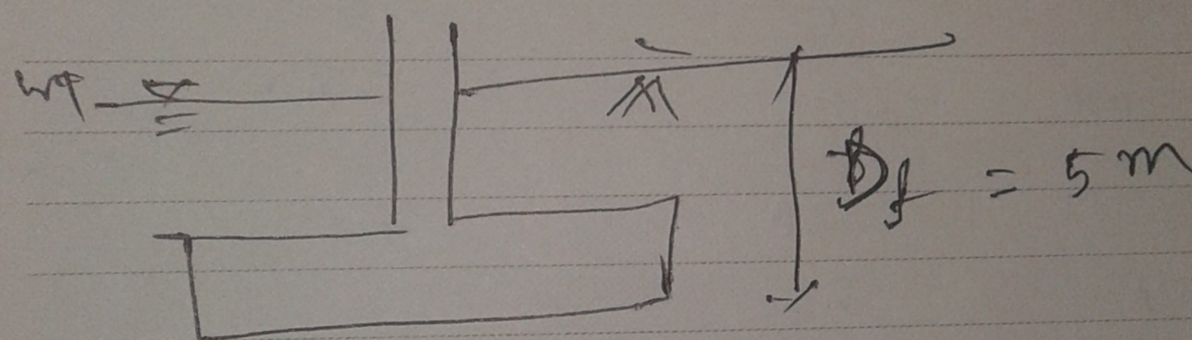
$$= 2.75$$

A footing size (2m x 2m), $\gamma_{sat} = 20.4\ kN/m^3$

$\phi = 20^\circ$, $N_c = 17.69$, $N_q = 7.44$, $N_\gamma = 3.64$

$c = 20\ kPa$. Depth of foundation $= 5m$

$F.S = 3$. Calculate the allowable B.C.



Sol: $q_{ult} = 1.3\, c N_c + 0.4\, \gamma B N_\gamma + q N_q$

$= 1.3 \times 20 \times 17.69 + 0.4 \times (20.4 - 9.81) \times 2 \times 3.64 + (20.4 - 9.81) \times 5$

$= 543.7\ kN/m^2$

$q_{allow} = q_{ult} / F.S = 181\ kN/m^2$

$\frac{3''}{2}$, $\frac{3''}{4}$, $\frac{3''}{8}$, #4, #8, #16, #30, #50, #100

38^m 19^{mm} 9.5^{mm} 4.75m 2.36

Sieve	% Retained	Cum % Retain	
25mm	0	0	
19mm	5	5	
12.5mm	35	40	X
9.5mm	30	70	
#4	25	95	
#8	5	100	
#16	0	100	
#30	0	100	
#50	0	100	
#100	0	100	

$$FM = \frac{5+70+95+100\times 5}{100}$$

$$= 6.7 \quad (\text{Ans})$$

	N_c	N_γ	N_q
$\phi' = 0$ হলে	5.7	0	1

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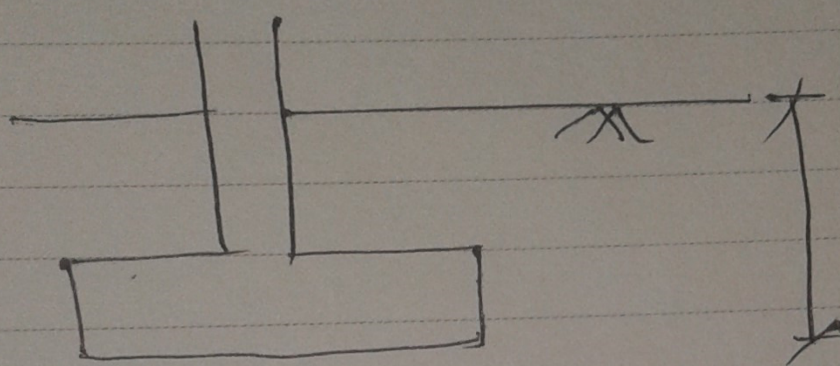
A continuous footing.

$\gamma = 19.5\ kN/m^3$

$c_u = 37\ kN/m^2$

$\phi' = 0$



$D_f = 0.75\ m$

$B = 2.5\ m$

$F.S = 6$

Sol: $q_u = cN_c + 0.5\gamma B \cdot \overset{0}{\cancel{N_\gamma}} + \gamma D_f \cdot \overset{1}{\cancel{N_q}}$

$= 225.5\ kN/m^2$

$q_{allow} = q_u / FS = 37.6\ kN/m^2$ (Ans:)

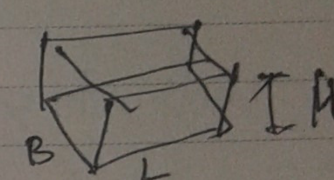
1. BOD Calculation:

$BOD_5 = (DO_i - DO_f) \times D.F$

$L_t = L_o (1 - 10^{-K_1 t})$; $K_1(T) = K_1(20)\theta^{T-20}$

$\theta = 1.082 \sim 1.087$

$pH = -\log[H^+]$



2. Sedimentation:

Vertical setting velocity, $V_s = \frac{g(\rho_p - \rho_w) d_p^2}{18 \mu}$

Horizontal velocity, $V_h = \frac{Q}{BH}$

Detention period, $t = V/Q$, V = Volume $= B \times L \times H$

Surface over flow rate,

$SOR = \frac{\text{Rate of flow}}{\text{plan area}} = \frac{Q}{B \times L}$

3. Upfeed Zone:

$P = p + 0.434h + f$

f → Min^m fixture pressure

h → Height (ft)

p → Pressure drop

P → Service main pressure

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4. Population, $P_n = P_0 (1+r)^n$

5. Simple pit :

$V_s = CPN$

$C \to$ dry, 06 $m^3/P/yr$

$C \to$ wet, 04 $m^3/P/yr$

Depth, $h_i = \frac{V_s}{A} = \frac{V_s}{\pi D^2/4}$ (1.25m)

$D \to$ 1 to 1.5 m

6. Pour flash :

$V_s = CPN$

$V_i = \frac{A_i D}{4} = \frac{QD}{4I}$; $A_i = Q/I$

Single pit, $V = V_s + V_i$

Alt twin pit, $V = V_s$ or V_i

7. pump :

water horse power, $WHP = \frac{Qh}{76}$

$Q \to$ Discharge, Lit/Sec

$h \to$ Height, m

shaft horse power, $S.H.P = \frac{WHP}{\eta}$

$\eta \to$ Efficiency (%)

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8. Trickling filter:

BOD removal efficiency,

$$E = \frac{100}{1 + 0.4443\sqrt{\frac{W}{VF}}}$$

W = BOD loading, gm/day

V = Volume, m^3

$$F = \frac{1+R}{(1+R/10)^2}$$

R = re-circulation ratio

9. Sodium Absorption Ratio:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Standard: Drinking water

	WHO	BD
pH	6.5-8.5	6.5-8.5
Turbidity (NTU)	5	10
Color (TCU)	15	15
Hardness	500	200-500
As (mg/L)	0.01	0.05
Fl (mg/L)		
Mg (mg/L)		

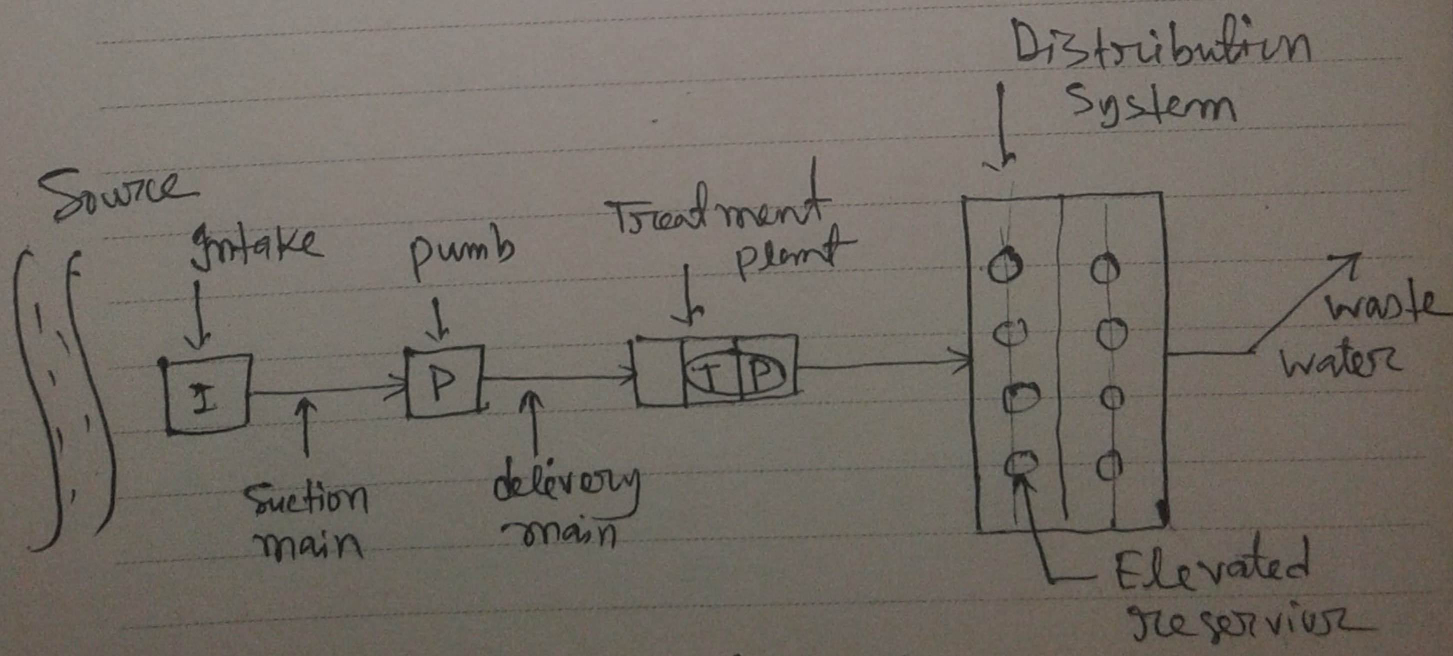

fig: water supply system

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BOD: The amount of oxygen required by the micro-organisms to oxidide organic wastes aerobically.

COD:

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8a. Calculate the BOD removal efficiency for the single stage high rate trickling filter. BOD Loading is 750 gm/m³/d & recirculation ration 0.6.

Sol^n: $E = \dfrac{100}{1+0.443\sqrt{\dfrac{W}{VF}}}$, $F = \dfrac{1+R}{(1+R/10)^2}$

$= 1.424$

$= 8.1\%$

?

2a.

What are the factors determine the per capita water consumption.

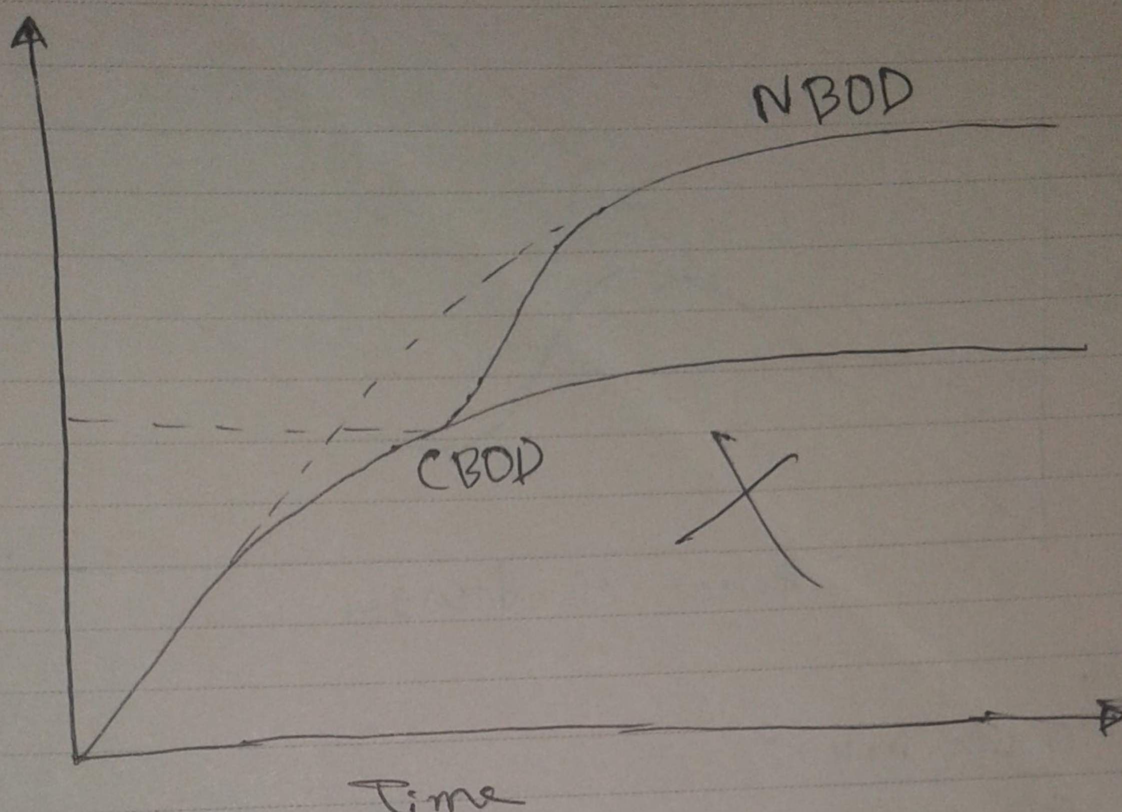
- See Book

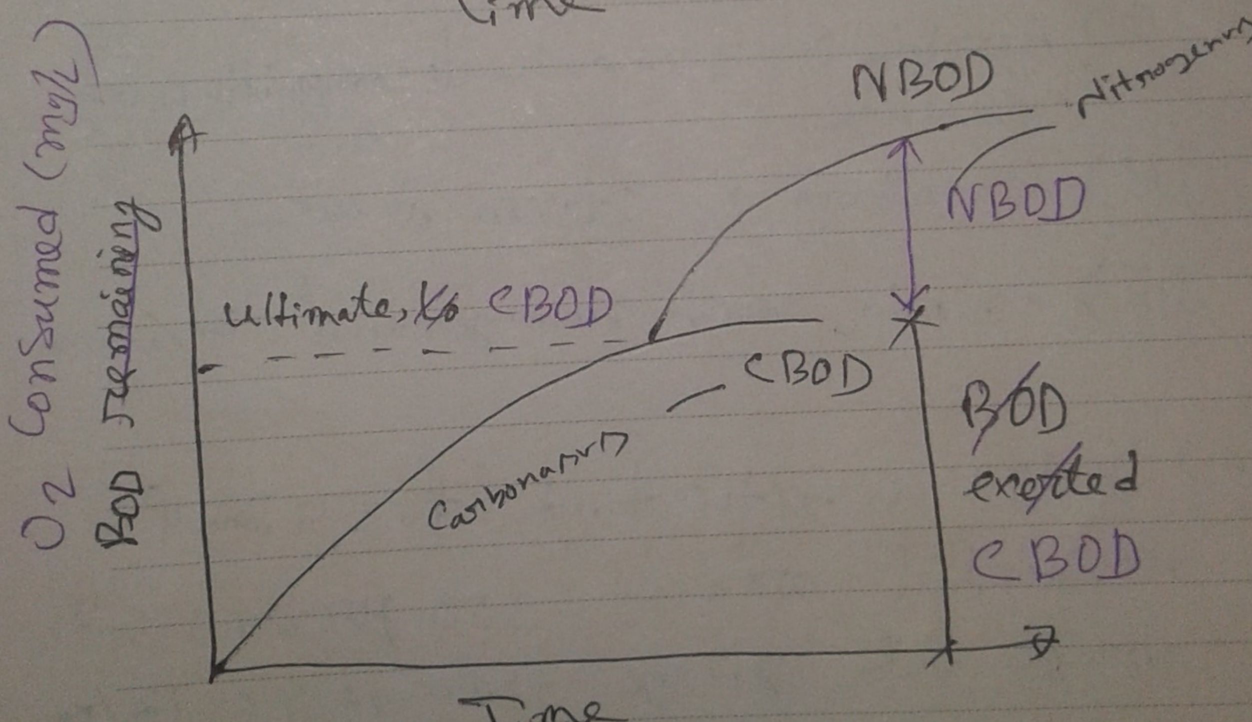
Sewage: Waste water & excrement conveyed in sewer. Sewage is a water-carried waste, in solution or suspension, that is intended to be removed from a community

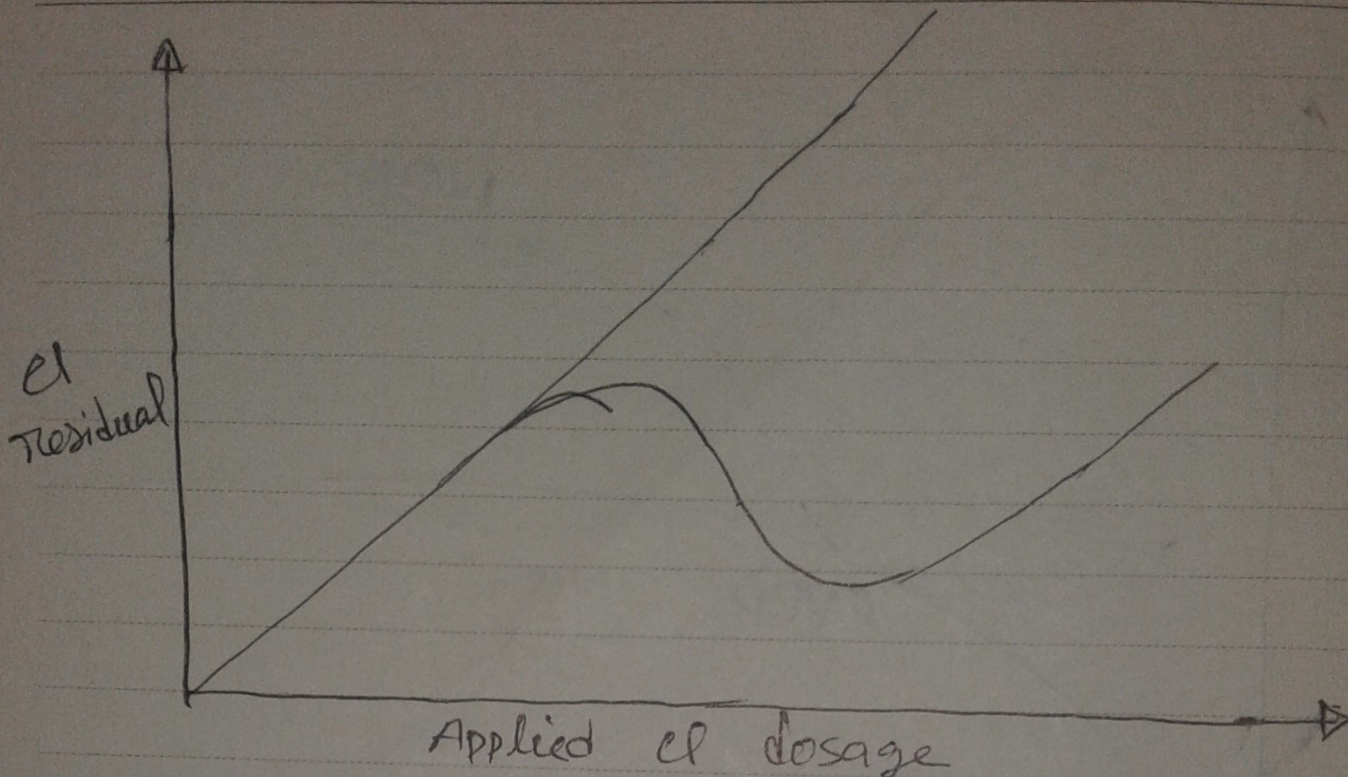
Sewer: An underground conduit for carrying off drainage water & waste matter.

Night soil: ~~Night~~ Night soil is euphemism for human feces collected at night from cesspools, privies, etc. and sometimes used as a fertilizer.

Stake: A pointed stick or post that is pushed into the ground especially to mark a place or to support something.


NBOD
CBOD
Time


O2 Consumed (mg/L)
BOD Remaining
NBOD
Nitrogenous
NBOD
Ultimate, L0 CBOD
CBOD
Carbonaceous
BOD
exerted
CBOD
Time



BCS-36

6 (a) Write Notes:

(i) Aerobic & anaerobic decomposition of sewage

(ii) Sanitary & storm sewer

(iii) Solid waste management system

(b) Design a Septic tank for a small residential area of 300 persons with average daily sewage flow of 85 Lit/person. Assume reasonable values for required design data.

1. **Braking distance:**

$$\underset{(m)}{d} = \frac{v^2}{2fg}$$

$v \rightarrow m/s$

$f \rightarrow$ coeff. friction

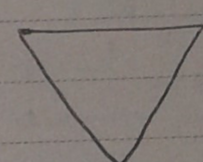
$g \rightarrow 9.81\ m/s$

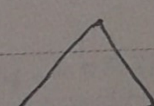
$$d = \frac{v^2}{30(f \pm g)}$$

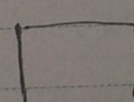
$g \rightarrow$ grade

2. **Traffic sign:**

Mandatory
Regulatory
Prohibitory



warning → 

Informatory → 

3*. **CBR Test:**

$$CBR_{0.1} = \frac{\text{Stress}}{1000} \times 150 \quad [0.1'' \text{ penetration } 1000\ psi/3000\ lb]$$

$$CBR_{0.2} = \frac{\text{Stress}}{1500} \times 100 \quad [0.2'' \text{ penetration } 1500\ psi/4500\ lb]$$

4. ESAL:

$$ESAL = \Sigma\,(\text{No. of axle in design period}) \times EWLF$$

$$\left(\frac{\text{Avg axle load}}{18\ \text{Kip}}\right)^4$$

5. Stopping sight distance : SSD

$$SSD = d_1 + d_2$$
(m)
$$= Vt + \frac{V^2}{2gf}$$

V = Speed (m/s)
t = Reaction time = 2.5 sec
f → Coeff. friction = 0.37
g → 9.81 m/s

6. Super Elevation : (e) (m per m)

$$e + f = \frac{v^2}{gR}$$

v → m/s
g → 9.81
R → curvature, m
f → Coeff. friction

v = 0.75V'
speed of vehicle = V'

7. Modulus of subgrade Reaction : K

$$K = \frac{P\,(KPa)}{\delta\,(mm)}$$

8. Traffic capacity : C

$$C = \frac{1000\,V}{S} \times n$$

V → mph
n → Lane number
S → c/c spacing of vehicle

3A. CBR :

$$CBR\,(\%) = \frac{\text{Unit load at } 0.1'' \text{ penetration}}{1000} \times 100$$

9. Expected traffic : T

$$T = \left[\frac{(1+r)^n - 1}{r}\right] T_1$$

→ traffic volume during first year

→ ESAL for n-year

10. Spiral or Transition curves : Min^m

$$L_s\,(m) = 0.035\,\frac{V^3}{R}$$

→ Velocity (km/hr)

→ curvature (m)

11. LOGIT Model :

Out of vehicle travel time

Auto, $V_a = -0.3 - 0.04X - 0.1Y - 0.03C$

Transit, $V_t = -0.04X - 0.1Y - 0.03C$

In vehicle travel time (min)

Cost of travel / income

Probability of selecting mode (t)

$$P_t = \frac{e^{V_t}}{e^{V_a} + e^{V_t}}$$

9.a Traffic growth rate of 4%, Determine Design ESAL for a 20-year design period.

Soln: design ESAL $= \left[\dfrac{(1+r)^n - 1}{r}\right] T_1$ → Given 61,590

$$= \left[\frac{(1+4/100)^{20} - 1}{4/100}\right] \times 61,590$$

$= 1834032$ (Ans:)

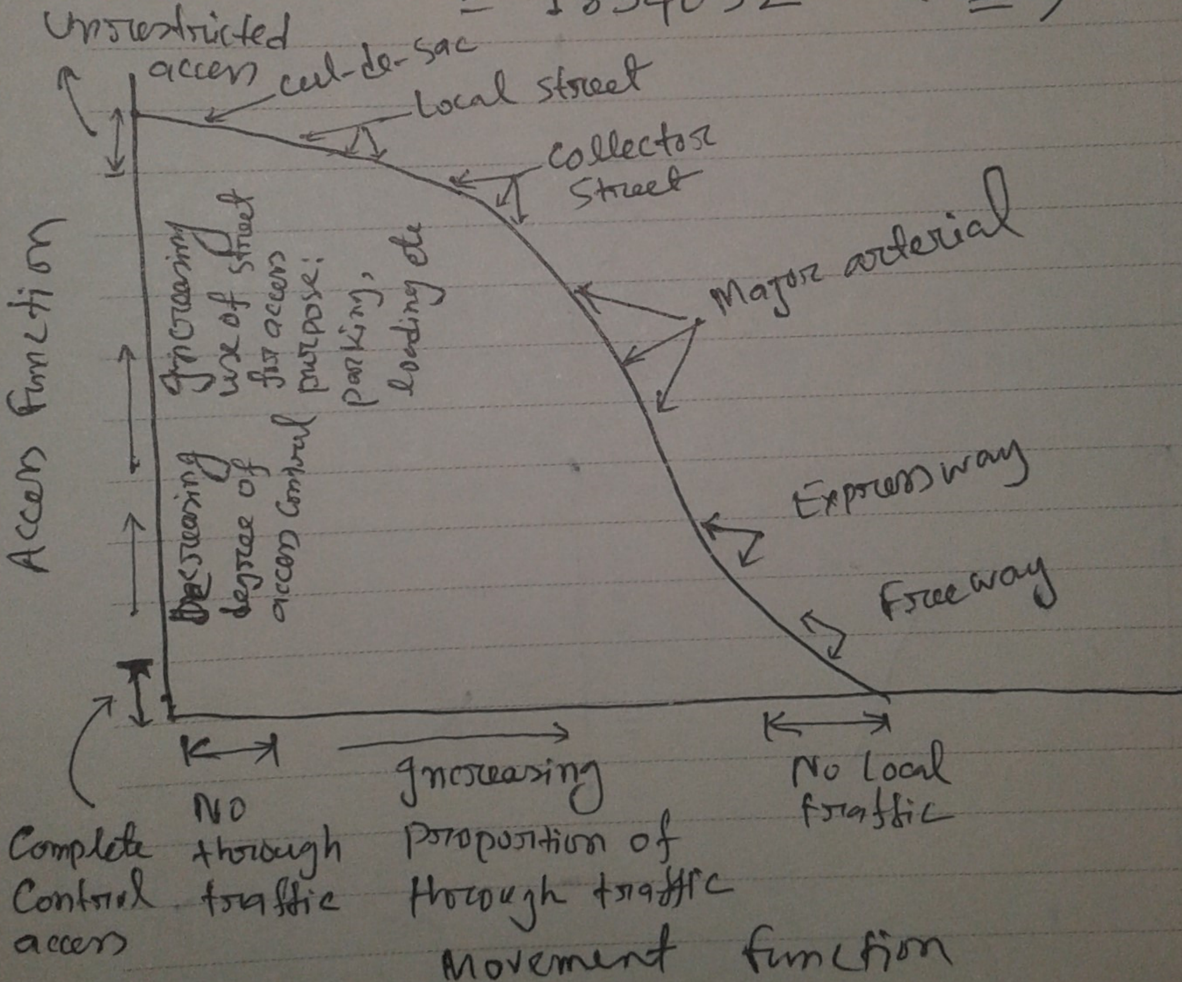
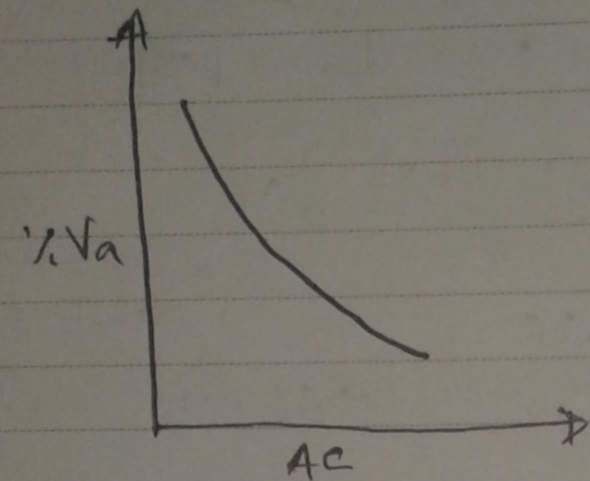
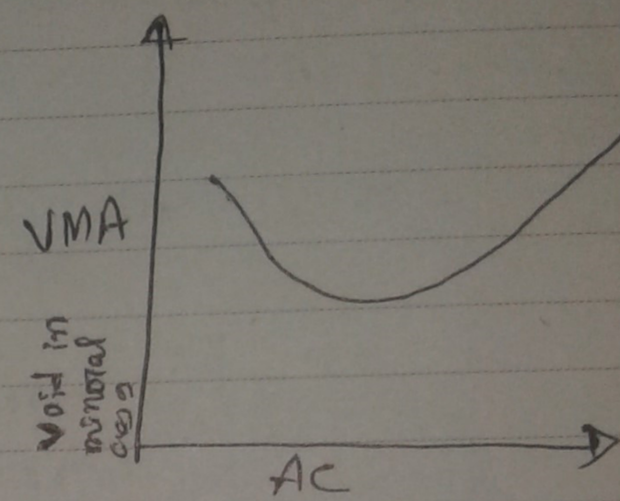
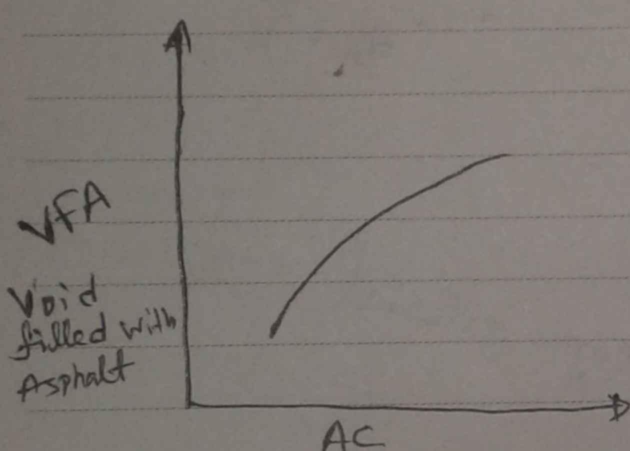


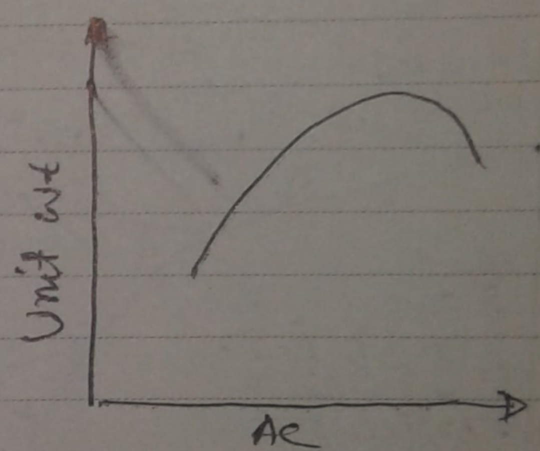
Fig: schematic relationship between access & movement function of streets & highway.

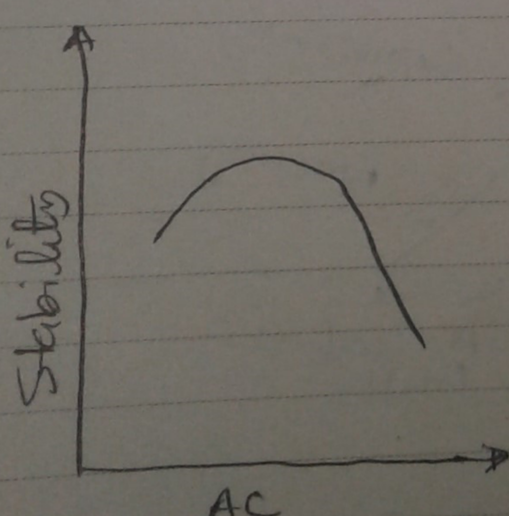
Marshall method of Mix Design:

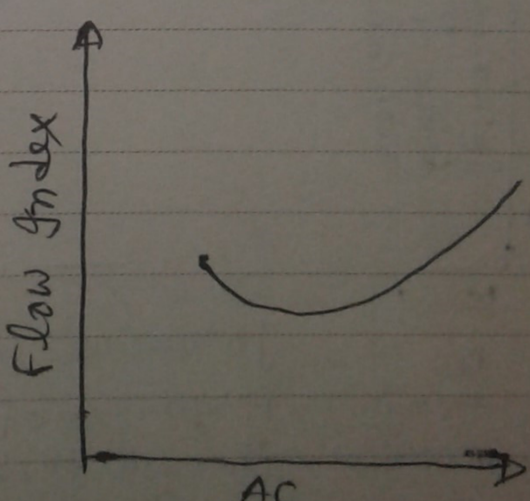


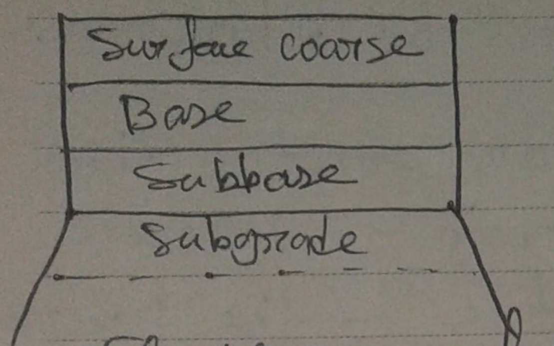




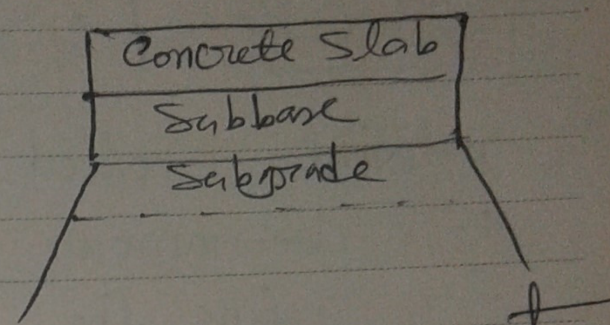








Flexible pavement



Rigid pavement

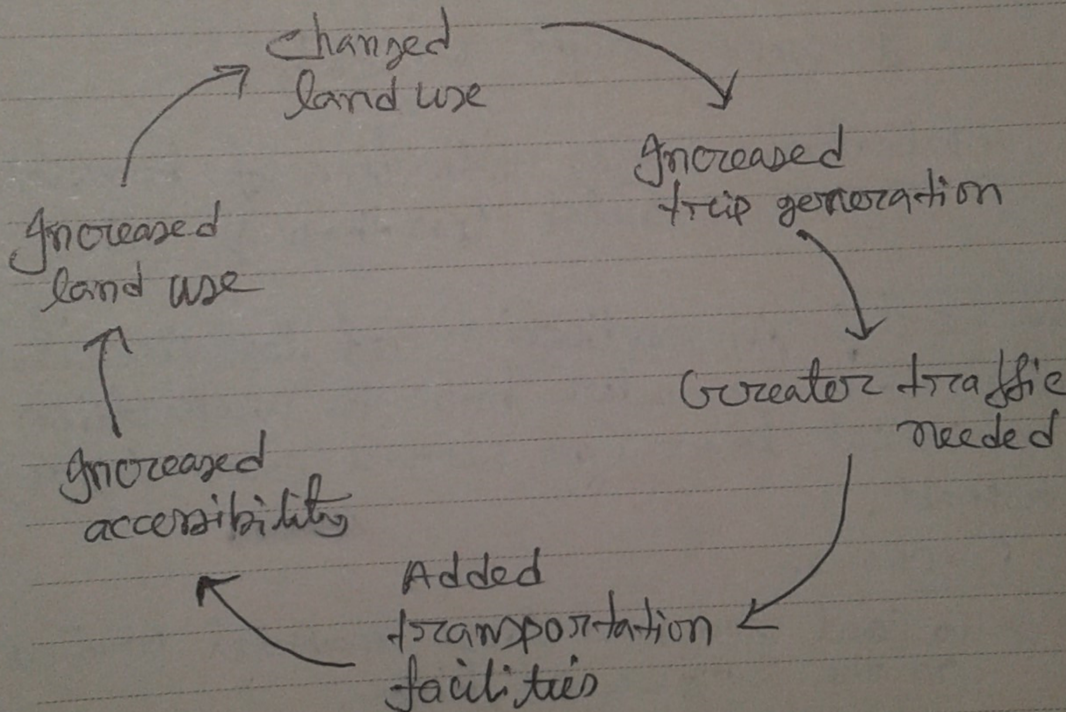


Fig: Land use cycle

Seal Coat: A final coat of bituminous materials applied during construction to a bituminous macadam or concrete for sealing the surface of the pavement.

Functions:

- To make surface "water proof"
- Improve night visibility

Application: Single application of bituminous material less than $\frac{1}{2}''$ thick

Prime coat: An application of low viscosity asphalt to a granular base in preparation for an initial layer (or surface course layer) of asphalt.

Functions:

- To coat and bond loose material particles on the surface of base.
- To harden the base surface to provide a work platform for construction equipment
- To fill the capillary voids to prevent migration of moisture.
- To provide adhesion between the base course & succeeding asphalt course.

Application: 0.9 to 2.3 L/m^2

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$\boxed{\text{Tack Coats}}$:

A thin layer of asphalt that ensures the bonding betweening old & new asphalt layer.

Functions:

- To provide adhesion between the existing surface & the new bituminous wearing surface.

Application: 0.19 to 0.38 L/m^2

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A = mass of oven dry sample in air

B = mass of SSD sample in Air

C = Mass of SSD sample in water

$$G_{sb} = \frac{A}{B-C} \quad \text{[Bulk)}$$

$$G_{sa} = \frac{A}{A-C} \quad \text{[Apparent]}$$

$$\text{Bulk SSD Sp Gravity} = \frac{B}{B-C}$$

$$\text{Absorption (\%)} = \frac{B-A}{A} \times 100$$

Meghna: For a coarse aggregate sample air dry wt. of sample is 1790 gm, wt. when it is immersed in water is 1180 gm and SSD wt is 1850 gm. Calc. bulk sp. Gravity, Apparent sp. Gravity & % Absorption.

Soln:

$A = 1790$

$B = 1850$

$C = \cancel{1790}\ 1180$

$$G_{sb} = \frac{A}{B - C}$$

$$= \frac{1790}{1850 - \cancel{1790}\ 1180}$$

$$= 2.67$$

$$G_{sa} = \frac{A}{A - C} = \frac{1790}{1790 - 1180} = 2.93$$

$$G_{bulk\ SSD} = \frac{B}{B - C} =$$

$$\text{Absorption}(\%) = \frac{B - A}{A} \times 100\%$$

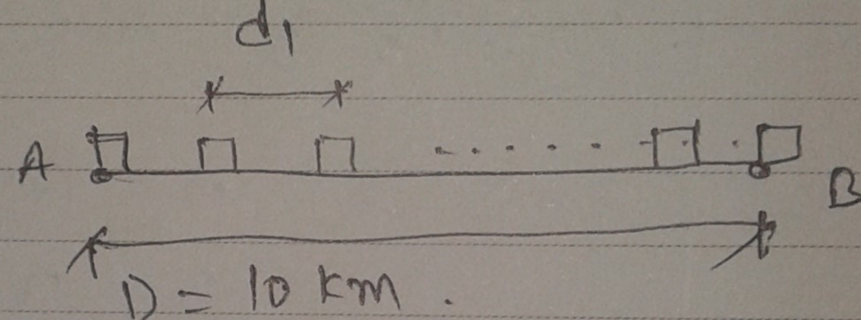
$$= \frac{1850 - 1790}{1790} \times 100$$

$$= 3.35\%$$

MSc-15: A 10 km road (each way) with operating velocity 20 km/hr will be the total no. of bus required for 3 min frequency?

$v = s/t$

Sol:



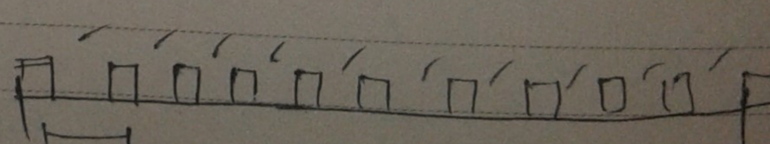
$$d_1 = vt = \underline{20 \times 1000/60 \text{ m/min} \times 3}$$

$$= 1000 \text{ m}$$

$$= 1 \text{ km}$$

$$n d_1 = D$$

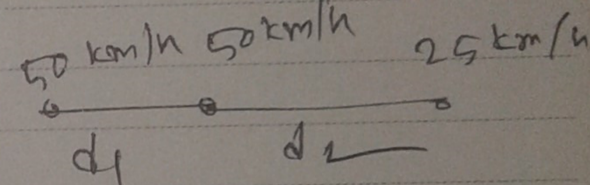
$$n = 10$$



no. of bus required = 10 Ans.

A Sign is to be given in a turnoff.

The value of 85th percentile speed is 50 km/h. The turnoff is to be approached at 25 km/h. The perception reaction time is 1.25 sec and deceleration rate is 0.3 g. The minm distance of the sign to be placed before the turnoff to have safe turning.



Soln: $d = d_1 + d_2$

$$= vt + \frac{v^2 - u^2}{2a}$$

$$= \frac{50\times1000}{3600} \times 1.25 + \frac{\left(\frac{50\times1000}{3600}\right)^2 - \left(\frac{25\times1000}{3600}\right)^2}{2\times0.3\times9.81}$$

$$= 17.36\,m + 24.58\,m$$

$$= 41.94\,m$$

DATE

* Two-lane two-way highway street having ADT 4000. If the commercial vehicle is 45% and loads 27 Kips then calculate the ESAL for commercial vehicle in one direction.

Sol:

$$ESAL = f_i \times N_i$$

$$= \left(\frac{27}{18}\right)^4 \times \left(4000 \times 0.45/2\right)$$

$$= 4556.25 \ \cancel{\text{Kip}} \quad (\text{Ans:})$$

1. **Bending of Homogeneous Beam:**

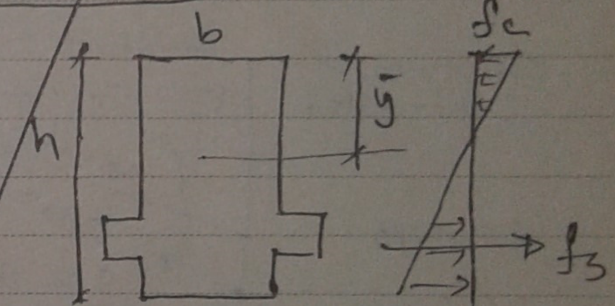
Stress, $f = \frac{My}{I}$

$f_{max} = \frac{Mc}{I} = \frac{M}{S}$; $S = \frac{I}{c}$ = section modulus

Shear stress, $v = \frac{VQ}{Ib}$ — V → Total shear at section; Q → statical moment

$Q = \frac{bh^2}{8}$ (Rectan.

2. **Stress Elastic - section uncracked:**



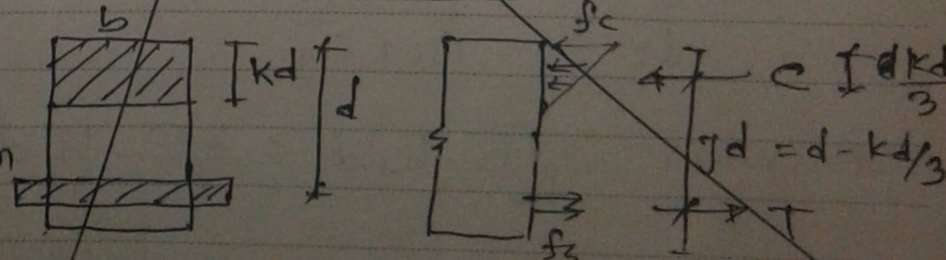
$f_c(\text{top}) = \frac{M\bar{y}}{I}$

$f_{ct}(\text{bot}) = \frac{My}{I}$

$= \frac{M(h-\bar{y})}{I} < f_{cr}$ (modulus of rupture)

$f_s = n\frac{My}{I}$

3. **Stress Elastic, section cracked:**



$\rho = A_s/bd$

$K = \sqrt{(\rho n)^2 + 2\rho n} - \rho n$

$j = \cancel{k}\ 1 - K/3$

Steel stress, $f_s = \frac{M}{A_s j d}$

Concrete stress, $f_c = \frac{2M}{kjbd^2}$

4. <u>Underreinforced Beam</u> : $\rho_{max} = \rho_b$

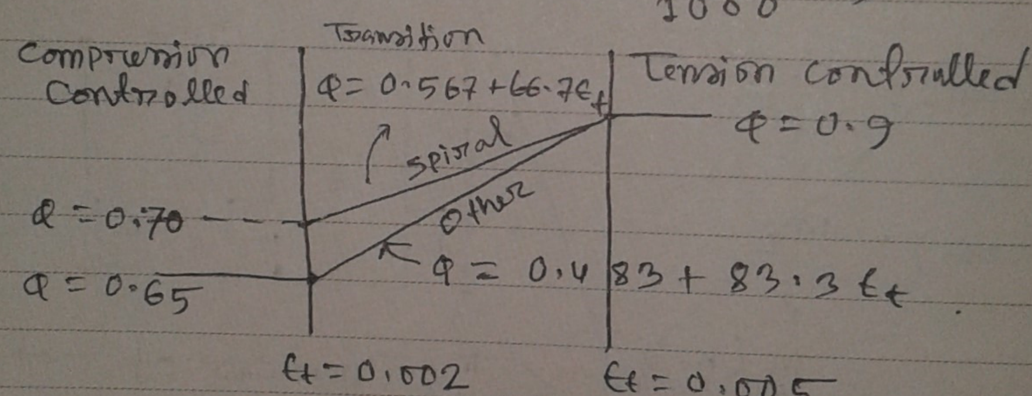
$$\rho_b = 0.85 \beta_1 \frac{f'_c}{f_y} \frac{\overset{0.003}{\epsilon_u}}{\epsilon_u + \underset{f_y/E_s = \frac{60}{29000}}{\epsilon_y}}$$

$$M_n = A_s f_y (d - a/2)$$

$$a = \frac{A_s f_y}{0.85 f'_c b}$$

$$M_u = \phi M_n$$

$$\beta_1 = 0.85 - 0.05 \frac{f'_c - 4000}{1000} \; ; \; 0.65 \le \beta_1 \le 0.85$$



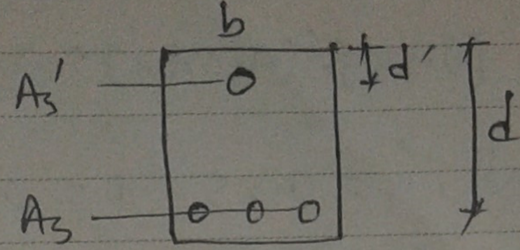
$$c = a/\beta_1$$

$$\frac{c}{d_t} = \frac{\epsilon_u}{\epsilon_u + \epsilon_y}$$

$$A_{s(min)} = \frac{3\sqrt{f'_c}}{f_y} b_w d \geq \frac{200}{f_y} b_w d$$

$$\phi M_n = \phi \rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f'_c}\right)$$

5. **Doubly reinforced beam :**



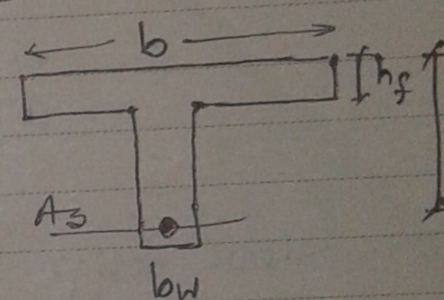
$$M_n = M_{n1} + M_{n2}$$

Compression steel, $M_{n1} = A_s' f_y (d - d')$

Tension steel, $M_{n2} = (A_s - A_s') f_y (d - a/2)$

$$a = \frac{(A_s - A_s') f_y}{0.85 f_c' b}$$

6. **T-beam :**



Eff. flange width, b

$$b = \min \begin{cases} 16 h_f + b_w \\ span/4 \\ c/c \text{ distance - beam} \end{cases}$$

T-beam check, ~~Ass~~ $a = h_f$ (Let), $A_s = \dfrac{M_u}{\phi f_y (d - a/2)}$

$$\cancel{a = \frac{A_s f_y}{0.85 b_w f_c'}} > h_f \;\therefore \text{T-beam}$$

$$* \quad A_{sf} = \frac{0.85 f_c' (b - b_w) h_f}{f_y}$$

$$M_{n1} = A_{sf} f_y (d - h_f/2)$$

$$M_{n2} = (A_s - A_{sf}) f_y (d - a/2)$$

$$a = \frac{(A_s - A_{sf}) f_y}{0.85 f_c' b_w}$$

*7. **Short column:**

$$\phi P_n (max) = \alpha \phi . [0.85 f'_c (A_g - A_{st}) + f_y A_{st}]$$

spiral, $\alpha = 0.85$, $\phi = 0.70$

tied, $\alpha = 0.80$, $\phi = 0.65$

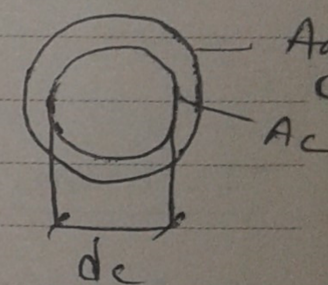
Min^m clear spacing $= 1.5 d_b$ or $1.5''$

clear spacing $< 6''$

spiral: Min^m #3, $1'' \le$ spacing $\le 3''$

$$\rho_s = 0.45 \left(A_g/A_c - 1\right) \frac{f'_c}{f_y}$$

$$s = \frac{4 A_{sp}}{\rho_s d_c}$$



8. **Shear design:**

$$\phi V_c = \phi . 2\sqrt{f'_c}\, b_w d$$

$\phi \longrightarrow 0.75$

$\phi V_s \le 4\sqrt{f'_c}\, b_w d$:

$$S_{max} = \min^m \begin{cases} \dfrac{A_v f_y}{0.75\sqrt{f'_c}\, b_w} \le \dfrac{A_v f_y}{50 b_w} \\ d/2 \quad (d/4) \\ 24'' \quad (12'') \end{cases}$$

$$s = \frac{\phi A_v f_y d}{V_u - \phi V_c}$$

Structure

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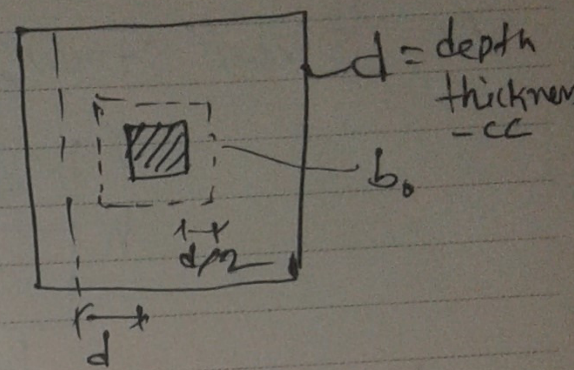
9. Footing :



Punching shear,

$$V_c = 4\sqrt{f_c'}\, b_0 d$$

Beam shear,

$$V_c = 2\sqrt{f_c'}\, bd$$

10. 100 CFT , 1:2:4

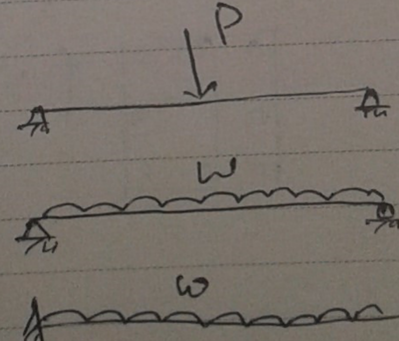
$$\text{cement} = \frac{1}{1+2+4} \times 100 \times \underbrace{1.5}_{SF}$$

$\boxed{\text{50 kg bag} \quad 1.25\ ft^3}$

11. 100 CFT , 1:2

$$\text{Cement} = \frac{1}{1+2} \times 100 \times \underbrace{1.25}_{SF}$$

12. Deflection



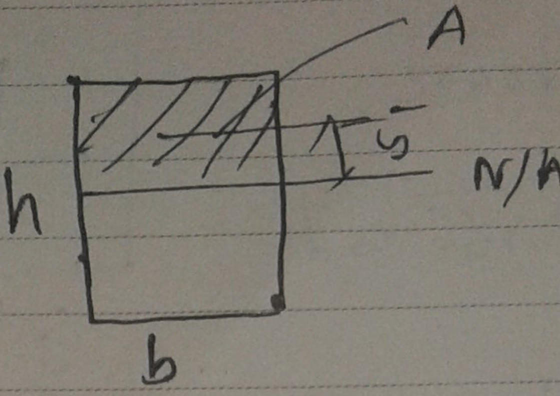
$$\delta_{max} = \frac{Pl^3}{48EI}$$

$$\delta_{max} = \frac{5wl^4}{384EI}$$

$$\delta_{max} = \frac{wl^4}{8EI}$$

[redacted]

1A. Shear stress:



$$Q = A\bar{y} = \frac{1}{2}bh \cdot \frac{h}{4} = \frac{bh^2}{8}$$

$$v = \frac{VQ}{Ib}$$, Q = Statical moment about NA of that portion of cross section betn N/A & fiber.

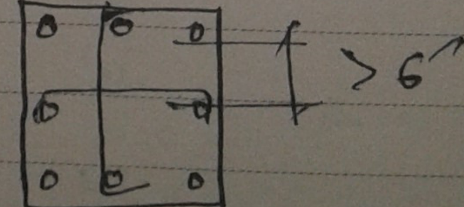
Ib → About N/A

7A. Tied column: Tie design

#3 → for ≤ #10

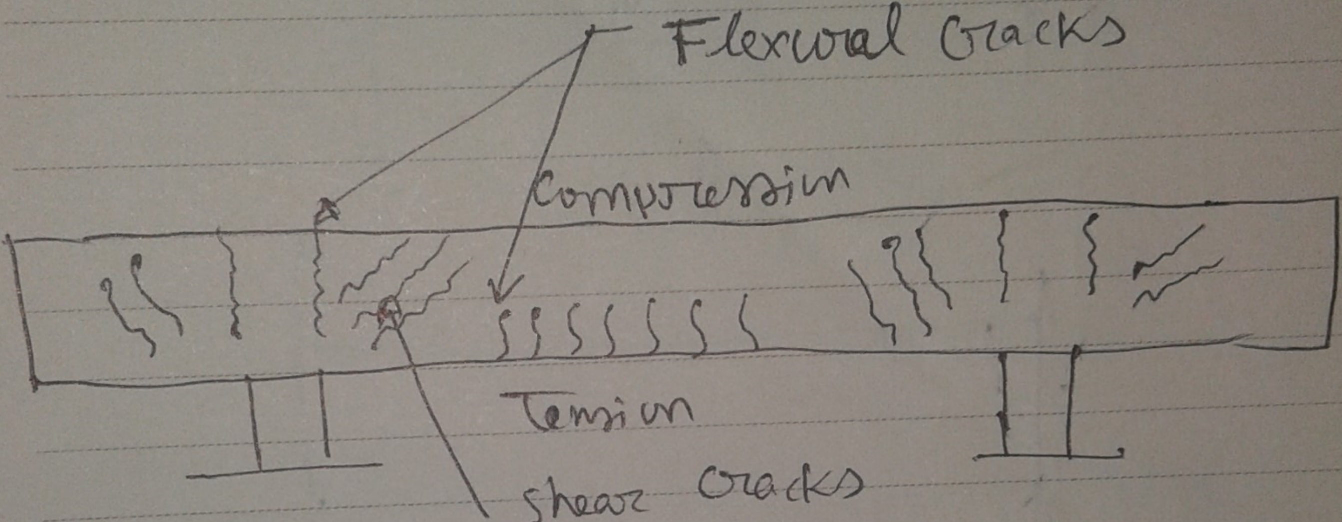
#4 → > #10 main

$$s = \min \begin{cases} 16\,d_b \text{ (long)} \\ 48\,d_b \text{ (tie)} \\ \text{least dim}^n \text{ of col} \end{cases}$$



δ- Calculation - Moment Area method

Portal Method



Failure Modes

Moment distribution method

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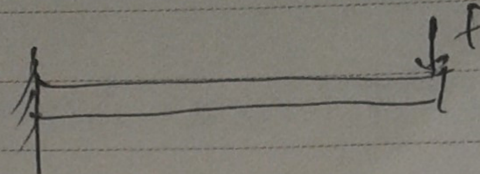
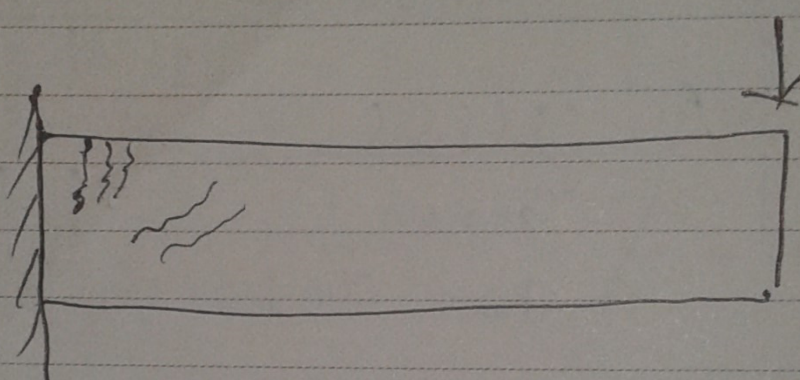
Draw the shear crack & bending crack on a typical overhanging beam with a point load "P" in the overhanging end.





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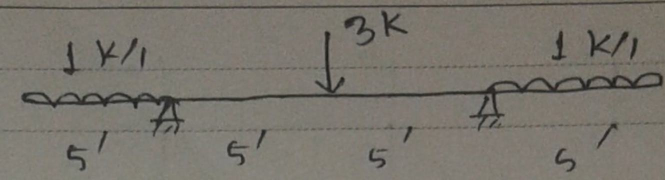
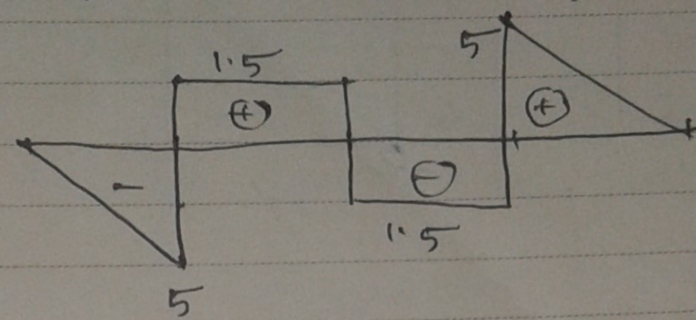
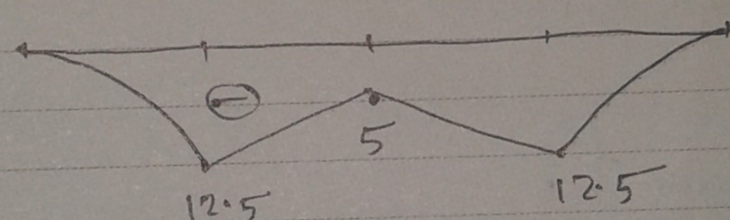


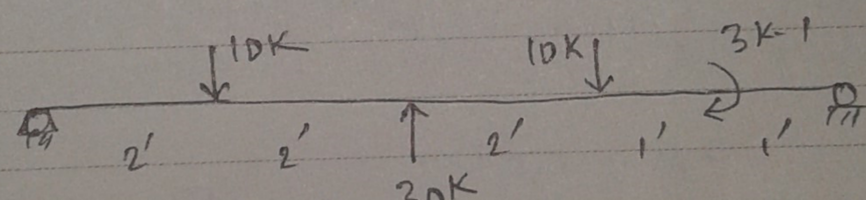


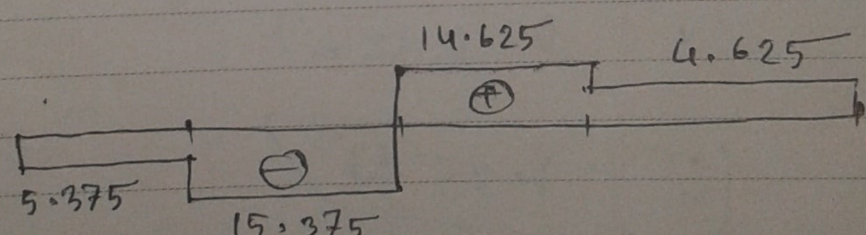
SFD (K)



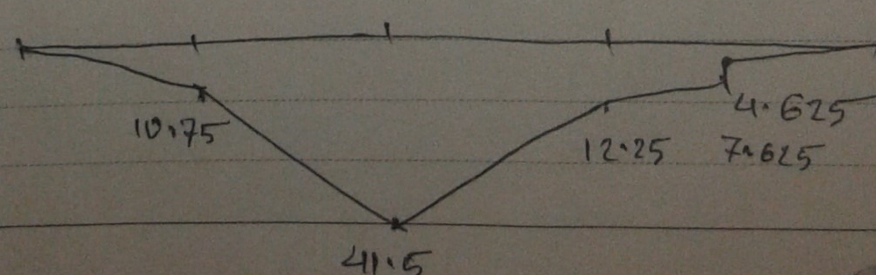
BMD (K-ft)

#

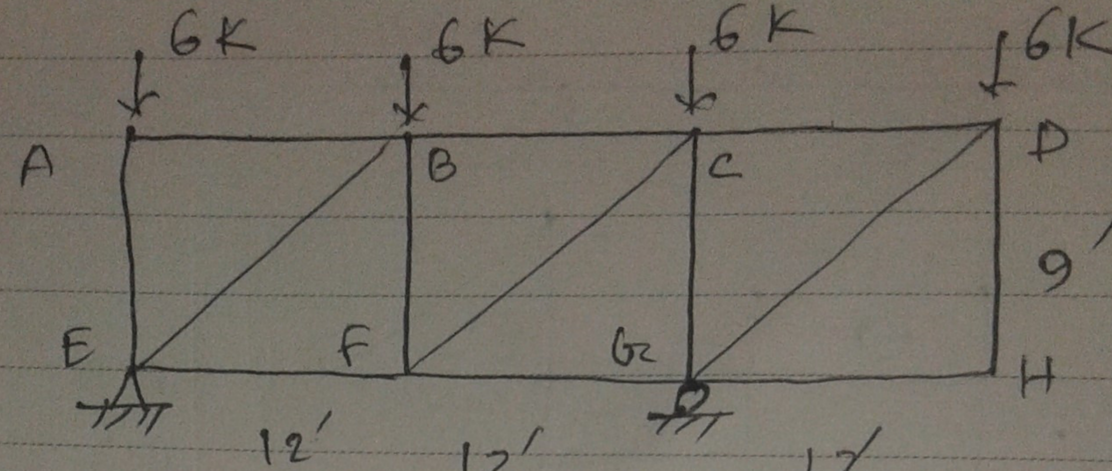




SFD (K)



#



$F_{BC} = 0$

$F_{CF} = 10$ (T)

$F_{CG} = 12$ (C)

$\boxed{\text{Cement}}$

$1440\ kg/m^3$

$m = 50\ kg$

$\rho = \frac{m}{V}$

$V = 0.035\ m^3$

$\boxed{V = 1.25\ ft^3}$

100 cft, 1:2:3

$M = \frac{1}{6} \times 100 \times 1.5$

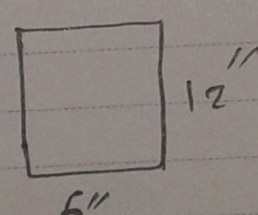
$\llcorner \rightarrow$ SF

1 bag cement = 1.25 cft

$F = \frac{2}{6} \times 100 \times 1.5$

$C = \frac{3}{6} \times 100 \times 1.5$

1. a find the max^m shear stress subjected to vertical shear force 48 kips.



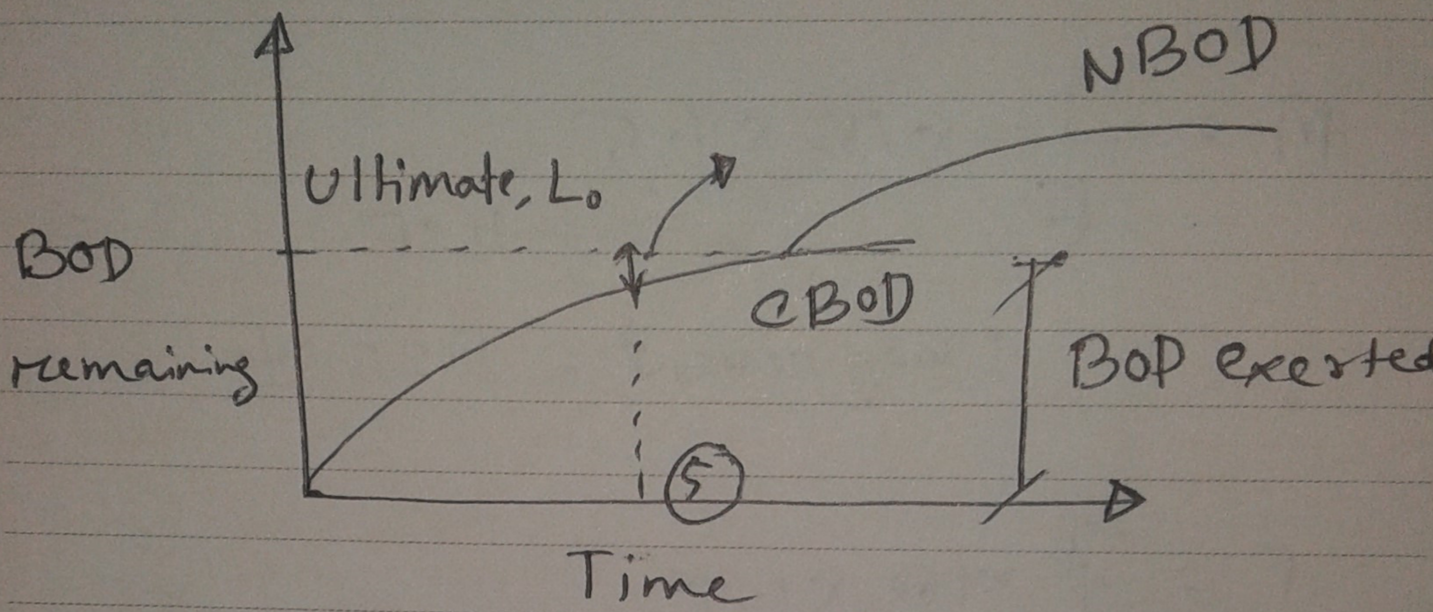
Sol^n: $v = \frac{VQ}{Ib}$

$= \frac{V \times \cancel{b}h^2/8}{\frac{bh^3}{12} \times \cancel{b}} = \frac{12 \times V}{8bh}$

$= \frac{1}{\cancel{144}}$ kip/ft^2

?

1 ksi
= 144 k/ft^2



$P_n = P_0(1+r)^n$

1. A bar dia 25.4 mm & load carried 25.1 tons. calculate stress & grade of rod.

$\boxed{1 \text{ Ton (metric)} = 2205 \text{ lb}}$

Sl: $f_y = P/A$

$$= \frac{(25.1 \times 2.205) \text{ kip}}{\pi \times (1)^2/4}$$

$$= 70.5 \text{ ksi}$$

2. Half brick area 22.1 in^2 & load is 200 Ton. Calculate Comp. stress & grade.

Sol^n: $f_c' = P/A = \dfrac{200 \times 2.205}{22.1}$

$$= 19.95 \text{ ksi}$$

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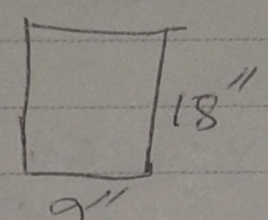
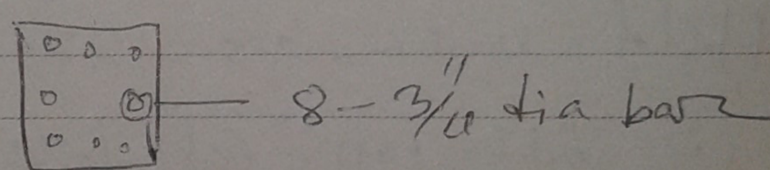
PDB - 2016, BUET Gen: 40, Tech: 60

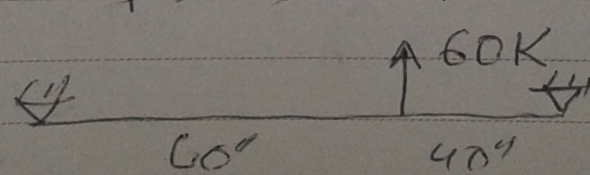
1. Calculate the shear stress of the following beam section carrying 18 kip shear force.



2. Calculate ultimate load bearing capacity of the column having $f_y = 60$ & $f_c' = 4$ ksi.



3. Draw SFD & BMD



4. For a wide channel, $Q = 20\ m^3/s$, $n = 0.016$, $S_0 = 0.002$, calculate normal depth & velocity.

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5. 25% materials retain at each seive #30, #50, #100 & #200. calculate FM.

6. Calcule Total pressure & eff. pressure at 5m from Top level of a swimming pool.

7. Settlement of a soil having 100 kN/m^2 of loading is 100mm.
....

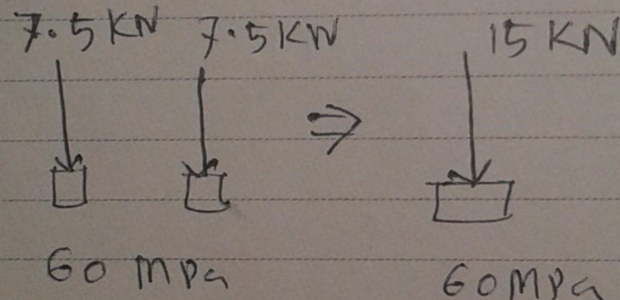
8.

8. Annual rainfall is 1.2m/yr. runoff coefficient is 0.65. If the per capita water demand is 70 gpcd, for 10 person, yr = 2 years calculate the catchment area needed?

9. Determine the ratio of energy of standard proctor & modified proctor test.

10. For a aggregate $e_{max} - e_{min} = 0.3$ Relative compaction 70%, $e = 0.7$ calculate bulk sp. gravity, apparent sp. gravity & % absorption.

11. Two wheels are closely spaced having tyre pressure 60 MPa. If two tyres are combined calculate new tyre diameter.

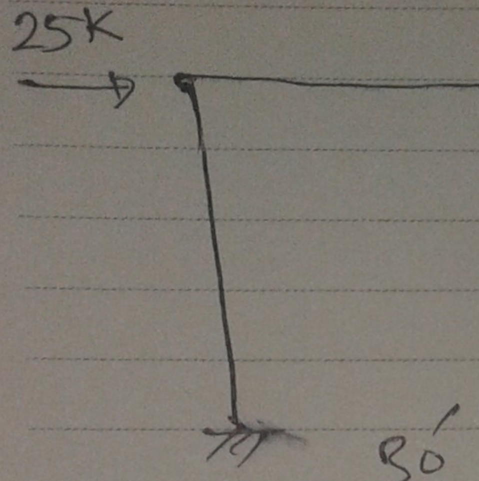


12. True/False
   - Grade of MS rod ? means ?
   - Flab slab
   - Tie rod, dowel bar

13. MCQ

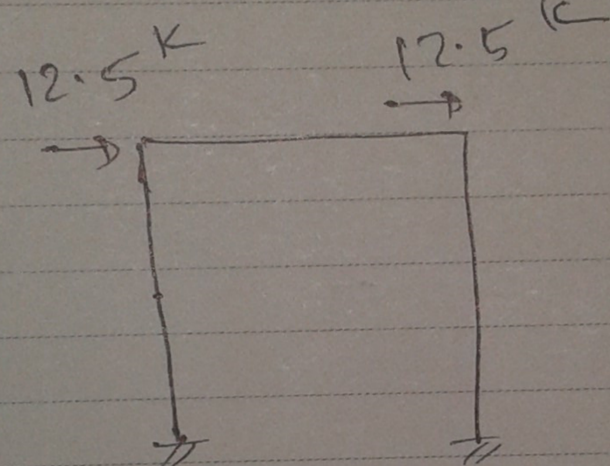
14. Fill in the gap

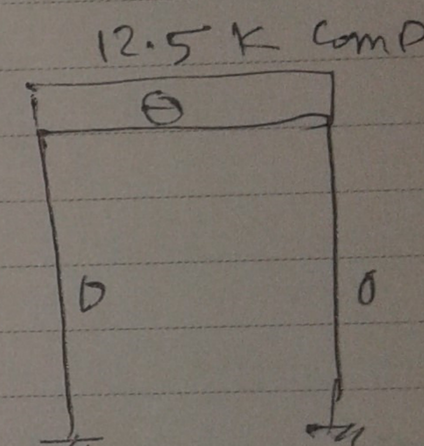
#



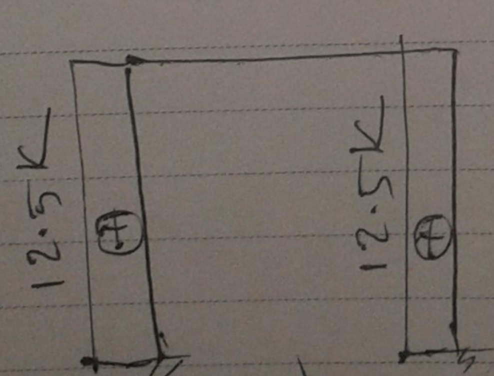
Draw SFD & BMD of column.

Sol:

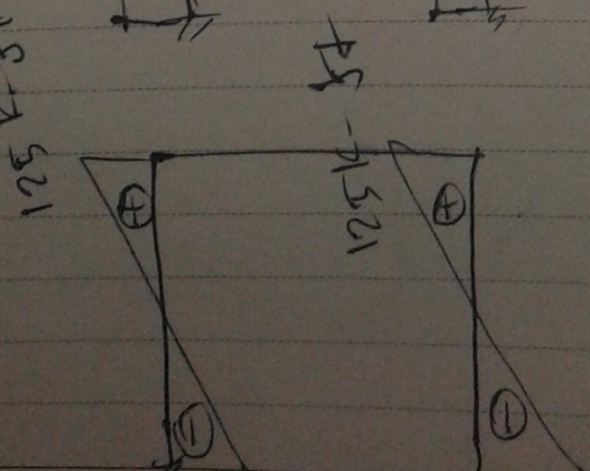




AFD



SFD



BMD

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$$\frac{C_c H}{1+e_0} \log \frac{p_0' + \Delta p'}{p_0'}$$

$$q_u = cN_c + \boxed{\gamma D_f \cdot N_q} + 0.5\gamma B N_\gamma$$

1.3   0.4

1.3   0.3