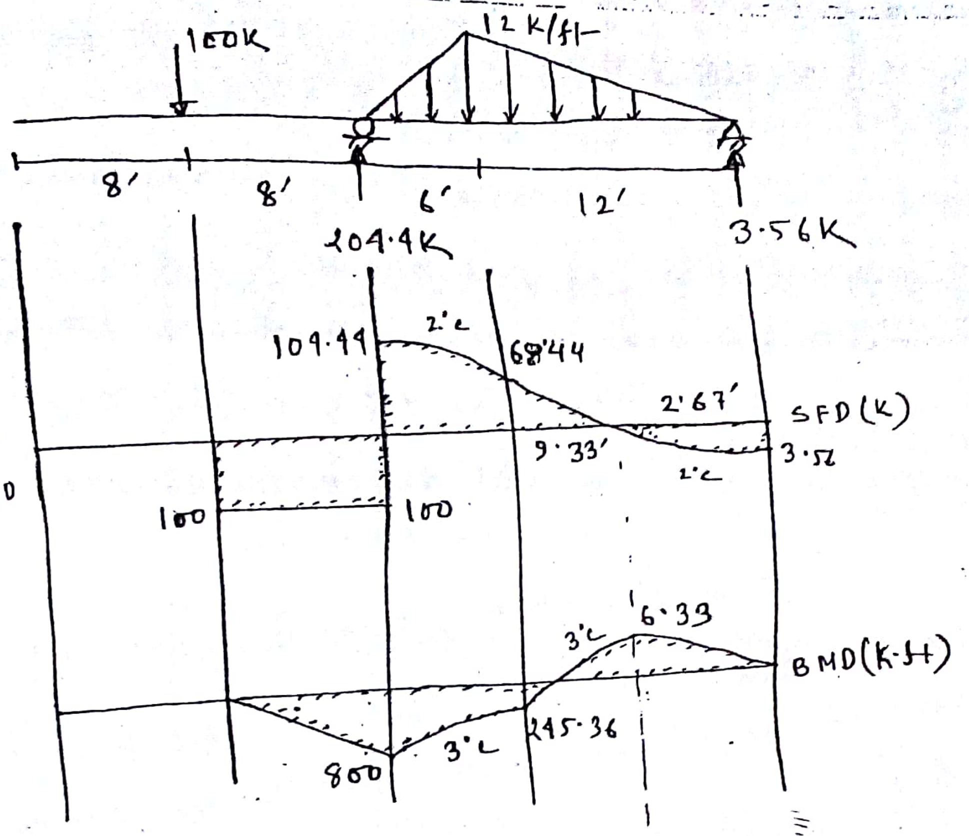
"PGCL-2017"

1/



$\frac{12}{12} = \frac{Y}{x}$

$\Rightarrow Y = x$

$3.56 - \frac{1}{2} x Y = 0$

$\Rightarrow 3.56 - \frac{1}{2} x^2 = 0$

$\Rightarrow x = 2.67'$

2/ Write down the five common structural system of building in Bangladesh.

1. Load bearing structure
2. Frame structure.
3. Composite structure
4. Steel structure
5. Concrete structure

Scanned by CamScanner

3/ Determine the allowable working moment of a singly reinforced beam having section of the beam is 10" x 18" and d = 15", use 3-20mm dia bars f_s = 20 ksi, f_c = 1.35 ksi, n = 9.

Soln: $r = \frac{f_s}{f_c} = 14.81$, $K = \frac{n}{n+r} = .378$, $j = 1 - K/3 = .874$

$M_c = \frac{f_c}{2} jK \cdot bd^2 = 501.75$ k-in

$M_s = A_s f_s jd = (3 * .486) * 20 \times .874 \times 15$

$= 382.29$ k-in

∴ Allowable working moment = 382.29 k-in Ans.

4/ Write down two major factors affecting the bearing capacity of shallow foundation resting of sand.

Ans:

1) Size, shape & depth of foundation.
2) Location of ground water table.
3) Nature of foundation.
4) Angle of internal friction.

5/ Find the unit weight of saturated soil, unit wt of dry soil γ_d = 110 pcf, G_s = 2.7.

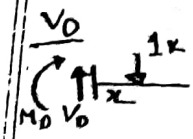
Soln.

$\gamma_d = \frac{G_s \gamma_w}{1+e} \Rightarrow e = \frac{G_s \gamma_w}{\gamma_d} - 1 = \frac{2.7 \times 62.4}{110} - 1 = .531$

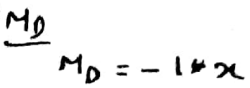
∴ $\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e} = \frac{(2.7 + .531)62.4}{1 + .531} = 131.69$ pcf

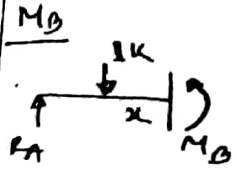
Ans.

6/ Draw IL for V_D, M_D, M_B, R_A for the beam

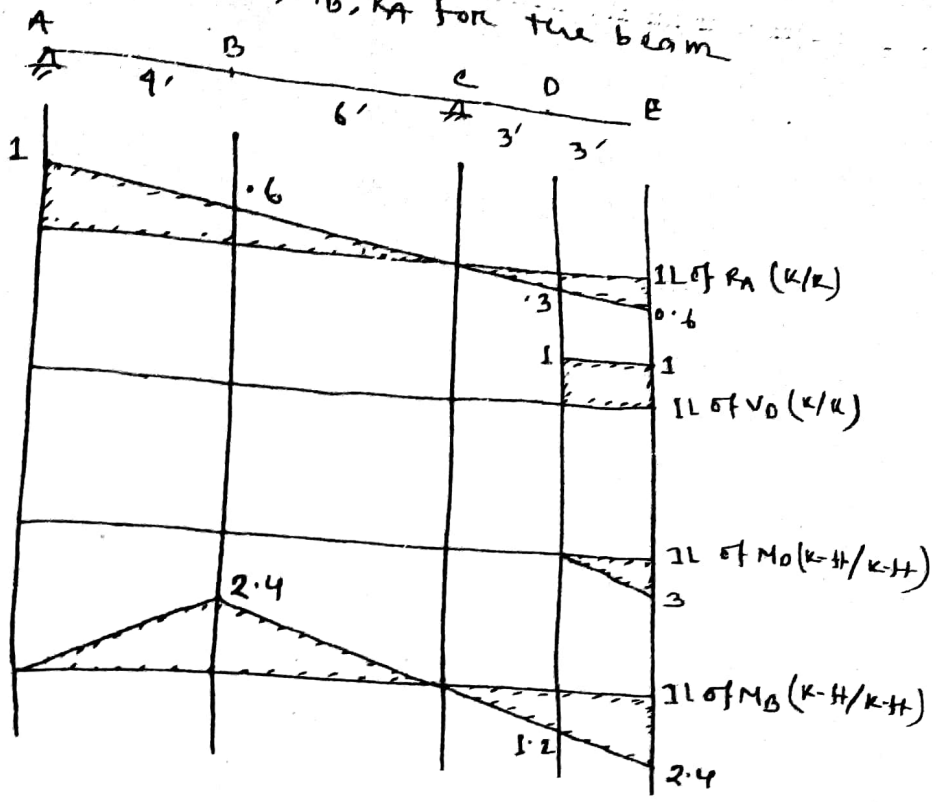


$\therefore V_D = 1$ K



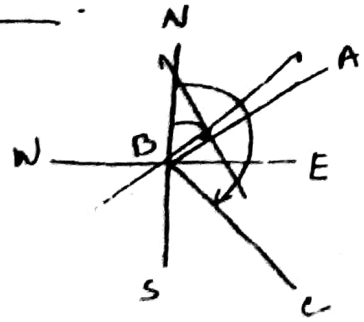


$M_B = 4R_A - 1Kx$



7/ Find the angle ABC if forward bearing of both lines CB & BA are 130°29'56" and 89°29'56"?

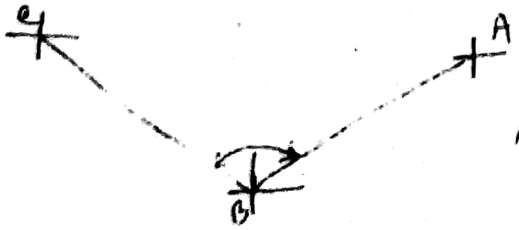
Soln.



∴ ~~Angle of ABC = (130°29'56" − 89°29'56")~~

~~= 40°55'0"~~

Ans.



Angle of ABC = (270° − 40°29'56") + 89°29'56"

= 139°5'

Ans.

12/ Flow diagram of activated sludge process.

→ Kuata

13/ Abbreviations –

① ETP → Effluent Treatment plant

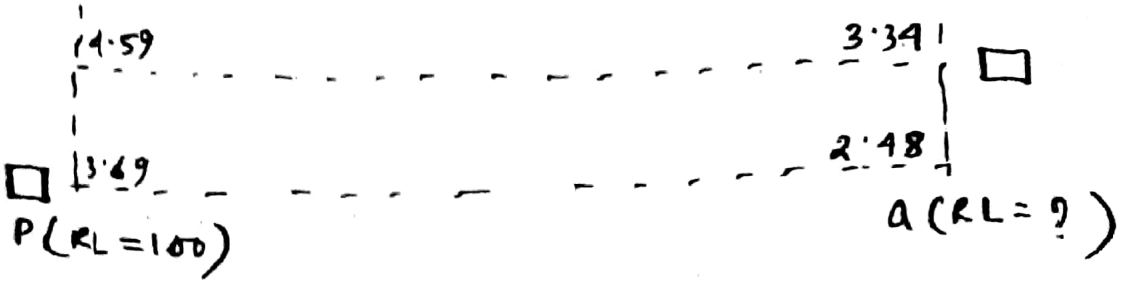
② STP → ~~Storage Tank pregrams~~ sewage Treatment Plant

③ ECR → Environment Conservation Rules

④ BOD → Biochemical oxygen demand.

⑤ COD → Chemical oxygen demand.

14/



Soln:

In first setting

Apparent difference of level between P & Q

$= 3.34 - 4.59 = -1.25$ m

In second setting

Apparent difference of level between P & Q

$= 2.48 - 3.69 = -1.21$

True difference of level $= \frac{-1.25 - 1.21}{2} = -1.23$m

RL of Q $= 100 - (-1.23)$

$= 101.23$ m

Ans.

15/ collection time required by 4 vehicles for travelling 1 km were 1·6, 1·2, 1·5 & 1·7 min respectively. Find space & time mean speed.

Soln:

$$\text{Time mean speed} = \left(\frac{1}{1·6} + \frac{1}{1·2} + \frac{1}{1·5} + \frac{1}{1·7}\right)/4$$

$$= 0·6783 \text{ km/min}$$

$$\text{Space mean speed} = \frac{1+1+1+1}{1·6+1·2+1·5+1·7}$$

$$= 0·667 \text{ km/min}$$

Ans.

(16) Determine the total^ green time for a 2 face traffic signal having cycle time C = 66 s, Green time for NS direction G_{NS} = 24 s, for EW direction G_{NW} = 27 s ?

Soln: We know,

$$\text{Cycle time, } C = \Sigma G + \Sigma I$$

$$\Rightarrow \Sigma I = C - \Sigma G$$

$$= 66 - (24+27)$$

$$= 15 \text{ s}$$ Ans.

"Sylhet Gas Field - 17"

(1) An artesian aquifer 10m thick with piezometric surface 5m above the bottom confining layer is being pumped by a fully penetrating well. The aquifer is medium sand (hydraulic conductivity 1.5×10^{-4} m/s). Steady state draw downs of 5.00m and 1.00m are observed at two non-pumping wells located 20m and 200m respectively, from the pumped well. Determine the discharge at the pumped well in m^3/s.

Soln:

$$Q = \frac{2\pi Km(s_1 - s_2)}{\ln\left(\frac{r_2}{r_1}\right)}$$

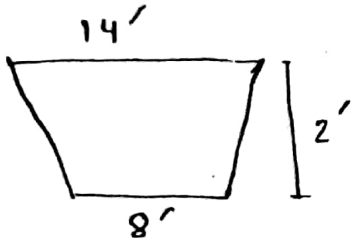
$s_1 = 5m$
$s_2 = 1m$
$r_1 = 20m$
$r_2 = 200m$

$$= \frac{2\pi \times 1.5 \times 10^{-4} \times 10 \times (5-1)}{\ln\left(\frac{200}{20}\right)}$$

$$= 0.01637 \ m^3/s$$

Ans.

2) The trapezoidal channel shown has a manning's co-efficient of, $n = 0.013$ and is laid at a slope of 0.0028. The depth of flow is 2 ft. what is the flow rate at ft^3/s?



Soln:

$A = \frac{1}{2}(14+8) \times 2 = 22 ft^2$

$P = 8 + 2 * \sqrt{2^2+3^2} = 15.21$ ft

$B = 14'$

$R = A/P = 1.446$ ft.

$$V = \frac{\Phi}{n} R^{2/3} S^{1/2}$$

$$= \frac{1.486}{.013} (1.446)^{2/3} * (.0028)^{1/2}$$

$= 7.73$ ft/s

$\therefore Q = AV = 22 \times 7.73 = 170.06 \ ft^3/s$

Ans.

(3) Laboratory analysis of water sample. All concentrations are in Ca^{++} = 74 mg/L, Mg^{++} = 18.3 mg/L, Na^{+} = 27.6 mg/L, K^{+} = 39.1 mg/L, pH = 7.8, HCO_3^- = 274.5 mg/L, SO_4^{2-} = 72 mg/L, Cl^- = 49.7 mg/L. Determine ① Hardness of water in mg/L of $CaCO_3$ ② Amount of lime needed to remove hardness by $CaCO_3$.

Soln:

① Total hardness $= \left(\frac{74}{20} + \frac{18.3}{12}\right) \times 50 = 261.25$ mg/L as $CaCO_3$.

② $pH = -\log[H^+]$

$\Rightarrow [H^+] = 10^{-7.8}$ mole/L $= 10^{-7.8} \times 1$ gm/L $= 1.58 \times 10^{-8}$ gm/L

$= 1.58 \times 10^{-5}$ mg/L

Again, $[OH^-] = \frac{10^{-14}}{[H^+]} = \frac{10^{-14}}{10^{-7.8}} = 6.31 \times 10^{-7}$ mole/L

$= 6.31 \times 10^{-7} \times 17$ gm/L $= 107.27 \times 10^{-4}$ mg/L

Total alkalinity $= CO_3^{2-} + HCO_3^- + OH^- - H^+$

$= \left(0 + \frac{274.5}{61} + \frac{107.27 \times 10^{-4}}{17} - \frac{1.58 \times 10^{-5}}{1}\right) \times 50$

$= 225$ mg/L as $CaCO_3$.

Lime requirement = Alkalinity + Mg^{2+} + CO_2 + Excess lime

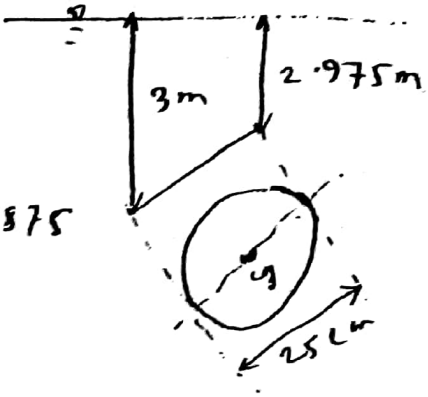
$= 225 \times \frac{56}{100} + 18.3 \times \frac{56}{100} + 0 + 0$

$= 168.17$ mg/L Ans.

4/ Find the resultant force on one side of a 25 cm dia vertical circular plate standing at the bottom of 3m pool of water. $\gamma_w = 1000\ kg/m^3$, $g = 9.81\ m/s^2$.

Soln:

$$\bar{x} = \frac{3 + 2.975}{2} = 2.9875\ m$$



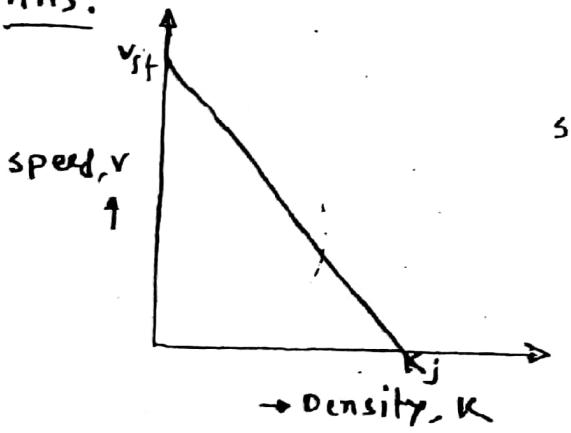
$$P = \gamma A \bar{x}$$

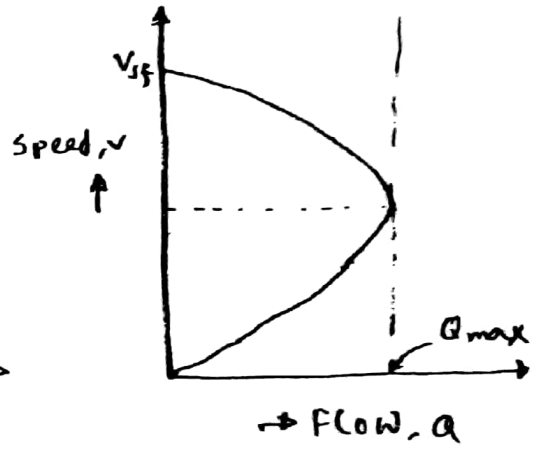
$$= (1000 \times 9.81) \times \frac{\pi}{4} \times (.025)^2 \times 2.9875$$

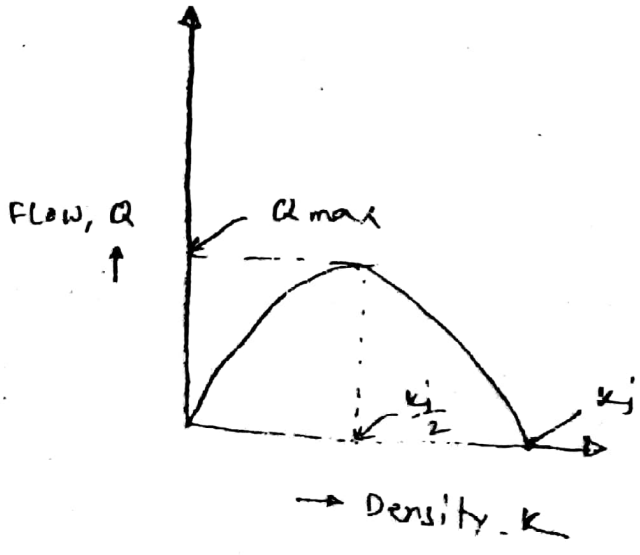
$$= 14.36\ N$$ Ans.

5/ Draw the typical fundamental diagram of traffic flow.

Ans:







(6) Standard rail length of BG track is 12.80 m. If 45 kg/m rail is used in a particular BG track, what is the total weight of each individual rail girder? What maxm axle load can be safely imposed on that track?

Soln:

total wt of a rail = No. of rail × wt of rail/length × length of rail

$= 1 \times 45 \times 12.8 = 576$ kg Ans.

Maximum axle load = 560 × sectional wt of rail kg/m

$= 560 \times 45$

$= 25200$ kg Ans.

7) 25% of total sand sample is retained on each of 0.6 mm, 0.425 mm, 0.30 mm. and 0.15 mm sieve. Find FM.

Soln:

sieve size	
(#30)	0.6 mm
	0.425 mm
(#50)	0.30 mm
(#100)	0.15 mm

$FM = \frac{25+75+100}{100} = 2.00$ Ans.

2/ If ground is level across an embankment width, determine the volume of earthwork. Given, RL of Foundation level (FL) 18 ft, width of FL = 25 ft, side slope = 2·5 H : 1V, RL of GL at chainage 0 ft, 80 ft and 200 ft are 21 ft, 18 ft and 16 ft.

Soln:

11/ Water content of a Saturated soil sample is 50%, specific gravity of soil solid 2.65. Find the values of bulk unit weight, dry unit wt, void ratio.

Soln: For saturated soil, $S = 1$

$\therefore e = wG_s = 0.5 \times 2.65 = 1.325$

$\gamma_d = \frac{G_s \gamma_w}{1+e} = \frac{2.65 \times 62.4}{1+1.325} = 71.12 \text{ lb/ft}^3$

$\gamma = \gamma_d (1+w) = 71.12 \times (1+0.5) = 106.68 \text{ lb/ft}^3$

Ans.

12/ A sample of dry sand was tested in direct shear apparatus under a normal load of 30 kg. The sample failed under a shearing load of 58 lb. The sample size was 2" x 2". What is the angle of internal friction?

Soln:

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

$\Rightarrow 14.5 = 0 + 19.8 \times \tan\varphi$

$\Rightarrow \varphi = 36.22°$ Ans.

$\tau = \frac{58}{4} = 14.5 \text{ psi}$

$\sigma = \frac{30 \times 2.2}{4} = 19.8 \text{ psi}$

$c = 0$

13/ Compute consolidation settlement of a 2.5 m thick clay layer due to an increase of 30 kN/m² pressure at the mid height of the layer. If the vertical stress at the mid height of layer is 40 kN/m² $e_c = 0.7$ $c_c = 0.25$.

Soln.

$S = \frac{c_c H}{1+e_0} \log \frac{\sigma_0' + \Delta\sigma'}{\sigma_0'} = \frac{.25 \times 2.5}{1+.7} \log \frac{40+30}{40}$

$= 0.08935 \text{ m}$ Ans.

14/ A nine pile group consisting of 18 inch diameter concrete pile was cast in situ whose unconfined compressive strength is 1000 psf. Each pile is 60ft long. using a reduction factor $\alpha = 0.5$ and F.S. is 3. Calculate allowable skin friction of single pile.

Sol^n:

$$Q_s = \alpha . c \, A_{surface} \qquad \left| c = \frac{1000}{2} = 500 \text{ psf.} \right.$$

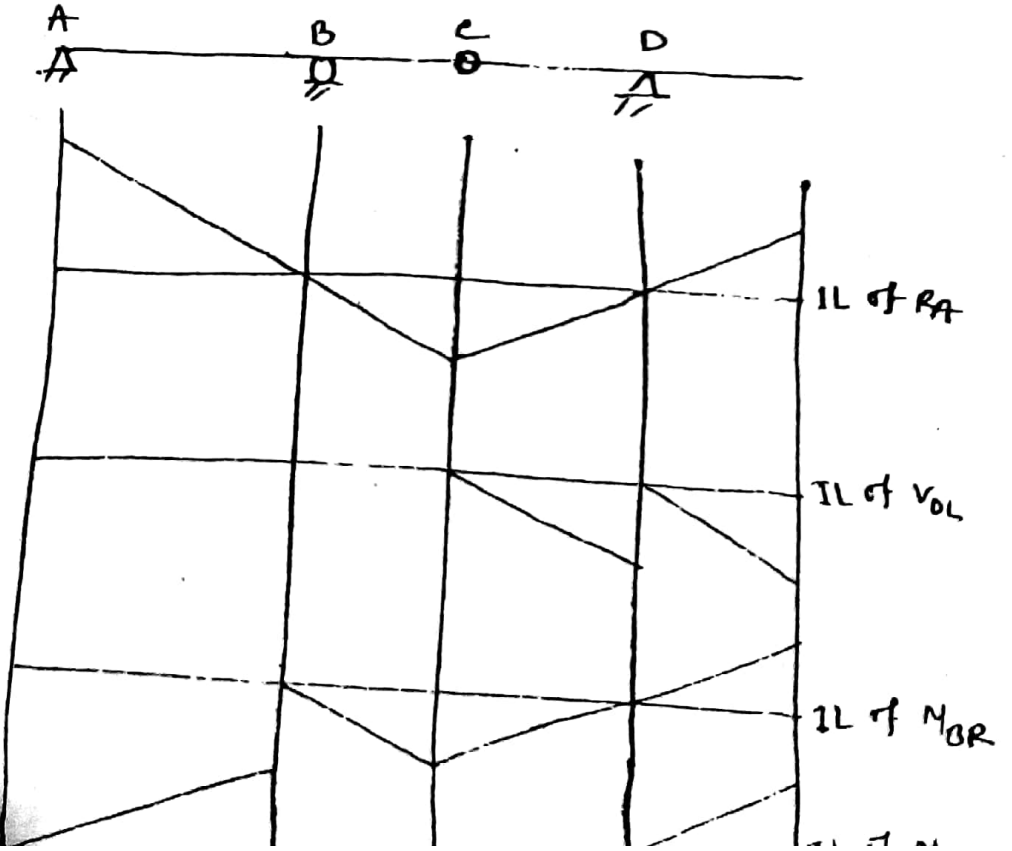
$$= 0.5 \times 500 \times \pi * \frac{18}{12} * 60$$

$$= 70.6858 \text{ kip}$$

$\therefore$ Allowable skin friction $= \frac{Q_s}{F.S} = \frac{70.68}{3} = 23.56$ kips

Ans.

15/ Draw IL of R_A, V_{DL}, M_B for the following



(16) A 300mm x 300mm beam is subjected to bending moment about both principal axis of 1 KN-m and 2 KN-m. Find the maximum bending stress.

Soln:

$$I_{x-x} = I_{y-y} = \frac{0.3 \times 0.3^3}{12} = 6.75 \times 10^{-4}\ m^4$$

$$\sigma_x = \frac{M_x c}{I_{x-x}} = \frac{2 * \frac{.3}{2}}{6.75 \times 10^{-4}} = 444.45\ KN/m^2$$

$$\sigma_y = \frac{M_y c}{I_{y-y}} = \frac{1 * \frac{.3}{2}}{6.75 \times 10^{-4}} = 222.22\ KN/m^2$$

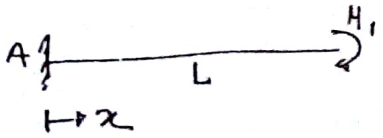
Maximum Bending stress, $\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2}$

$= 333.33 + 111.11$

$= 444.45\ KN/m^2$ Ans.

17) A bending moment of M_1 is applied at the free end of a cantilever beam of length L of continuous flexural rigidity EI. Find the equation of elastic curve.

Soln:



Now,

$$EI \frac{d^2y}{dx^2} = M_1$$

$$EI \frac{dy}{dx} = M_1 x + c_1$$

$$EI\,y = \frac{M_1 x^2}{2} + c_1 x + c_2$$

When, $x = 0,\ y = 0 \ ;\ c_2 = 0$

When, $x = 0,\ \frac{dy}{dx} = 0 \ ;\ c_1 = 0$

$$EI\,y = \frac{M_1 x^2}{2}$$

$$\Rightarrow y = \frac{M_1 x^2}{2EI}$$ → Equation of elastic curve.

18/ Write down the advantages of Reinforced Concrete.

Ans:

① It has relatively high compressive strength.
② It has better resistance to fire than steel.
③ It has long service life.
④ It needs low maintenance cost.
⑤ It can be cast to make any shape.

1/ Design ties (size & spacing) for 24"×16" column and 12-#9 bars used in column.

Soln: Let, #4 bar is used

① $16\, d_{LB} = 16 * \frac{9}{8} = 18''$

② $48\, d_{TB} = 48 * \frac{4}{8} = 24''$

③ $a_{min} = 16''$

So, use 12 mm-φ bar @ 16" c/c Ans.

2/ Find the nominal axial compression and design capacity of a rectangular column size 16"×24" and reinforced with 12-20mm bars. $f_y = 60$ksi, $f'_c = 4$ksi

Soln: $P_n = 0.85 f'_c (A_g - A_{st}) + f_y A_{st}$ $\quad [A_{st} = 12 * .44 = 5.28 in^2]$

$= 0.85 * 4 (384 - 5.28) + 60 \times 5.28$ $\quad A_g = 384 in^2$

$= 1604$ kips.

$\therefore P_u = \varepsilon \varphi P_n$

$= 0.80 * 0.65 * 1604$

$= 834$ kips Ans.

3/ Determine the number of bags of cement required to cast two 30 ft long spanbeams if the beam section is 12"×18" and mix ratio is 1:1.5:3.

Soln:

Wet volume $= 2 \left(30 \times \frac{12}{12} \times \frac{18}{12}\right) = 90\, ft^3$

Dry volume $= 1.5 \times 90 = 135$ cft

$\therefore$ cement $= \frac{1}{5.5} \times 135 = 24.55$ cft ~ 19.64

$= 20$ bags Ans

4/ Calculate the velocity of a trapezoidal section if the discharge is 11.25 m^3/sec, side slope 1:1, bottom width 6m, depth of flow 1.5 m.

Soln:

$$A = bh + sh^2 = 6 \times 1.5 + 1 \times 1.5^2 = 11.25 \text{ m}^2$$

$$\therefore V = \frac{Q}{A} = \frac{11.25}{11.25} = 1 \text{ m/s}$$ Ans.

5/ 25 mm dia circular disk is on the base of a swimming pool of depth 2.5m, width 3m. find the force on the circular disk, $g = 9.8 \text{ m/s}^2$.

Soln:

$$P = wA\bar{x}$$

$$= 9800 \times \frac{\pi}{4} \times (.025)^2 \times 2.5$$

$$= 12.03 \text{ N}$$ Ans.

6/ What is ESAL? Determine ESAL for 1 million repetition.

Ans: The traffic characteristics are determined in terms of the number of repetitions of 18,000 Lb single axle load applied to the pavement on two sets of dual tires. This is usually referred to as ESAL.

$$\therefore ESAL = 1 \times 10^6 * 18000$$

$$= 1.8 \times 10^{10}$$

Ans.

(7) Initial & final dissolved oxygen in a BOD bottle after 3 days is 7 mg/L and 3 mg/L. K = 0.2/day. Determine BOD in 5 days and ultimate BOD.

Sol^n: Let, 1 mL sewage is diluted to 20 mL by adding water

$\therefore BOD_3 = (D_{oi} - D_{o3}) DF$

$= (7-3)\frac{20}{1} = 80 \text{ mg/L}$

$\therefore BOD_3 = L_o(1 - e^{-kt})$

$\Rightarrow 80 = L_o(1 - e^{-0.2 \times 3})$

$\Rightarrow L_o = 177.31 \text{ mg/L}$

$\therefore BOD_5 = L_o(1 - e^{-kt})$

$\Rightarrow BOD_5 = 177.31(1 - e^{-0.2 \times 5})$

$= 112.08 \text{ mg/L}$ Ans.

8/ Write down the name of tests (two for each) of Rebar, Asphalt & Aggregates.

Ans:

Rebar:

①

②

Asphalt:

① Specific gravity test

② Solubility test

Aggregates:

① Loss angles abrasion test.

② Aggregate impact value test.

③ Aggregate crushing value test.

(7) Initial & final dissolved oxygen in a BOD bottle after 3 days is 7 mg/L and 3 mg/L, K = 0.2/day. Determine BOD in 5 days and ultimate DOD.

Sol^n: Let, 1 mL sewage is diluted to 20 mL by adding water

$\therefore BOD_3 = (DO_i - DO_3)\,DF$

$= (7-3)\frac{20}{1} = 80 \text{ mg/L}$

$\therefore BOD_3 = L_o(1 - e^{-kt})$

$\Rightarrow 80 = L_o(1 - e^{-0.2*3})$

$\Rightarrow L_o = 177.31 \text{ mg/L}$

$\therefore BOD_5 = L_o(1 - e^{-kt})$

$\Rightarrow BOD_5 = 177.31(1 - e^{-0.2*5})$

$= 112.03 \text{ mg/L}$ Ans.

8/ Write down the name of tests (two for each) of Rebar, Asphalt & Aggregates.

Ans:

Rebar:

①

②

Asphalt:

① Specific gravity test

② Solubility test

Aggregates:

① Loss angles abrasion test

② Aggregate impact value test.

③ Aggregate crushing value test.

ERL - 2017

1/ Determine the shear stress of a rectangular beam having shear V & x-sectional dimension b x h ?

soln:

$$\tau = \frac{VQ}{Ib} \qquad I = \frac{bh^3}{12}$$

$$Q = A'\bar{y} = \left(b * \frac{h}{2}\right) * \frac{h}{4} = \frac{bh^2}{8}$$

$$= \frac{V * bh^2 * 12}{8 * bh^3 * b}$$

$$= \frac{3V}{2bh}$$ Ans.

2/ Two-lane two-way highway street having ADT 4000. If the commercial vehicle is 45% and loads 27 kips, calculate ESAL for commercial vehicles in one direction?

soln:

$$ESAL = \left\{\left(\frac{27}{18}\right)^4 * 0.45 * ADT\right\}/2$$

$$= 4556$$ Ans.

3/ Have to disinfect 1×10^6 liter of water, having chlorine 0.5 ppm, bleaching powder contains 25% of chlorine. Determine the amount of bleaching powder required to disinfect water.

soln: Available Cl_2 in $Ca(OCl)Cl$ is 25%

∴ 1 kg of Cl_2 is available in 4 kg of $Ca(OCl)Cl$

we know, 1 mg/l of Cl_2 = 3.79 kg of Cl_2 / million gallon

∴ Amount of bleaching powder / million gallon

$$= 4 \times 3.79 = 15.16 \text{ kg}.$$

$$\therefore \text{Amount of } Ca(OCl)Cl = 15.16 * \frac{1 \times 10^6}{1 \times 10^6 * 3.78} * 0.5$$

$$= 2 \text{ kg}$$ Ans

4/ Write down the standard sieves in mm. Test for fine aggregate sample 25% retain on 1.18, 0.6mm, 0.425mm, 0.3mm sieve. Find FM

Soln:

S.S.	Wt retained (%)	Cum. wt retained (%)
(#16) 1.18	25%	25%
(#30) 0.60	25%	50%
(#40) 0.425	25%	75% → (Ans)
(#50) 0.30	25%	100%
(#100) 0.15	–	100%

$$\therefore FM = \frac{25 + 50 + 100 + 100}{100} = 2.75$$ Ans

Standard sieve:

75mm, 37.5mm, 18.75mm, 9.375mm, 4.75mm, 2.375mm, 1.18mm, .6mm, .3mm, .15mm

5/ Test for bitumen, cement, bricks.

Ans: Bitumen:

① sp. gr. test ② softening point test
③ solubility test ④ Ductility test.

Cement:

① Initial setting time test
② Normal consistency of cement.

Brick:

① Water absorption test
② Compressive strength test.

BWDB-2076

1/ A canal commands an irrigation area of 100 ha. The duty of water on the field during the peak period is 220 ha/cumec. Determine the design discharge of the canal at the off-take if the water loss in canal 30%?

Ans:

$$\text{Discharge} = \frac{\text{Area}}{\text{Duty}} = \frac{100}{220} = 1.82 \text{ m}^3/\text{s}$$

$$\text{Design Discharge} = \frac{1.82}{0.7} = 2.60 \text{ m}^3/\text{s}$$ Ans.

2/ The value of total direct runoff volume of catchment 6×10^3 m^3. If rainfall depths in 8 cm and 0.5 is the runoff co-efficient. Determine the catchment area in km^2.

Soln: We know,

$$\text{Co-efficient of runoff} = \frac{\text{Runoff volume}}{\text{Rainfall volume}}$$

$$\Rightarrow 0.5 = \frac{6 \times 10^3}{\text{Rainfall depth} \times \text{Catchment Area}}$$

$$\Rightarrow \text{Catchment Area} = \frac{6 \times 10^3}{\frac{8}{100} \times 0.5}$$

$$= 150 \times 10^3 \text{ m}^2$$

$$= 0.15 \text{ km}^2$$ Ans.

3/ The field capacity and moisture content at time of irrigation are 27% and 19% respectively. The apparent specific gravity is 1.3 and root zone depth is 100 cm. Determine the time required to irrigate 2 ha with a flow of 60 l/s if the water application losses is 20%.

Soln: Readily available moisture = 80% of A M

= 80% of 17

= 15.2

$$CMC = FC - R.A.M$$

$$= 27 - 15.2$$

$$= 11.8\%$$

$$Y = \frac{\gamma_d}{\gamma_w}(FC - CMC)$$

$$= 1.3 \times 1 (.27 - .118)$$

$$= 0.197 \text{ m}$$

639

$Q = 60$ l/s , Q (after loss) $= 60 - (.2 \times 60) = 48$ l/s
$= 0.06\ m^3/s$
$= 0.048\ m^3/s$

$t = 2.3 \frac{Y}{f} \log \frac{Q}{Q - fA}$ | $f = \frac{0.048}{2 \times 10^4}$ $\left[f = \frac{Q}{A}\right]$

$= 2.3 \frac{.1976}{2.4 \times 10^{-6}} \log \frac{.06}{.06 - 2.4 \times 10^{-6} \times 2 \times 10^4}$ $f = 2.4 \times 10^{-6}$

$= 132961.62$ s

Ans.

4/ What is best hydraulic section. Prove that the hydraulic section of a triangle is ½ of a rectangle.

Ans: → Khata

5/ The river Ganga flows bank full of rate is 2500 m^3/s. Find i) Hydraulic Geometry ii) Scour depth. Bed material size is 0.15 mm.

Sol^n: Hydraulic Geometry: $f = 1.76 \sqrt{d_{mm}} = 1.76\sqrt{.15} = 0.68$

① $V = \left(\frac{Qf^2}{140}\right)^{1/6} = 1.42$ m/s

② $A = \frac{Q}{V} = 1760.56\ m^2$

③ $P = 4.75 \sqrt{Q} = 237.5$ m

④ $R = \frac{5}{2} \frac{V^2}{f} = 7.41$ m ⟶ A/P করলেও হবে

⑤ $S = \frac{f^{5/3}}{3340\, Q^{1/6}} = 1.27 \times 10^{-5}$

Scour depth

$d_s = .47 \left(\frac{Q}{f}\right)^{1/3}$

$= 7.25$ m

6/ In a field hole, cut off volume 1.1 ft^3 and the wet mass of the hole is 130 lb and dry mass in 119 Lb. Determine the degree of saturation if sp gr. is 2.7?

Soln:

$$w = \frac{130-119}{119} * 100 = 9.24\%$$

$$\gamma_d = \frac{119}{1.1} = 108.18 \ lb/ft^3$$

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

$$= \frac{2.7 \times 62.4}{108.18} - 1$$

$$= 0.557$$

$$\therefore S = \frac{w G_s}{e} = \frac{.0924 \times 2.7}{.557} * 100 = 44.79\%$$ Ans.

7/ If co-efficient of dynamic viscosity, $\mu = 1 \ N\text{-}s/m^2$ and velocity distribution, $v = 0.9 - y^2$, Determine the shear stress in $y = 0.45$

Soln:

$$V = 0.9 - (0.45)^2$$

$$= 0.6975$$

$$\tau = \mu \frac{v}{y} = 1 * \frac{0.6975}{.45} = 1.55 \ N/m^2$$ Ans.

8/ The value of dimensionless effective stress is 0.045. Find the effective velocity, the value of incipient depth of a wide river channel with the bed sediment size 0.2mm with longitudinal river bed slope 0.0001. Assume other data.

Soln:

9/ The value of peak of a 6-h flood hydrograph is 35 m^3/s and constant base flow is 10 m^3/s. If the rainfall depth is 3.25 cm and infiltration rate is 0.125 cm/h. Determine peak of 6-h unit hydrograph and runoff co-efficient.

Soln:

peak of DRH = 35 − 10 = 25 m^3/s

Rainfall excess = 3.25 − .125 × 6 = 2.5 cm

peak of 6-h unit hydrograph = $\frac{25}{2.5}$ = 10 m^3/s.

Co-efficient of runoff = $\frac{\text{Runoff}}{\text{Rainfall}}$

= $\frac{2.5}{3.25}$ = 0.77 Ans.

10/ A pile having embedded length of 100 ft and diameter 24" and unconfined compression strength is 2000 psf. Determine the ultimate capacity of pile, $\alpha = 0.5$.

Soln:

$Q_u = Q_p + Q_s$

$= 9 C_u A_p + \alpha C_u A_{surface}$

$= 9 \times \frac{2000}{2} * \frac{\pi}{4} * \left(\frac{24}{12}\right)^2 + 0.5 * \frac{2000}{2} * \pi D * 100$ ($\frac{24}{12} = 2'$)

= 342433.6 lb = 342.43 Kips Ans.

11/ An engineer checking the speed characteristics of confidence level 95%, acceptable limit 1.0 km/h and 130 spot-speed variance 25 km/hr. Has the engineer meet the entire requirement?

Soln.

$N = \frac{Z^2 s}{e^2} = \frac{1.96^2 * 25}{1^2}$ [$Z = 1.96$ for 95%]

= 96 < 130

So, Engineer meets the requirement.

12/ A rectangular channel 6 m wide and discharge 1200 l/s of water into a 6m wide apron with zero slope with a mean velocity of 16 m/s what is the height of jump?

Soln. $Q = 1.2\ m^3/s$, $v = 16\ m/s$, $A = \frac{Q}{v} = 0.075\ m^2$

$\therefore y_1 = \frac{A}{b} = \frac{0.075}{6} = 0.0125\ m$

$\therefore F_1 = \frac{v}{\sqrt{g y_1}} = 45.69 > 9 \rightarrow$ strong jump

$\frac{y_2}{y_1} = \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right) = \frac{1}{2}\left(\sqrt{1+8\times 45.69^2} - 1\right)$

$\Rightarrow y_2 = 64.12 \times 0.0125 = 0.801$

$\therefore$ Height of jump $= y_2 - y_1 = 0.78897\ m$ Ans.

13/ A pipe lying at a head of 525 m one end P and other end Q at elevation is 581 m and diameter at P 50 mm and 75 mm at Q. If pressure at P is $100\ KN/m^2$. Determine the pressure at Q if head loss 1 m.

Soln

$$z_1 + \frac{P_1}{\gamma} + \frac{v_1^2}{2g} = z_2 + \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + h_f$$

$$\Rightarrow 525 + \frac{100}{9.81} + \frac{35.71^2}{2\times 9.81} = 581 + \frac{P_2}{9.81} + \frac{19.45^2}{2\times 9.81} + 1$$

$\Rightarrow P_2 = 22.1\ KN/m^2$

Ans.

$A_P = \frac{\pi}{4} \times \left(\frac{50}{1000}\right)^2 = 1.91 \times 10^{-3}\ m^2$

$A_Q = \frac{\pi}{4} \times \left(\frac{75}{1000}\right)^2 = 3.34 \times 10^{-3}\ m^2$

$Q = 70\ lit/s = 0.07\ m^3/s$

$v_1 = \frac{Q}{A_P} = 35.71\ m/s$

$v_2 = \frac{Q}{A_Q} = 19.23\ m/s$

14/ A directional sign is needed. Highway turnoff 85th percentile speed is 50 mph, vehicle turn at design speed 25 mph, car travel at 50 mph during perception and reaction time, using perception and reaction time 1.5 sec to read & understand the sign and deaccelerate (braking) at 0.3 g. What is the minimum distance the directional sign should be placed in advance of the turn off?

Soln,

$$S = 1.47Vt + \frac{V^2 - v^2}{30f}$$

$$= 1.47 * 50 * 1.5 + \frac{50^2 - 25^2}{30 \times .3}$$

$$= 318.58 \text{ ft}$$

Ans,

15/

18/ (i) The value of porosity of a soil sample is 30%, what is the void ratio of the sample?

soln: $n = 0.3$, $e = \frac{n}{1-n} = \frac{.3}{1-.3} = 0.428$

(ii) The angle of internal friction is 30°, Find active & passive earth pressure co-efficient. Ans.

soln:

$K_a = \tan^2(45 - \phi/2) = 0.333$

$K_p = \tan^2(45 + \phi/2) = 3.0$

19/ (i) Find the depth of tension crack of a soil sample having Cohesion 1000 psf and unit wt 130 pcf.

soln: Depth of tension crack, $z_c = \frac{2c}{\gamma\sqrt{K_a}}$ $[K_a = 1]$

$= \frac{2 \times 1000}{130} = 15.38$ ft Ans.

~~(ii) The value of car crash is found 40 in a 17.5 miles highway segment in one year. The ADT is 5000 vehicle.~~

(ii) 40 traffic crashes occur at 17.5 miles long section in one year. ADT of the section is 5000 vehicles. What is the rate of total crash per 100 million vehicle mile.

soln:

Rate of car crash, $R = \frac{\text{No. of crash} * (100 * 10^6)}{\text{ADT} * \text{No. of days in a year} * \text{Length}}$

$= \frac{40 * 100 * 10^6}{5000 * 365 * 17.5}$

$= 125.24$ / Hmvm

Hundred million vehicle mile

20/ 1) Racked in surface dressing
2) sandwich surface dressing.

21/ Draw four phases of bacterial growth.

Ans: → Khata.

22/ Define i) sewage ii) sewer iii) sullage
→ Khata.

23/ Factors affecting bearing capacity of shallow foundation on clay.

Ans: ~~→ Khata~~.

① Nature of the foundation
② Location of ground water table
③ size, shape & depth of foundation
④ Cohesion of soil.

24/ A rectangular beam having width 12" and effective depth 16". Using 4 - #9 bars. Check whether the beam is tension controlled or not. Determine design capacity of the beam. $f_y = 60$ ksi, $f'_c = 4$ ksi

Soln:

$$\rho_b = 0.85\beta_1 \frac{f'_c}{f_y} * \frac{87000}{87000 + f_y}$$

$$= 0.85 * 0.85 * \frac{4}{60} * \frac{87000}{87000 + 60000} = 0.0285$$

$$\rho_{max} = 0.75\,\rho_b = 0.0155$$

$$\rho = \frac{A_s}{bd} = \frac{4*1}{12*16} = 0.0208$$

$\because \rho_{max} < \rho$; So the beam is not tension controlled.

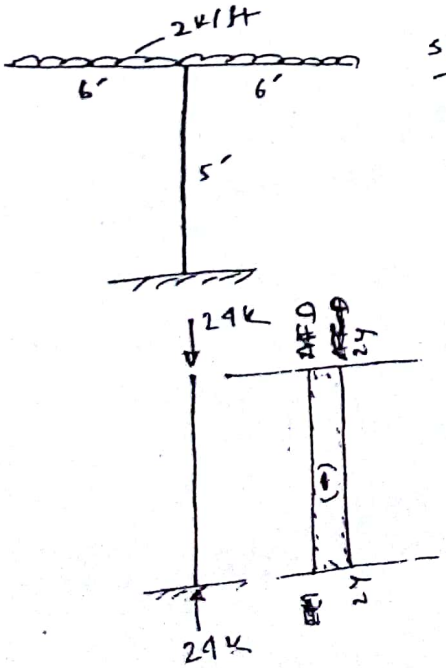
$\therefore$ Nominal moment capacity, $M_n = \rho b d^2 f_y \left(1 - .59 \frac{f_y}{f'_c}\right)$

$$= .0208 \times 12 \times 16^2 \times 60 \times \left(1 - .59 \times .0208 \times \frac{60}{4}\right)$$

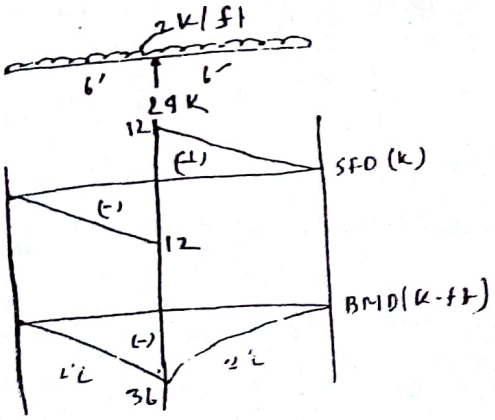
$$= 3128 \text{ K-in}$$

$\therefore M_u = \phi M_n = 0.9 \times 3128 = 2815.2$ K-in Ans.

25/ Draw SFD, BMD, AFD of the following frame.



Soln:



1/ Fill in the Gap –

(i) The value of friction angle of a soil is 30°, the active earth pressure co-efficient 0.26. ← $k_a = \tan^2(45-\phi/2)$

(ii) The D_{10}, D_{60} are given, $C_u = \frac{D_{60}}{D_{10}}$

(iii) A sieve analysis results in 100% retained in no. 50 sieve, the FM is 2.00.

(iv) PL, PI values are given, the value of LL = PL + PI.

2/ A sand layer has 8' depth, WT is at 2' below GL. The sand layer is overlying a clay layer of large depth. The moist unit wt (above WT) is 16 kN/m³, saturated unit wt of sand is 20 kN/m³ and saturated unit wt of clay is 20 kN/m³. Find the total & effective pressure at a depth of 15 ft.

Soln:

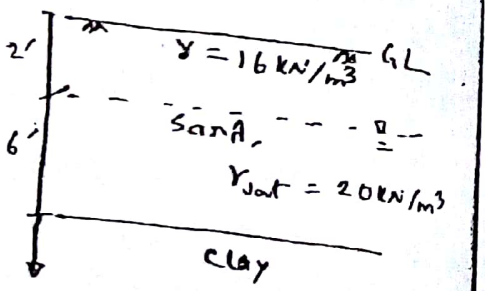
$\sigma' = 16\times2 + (20-9.81)\times6 + (20-9.81)\times7$

$= 169.97$ kN/m²

$\sigma = 16\times2 + 20\times6 + 20\times7$

$= 292$ kN/m²

Ans.



3/ The dry & moist wt of a sample is 40 lb & 50 lb. the volume of soil is 0.21 ft³. Find MC, Bulk unit wt and Dry unit wt.

Soln:

$w(\%) = \frac{50-40}{40}\times100 = 25\%$.

$\gamma_{bulk} = \frac{50}{.21} = 238.1$ lb/ft³

$\gamma_{dry} = \frac{40}{.21} = 190.5$ lb/ft³

Ans.

4/ Find the value of angle of internal friction of a soil sample which is subjected to direct shear test, 2" x 1" in size. normal force was 36 kg with a shear force at failure of 58 lb.

Soln: $\sigma = \frac{36}{4} = \frac{36 \times 2.20}{4} = 19.8$ psi

$\tau = \frac{58}{4} = 14.5$ psi, $c = 0$

we know,

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

$\Rightarrow 14.5 = 0 + 19.8 \tan\phi$

$\Rightarrow \phi = \tan^{-1}\left(\frac{14.5}{19.8}\right) = 36.22°$

Ans.

5/ The value of pH 7.5 and $CaCO_3$ alkalinity is 332 mg/L. Find the value of carbonate & bicarbonate alkalinity. and carbonate and bicarbonate concentration.

Soln: at 25°C, $K_{A_2} = 10^{-10.32}$, $K_{A_1} = 10^{-0.3}$, $[H^+] = 10^{-pH} = 10^{-7.5}$

$$\text{Carbonate alkalinity} = \frac{50,000 * \left\{\frac{\text{alkalinity}}{50,000} + [H^+] - \frac{K_w}{[H^+]}\right\}}{1 + \frac{[H^+]}{2 \cdot K_{A_2}}}$$

$$= \frac{50000 * \left\{\frac{332}{50000} + 10^{-7.5} - \frac{10^{-14}}{10^{-7.5}}\right\}}{1 + \frac{10^{-7.5}}{2 \cdot 10^{-10.32}}} = 1 \text{ mg/L}$$

$$\text{Bicarbonate alkalinity} = \frac{50000 * \left\{\frac{\text{alkalinity}}{50,000} + [H^+] - \frac{K_w}{[H^+]}\right\}}{1 + \frac{2 \cdot K_{A_2}}{[H^+]}} = 391 \text{ mg/L}$$

$\therefore$ Carbonate Concentration = 0.6 * Carbonate alkalinity = 0.6 mg/L

Bicarbonate " = 1.22 * Bicarbonate " = 403.82 mg/L

Ans.

6/ (i) The cause of hardness of water multivalent- positive cation

(ii) The OH^- is 10^{-4} mole/L, the pH is 10 $[pH + pOH = 14]$

(iii) The unit of turbidity NTU.

7/ True / false.

(i) The layer of road foundation just- above the existing ground level is wearing course. F

(ii) Stopping sight- distance only depends on vehicle speed F

(iii) The speed of vehicle instantaneous at the moment of passing a point is the design speed. F

(iv) AIV, TPF, soundness, brittleness etc. tests are of bitumen contents. F.

(v) In under developed area, meter gauges are used. T.

(vi) In Bangladesh, the ballast- used is mainly broken stone. T

(vii) The track from which the train diverts is called the main Track. T

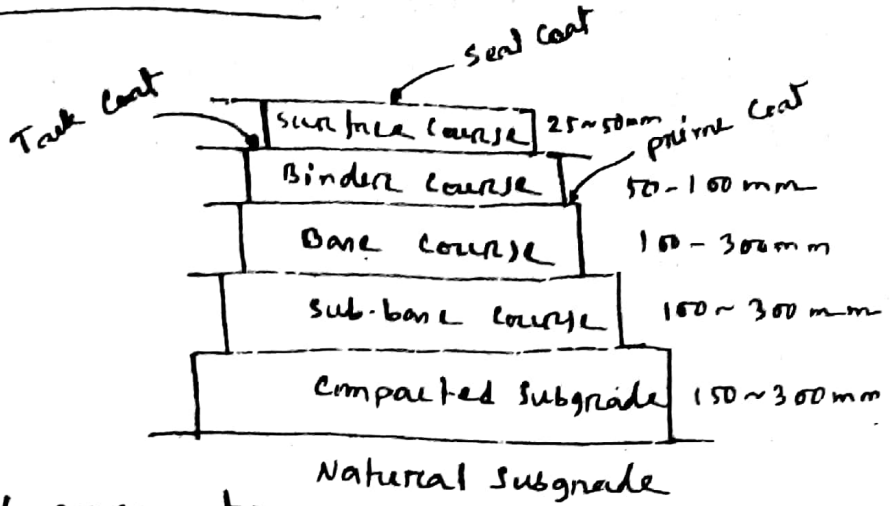
(viii) The longitudinal deformation of rail is technically known as creeping. T

(ix) The light that is used to see in fogg is green light. F.

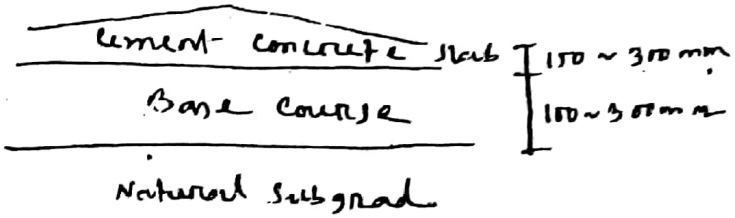
8/ Draw the x-section detailing of flexible & rigid pavement

Ans:

Flexible pavement-



Rigid pavement:



9/ The sign shape for

(i) Madatory sign - Rectangular
(ii) Cautionary sign - Round.
(iii) Information (guide) sign - Triangle.

10/ Factors affecting pavement design

Ans:

(1) Design life
(2) Reliability
(3) Traffic factors
(4) Climatic factors
(5) Subgrade strength & drainage
(6) Road geometry.
(7) Material properties.

11/ write down the difference between prime coat, tack coat & seal coat.

Soln: prime coat: A prime coat is the application of liquid bituminous materials to a previously untreated base or wearing surface.

Tack coat: A tack coat is a thin layer of asphaltic materials sprayed over an old pavement.

seal coat: It is the single application of asphaltic materials that may or may not contain aggregate. It acts as a final step in the construction of many types of bituminous wearing surface.

12/ Fill in the gap

① In RCC structure, the reinforcement is provided by tension zone.

② In slab, the short direction bar is perpendicular to the long direction bar.

③ The value of bending moment is maximum at the point where the shear force change its sign.

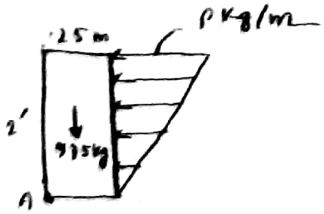
④ Brick aggregates are normally weaker than stone aggregates.

⑤ The MS steel bars are provided a grade based on yield strength.

13/ The thickness of a brick wall 250 mm, 2m in height. Find the horizontal distributed wind load for which the base shear is just negative. The unit wt of the masonry is given 1950 kg/m³

Soln:

wt of masonry = 2 × .25 × 1 × 1950
= 975 kg

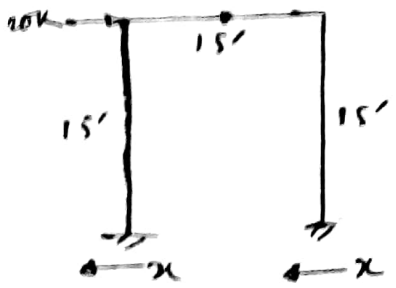


$\Sigma M_A = 0$ (+ve)

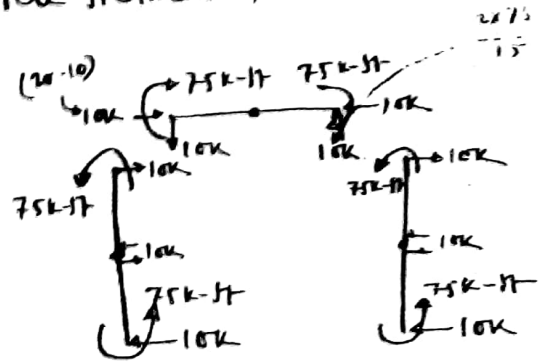
$975 \times \frac{.25}{2} - \frac{1}{2} \times 2 \times P \times \frac{2}{3} \times 2 = 0$

$\Rightarrow P = 91.4$ kg/m Ans.

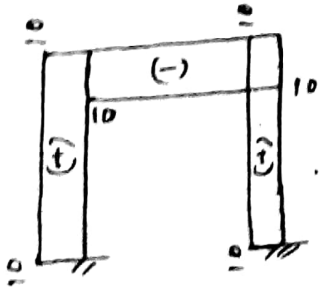
14/ Find the SFD & BMD of the frame by portal method.



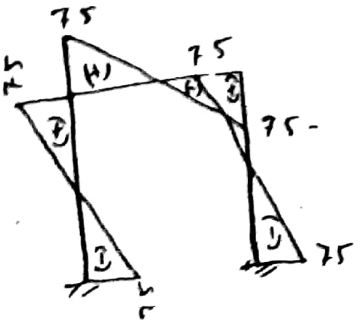
Soln:



SFD



BMD



15/ The value of f'_c is 9000 psi, f_y is 60000 psi and steel is 2% of gross area, column section is 12" x 12". Find the design ultimate axial stress of the column with zero eccentricity.

Soln: For zero eccentricity, $\alpha = 1$

$$P_u = \alpha \phi [.85 f'_c (A_g - A_{st}) + f_y A_{st}]$$

$$= 1 \times .65 [.85 \times 4 (144 - 2.88) + 60 \times 2.88]$$

$$= 386.17 \text{ kips.}$$

$A_g = 144 \text{ in}^2$

$A_s = 2\%$ of 144

$= 2.88 \text{ in}^2$

$\therefore$ Stress $= \frac{386.17}{144} = 2.68$ ksi

Ans.

DSCC - 2016

1/ Full meaning of -

Internet - Interconnected Network

WiFi - Wireless Fidelity

BIMSTEC - Bay of Bengal Initiative for Multi-sectoral Technical Economic Cooperation

BRAC - Bangladesh Rehabilitation Assistance committee

ASEAN - Association of southeast Asian Nations.

2/ A RCC footing is (10'x10'). Determine punching stress when d = 16.5" and a = 10". f_y = 60ksi, f'_c = 4ksi.

Soln:

Shear force, $V = \left\{10\times10 - \frac{(a+d)^2}{144}\right\} * \text{soil pressure}$

$= 95.12\,w$

punching area, $A_o = 4(a+d)*d = 1749\ in^2$

punching stress $= \frac{V}{A_o} = 0.0544\,w$ psi

Allowable stress, $v_o = 2\sqrt{f'_c} = 126.49$ psi

$\therefore 0.0544\,w = 126.49$

$\Rightarrow w = 2325.2$ psi

$\therefore$ punching stress, $= 0.0544\,w = 126.49$ psi Ans.

3/ If the BOD_5 at 20°c of a sewage sample is 320 mg/L. Calculate its 10 days BOD at 30°c.

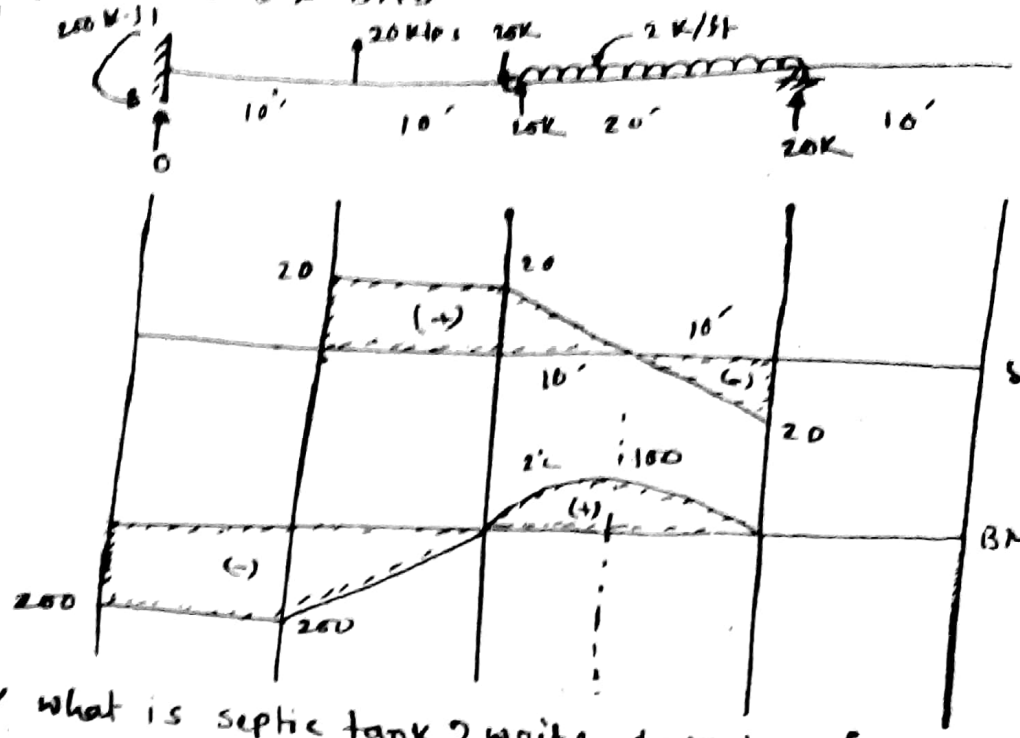
Soln. Let, $k_{20} = 0.1\ day^{-1}$

$BOD_5 = L_o(1-e^{-kt}) \Rightarrow 320 = L_o(1-e^{-.1\times5}) \Rightarrow L_o = 813.28$ mg/L

$k_{30} = k_{20}(1.047)^{T-20} = 0.1*(1.047)^{30-20} = 0.158\ day^{-1}$

$BOD_{10} = L_o(1-e^{-k_{30}t}) = 813.28\left(1-e^{-.158\times10}\right) = 696$ mg/L Ans.

3/ Draw SFD & BMD



5/ What is septic tank? write down the function of septic tank with neat sketch.

Ans: Septic tank: A septic tank is a buried, watertight receptacle designed and constructed to receive wastewater from a home.

Function:

① to seperate the solids from the liquid.
② to provide digestion of organic matter.
③ to store solid
④ to allow the clarified liquid to discharge for further treatment.

Sketch → sketch

[illegible] 2016

1/ determine the compressive strength of 6"x6" cube test having load 12,000 lb in 28 days if satisfies the ASTM C192 specification or not

Sol^n: Compressive strength = $\frac{P}{A} = \frac{12000}{6 \times 6}$ = 333.3 PSI

$= \frac{333.3}{145}$ MPa

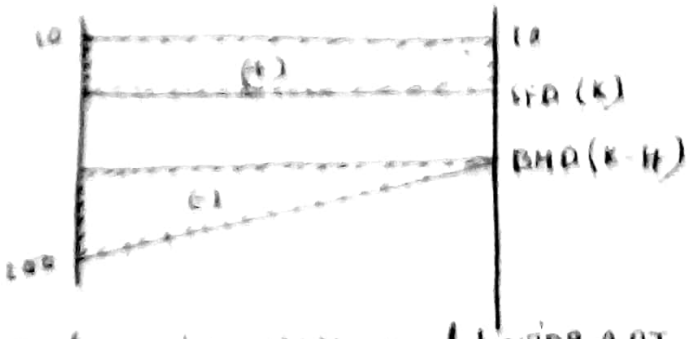
= 2.29 MPa

According to ASTM, 28 days cube compressive strength = 28 MPa

so, 2.29 MPa isn't satisfactory

2/ find the maximum shear and maximum moment in [illegible] for a 20' long cantilever beam which free end load 10 kips

Sol^n:



3/ A four lane two way road having ADT 1000 of commercial vehicle 45%. Determine the number of commercial vehicle of one way road

Sol^n: no of commercial vehicle of one way road

$= \frac{1000 \times 45}{2} = 900$ veh/day

Ans

4/ Determine the no. of brick required for a 15 m³ brick wall.

Soln: Brick size with mortar = 10" x 5" x 3"

= 25.4 cm x 12.7 cm x 7.62 cm

= 0.254 m x 0.127 m x 0.0762 m

∴ Brick required = $\frac{15}{0.254 \times 0.127 \times 0.0762}$

= 2.46 x 10³ Ans.

Brick size with mortar = 10" x 5" x 3"

= 0.0762 cft

= 2.16 x 10⁻³ m³

∴ Brick required = $\frac{15}{2.16 \times 10^{-3}}$ = 30488 nos

5/ 25.4 mm rebar yielding 120 ton. Determine the grade of rebar. Ans

Soln: $A = \frac{\pi}{4} \times \left(\frac{15.4}{25.4}\right)^2 = 0.785 \text{ in}^2$

P = 120 ton = 120 x 10³ kg = 264 kips

∴ Yield Strength = $\frac{P}{A} = \frac{264}{0.785}$ = 336 ksi

So, Grade of Steel = 300 grade.

6/ In a load brick test, the maximum compressive load 15 ton and area of brick 21.5 in². Determine the compressive strength is grade.

Soln: Compressive strength = $\frac{P}{A} = \frac{15 \times 10^3 \times 2.2}{21.5}$ = 1534.88 psi

The minimum compressive strength of 1st class brick not less than 2500 psi (range 5000 ~ 8000 psi)

So, the brick is 2nd class

7/ In a sieve analysis, 30% sample passing 4.75 mm sieve and 2% passing 0.075 mm sieve. Determine % of coarse, silt and clay.

soln: C.A = 70% → retained on 4.75 mm

Silt & Clay = 2% → passing 0.075 mm sieve

F.A = 100 − 72 = 28% → passing 4.75, retained .075 mm

8/ Determine the wt of cylinder, if the height of cylinder is 15 m, outside & inner dia 14 mm and 10 mm.

soln: unit wt of steel = 490 lb/ft^3 = 7850 kg/m^3

volume of cylinder = $\pi \left\{ \left(\frac{d_o}{2}\right)^2 - \left(\frac{d_i}{2}\right)^2 \right\} * h$

$= \pi \left(\frac{.014^2 - .010^2}{4} \right) * 15$

$= 1.131 * 10^{-3}$ m^3.

∴ wt of cylinder = $1.131 * 10^{-3} * 7850$

= 8.88 kg Ans.

9/ Beam having dimension 1' × 1', maximum moment 100 k-ft. Find max^m bending & max^m shear stress.

soln:

$\sigma_{max} = \frac{Mc}{I}$

$= \frac{100 * 0.5}{\frac{1*1^3}{12}} = 600$ k/ft^2

$\tau_{max} = \frac{3}{2} \frac{V}{A}$

$= \frac{3}{2} \frac{V}{1 \times 1}$

$= 1.5 V$

Ans.

10/ If a raft foundation is 10m x 10m. Its depth 5m and undrained cohesion 44 KN/m², F.S = 2, N_c = 7.0. What is the allowable bearing pressure?

Sol^n:

$$q_u = N_c c_u \left(1 + \frac{1}{N_c}\frac{B}{L}\right)\left(1 + 0.4\frac{D}{B}\right) + \gamma D$$

$$= 7 * 44\left(1 + \frac{1}{7}\frac{10}{10}\right)\left(1 + 0.4\frac{5}{10}\right) + 19 \times 5$$

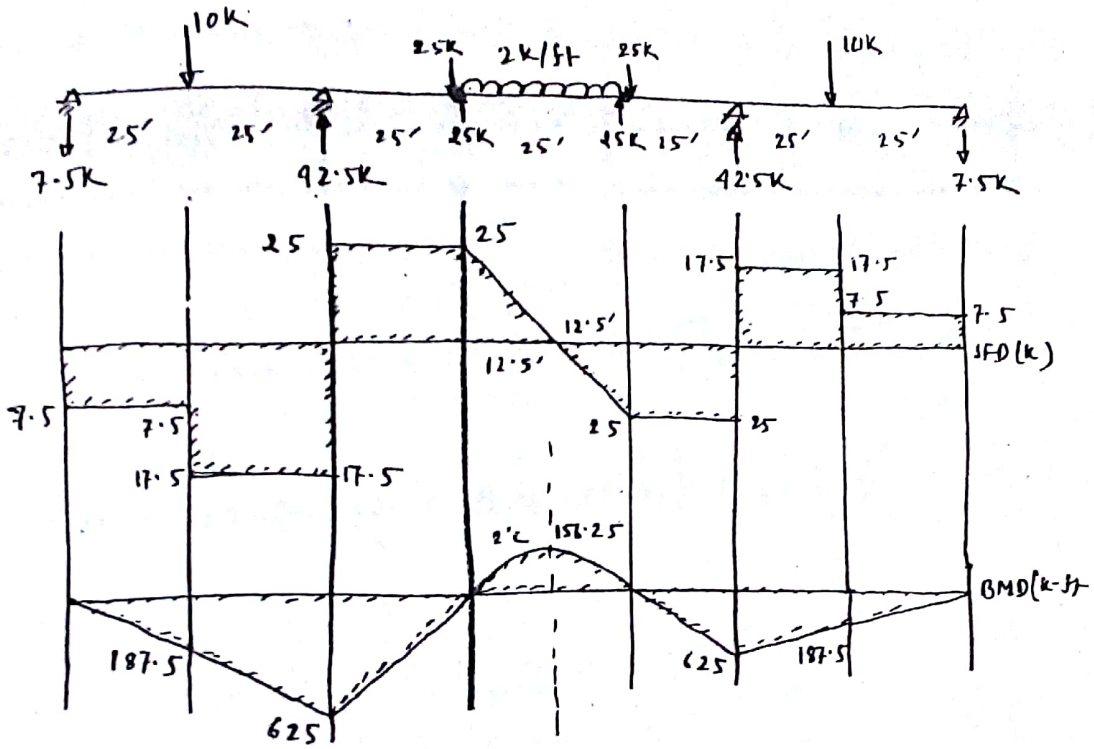
$$= 517.4 \text{ KN/m}^2$$

$$q_{all} = \frac{q_u}{FS} = \frac{517.4}{2} = 258.7 \text{ KN/m}^2$$

Ans.

BWDB - 2014

1/ DRAW SFD & BMD



2/ A square footing (2.5m x 2.5m) is to be placed on a homogenous clay layer at 3m depth. The load on footing base from corresponding column is 50 KN. Determine net pressure on the base.

Soln: Let, unit wt of soil = 19 KN/m³

$$\therefore \text{net pressure at base} = \frac{50}{2.5 \times 2.5} + 19 \times 3$$

$$= 65 \text{ KN/m}^2$$

3/ The unconfined compression of the soil is 50 kPa. Determine the depth of excavation without any lateral support.

Soln:

$$\text{Depth of excavation} = \frac{4c}{\gamma\sqrt{K_a}}$$

$$= \frac{4\times 25}{16\sqrt{1}}$$

$$= 6.25\ m$$

Ans.

$c = \frac{50}{2} = 25$ kPa

$\phi = 0$

$K_a = \tan^2(45 - \phi/2)$

$= 1$

$\gamma = 16\ KN/m^3$

4/ The sequent depth ratio of a hydraulic jump in a rectangular channel is 16.48. Find froude no. at the beginning of jump & type of jump.

Soln:

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

$$\Rightarrow 16.48 = \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right)$$

$$\Rightarrow F_1 = 12 > 9$$

So, Jump is strong jump.

5/ Determine the skin friction capacity of a cast in situ bored RCC pile of dia 20" & length 50 ft in a homogenous sand layer. The top of pile is at 10ft below the ground surface. Unit weight at saturated condition 120 pcf and angle of friction 30°. GWT is at ground surface.

Soln:

6/ A canal commands an irrigation area of 950 ha. The peak field irrigation requirement is 9 mm/day. Determine the design discharge of the canal at the off-take, water loss is 25%.

Soln: Total water requirement $= \frac{9}{1000} * \frac{350 \times 10^4}{24 \times 3600} = 0.361\ m^3/s$

Design discharge $= \frac{0.361}{0.75} = 0.485\ m^3/s$

7/ The CBR values are calculated after every kilometer on selected 10 km having same type of soil. The values are 3.2, 3.8, 2.8, 4.5, 3.9, 4.2, 2.8, 4.7, 4.0 and 4.5%. Find the average CBR, Standard deviation and design CBR values for 50% and 85% reliability.

Soln: Avg. CBR, $\bar{x} = \frac{3.2+3.8+2.8+4.5+3.9+4.2+2.8+4.7+4.5+4.0}{10}$

$= 3.84\%$

Standard deviation, $s_0 = \sqrt{\frac{\sum_{i=1}^{n}(x-\bar{x})^2}{n-1}}$

$= \sqrt{\frac{.64^2+.04^2+1.04^2+0.66^2+.06^2+.36^2+1.04^2+.86^2+.66^2+.16^2}{10-1}}$

$= 0.659$

CBR at 50% reliability $= \bar{x} - k_x s_0$

$= 3.84 - 0 \times .659$

$= 3.84\%$

CBR at 85% reliability $= \bar{x} - k_x s_0$

$= 3.84 - 1.062 \times .659$

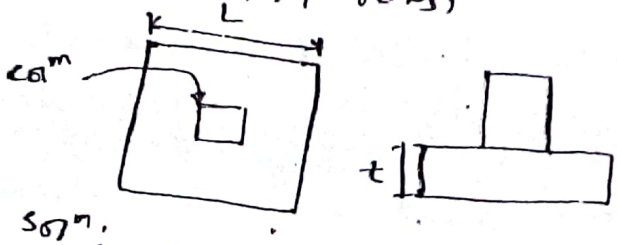
$= 3.14\%$

Reliability	k_x
50%	0
80%	0.842
90%	1.282
95%	1.695

For 85% reliability, $k_x = .842 + \frac{1.282 - .842}{10} * 5$

$= 1.062$

8/ For the footing shown in figure, calculate the ultimate punching shear capacity. If L = 10 ft, a = 12", t = 20", f'_c = 3 ksi, f_y = 60 ksi;



Soln:

$d = 20 - 3 = 17''$

perimeter, $b_o = 4(a+d)$

$= 4(12+17) = 116''$

∴ shear capacity $= \phi 4\lambda \sqrt{f'_c}\, b_o d$

$= 0.75 \times 4 \times 1 \times \sqrt{3000} \times 116 \times 17$

$= 324032.67$ lb

$= 324.04$ kips Ans.

RRI - 2015

1/ What is clear cover? Why it is used?

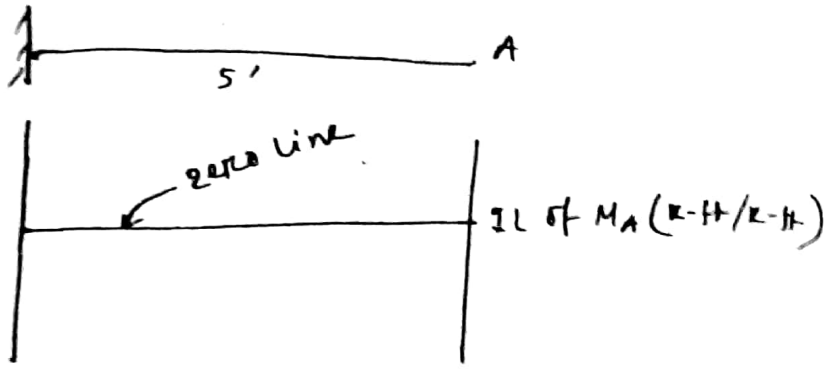
Ans: Clear Cover: The distance between the outer face of the stirrup to the finished concrete surface is called clear cover.

Uses:

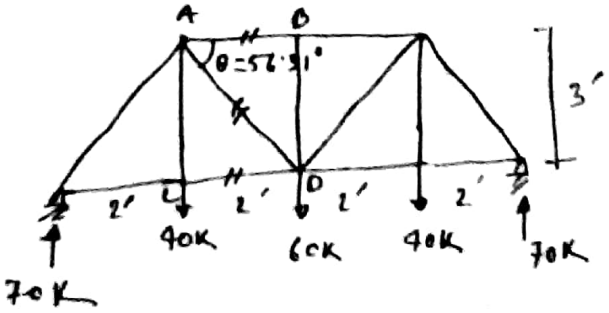
① To protect the reinforcement from weathering effect and corrosion.

② To provide thermal insulation.

2/ Draw IL for moment at A.



3/ Determine the member force which is marked.



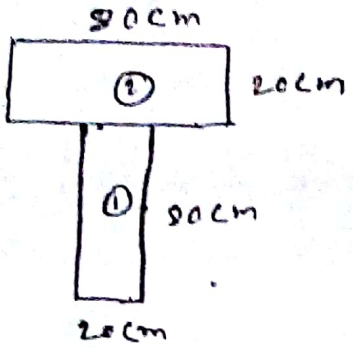
AB = 36.06 K (T)

AB = -66.67K = 66.67 K (C)

CD = 46.67 K (T)

Ans.

4/ Determine cg and moment of inertia for the following structure.



Soln:

$$\bar{y} = \frac{20\times80\times40 + 20\times80\times90}{20\times80 + 20\times80}$$

$$= 65 \text{ cm from bottom.}$$

$$I_x = \frac{20\times80^3}{12} + (20\times80)\times(65-40)^2 + \frac{80\times20^3}{12} + 20\times80\times25^2$$

$$= 2.907\times10^6 \text{ cm}^4$$ Ans.

5/ A 10' simply supported beam, applied distributed load 1 K/ft above the beam. If size of beam 10"x10", find the maximum bending & shear stress.

Soln:

$$V_{max} = \frac{wl}{2} = \frac{1\times10}{2} = 5K, \quad I = \left(\frac{10\times10^3}{12}\right)/12^4 = 0.040188 \text{ ft}^4$$

$$M_{max} = \frac{wl^2}{8} = \frac{1\times10^2}{8} = 12.5 \text{ K-ft},$$

$$\therefore f_{max} = \frac{Mc}{I} = \frac{12.5\times\frac{5}{12}}{.040188} = 129.6 \text{ K/ft}^2$$

$$\therefore \gamma_{max} = \frac{3}{2}\frac{V}{A} = \frac{3}{2}\times\frac{5}{\frac{10}{12}\times\frac{10}{12}} = 10.8 \text{ K/ft}^2$$ Ans.

6/ Write down the design factor for flexible pavement.

Ans:

① Design life ② Reliability ③ Traffic factors
④ Climatic factors ⑤ Road geometry.
⑥ Subgrade soil strength & drainage.
⑦ Material properties.

7/ A box plate is constructed with brass and steel material. X-sectional area of brass & steel are 6 cm² & 4 cm². Length & unit wt of brass and steel 1 m, 900 kN/m³ and 4 m, 900 kN/m³ respectively. Determine total elongation of this composite bar if applied load is 45 kN.

Soln:

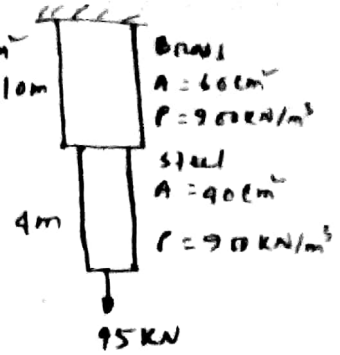
$W_B = \rho A L$, let, $E = 200\ GPa = 200 \times 10^6\ kN/m^2$

$= 900 \times 6 \times 10^{-3} \times 1$

$= 5.4\ kN$

$W_S = 900 \times 4 \times 10^{-3} \times 4$

$= 14.4\ kN$



$\therefore \delta_B = \frac{PL}{AE} = \frac{(5.4+45) \times 1}{6 \times 10^{-3} \times 200 \times 10^6}$

$= 8.25 \times 10^{-4}\ m$

$\therefore \delta_S = \frac{(14.4+45) \times 4}{4 \times 10^{-3} \times 200 \times 10^6} = 2.97 \times 10^{-4}\ m$

$\therefore \delta_T = \delta_B + \delta_S = 1.122 \times 10^{-3}\ m$ Ans.

8/ Write down the 6 point of BRT (Bus Rapid Transit).

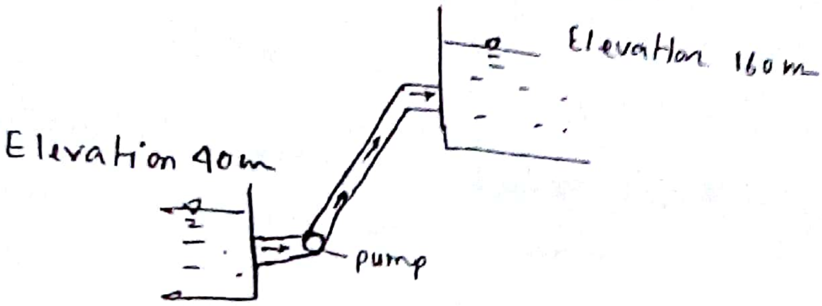
Soln:

9/ Write down the distress of flexible pavement and maintenance.

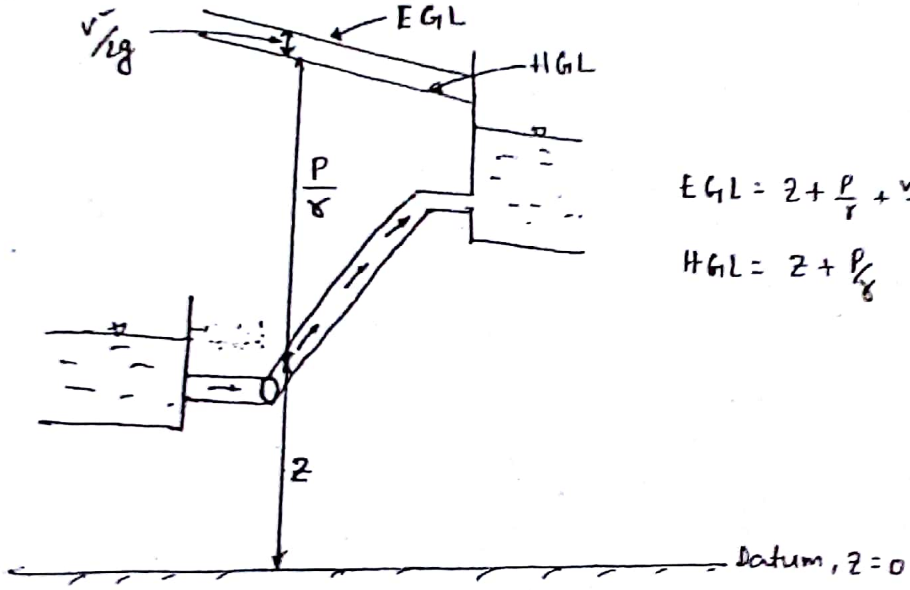
10/ What is SPT - 'N' value? How to collect it?

Note: For pipe flow, datum ধরে centre of pipe হতে z,
For channel " , " " bottom of channel হতে z

11/ Draw HGL & EGL for the figure.

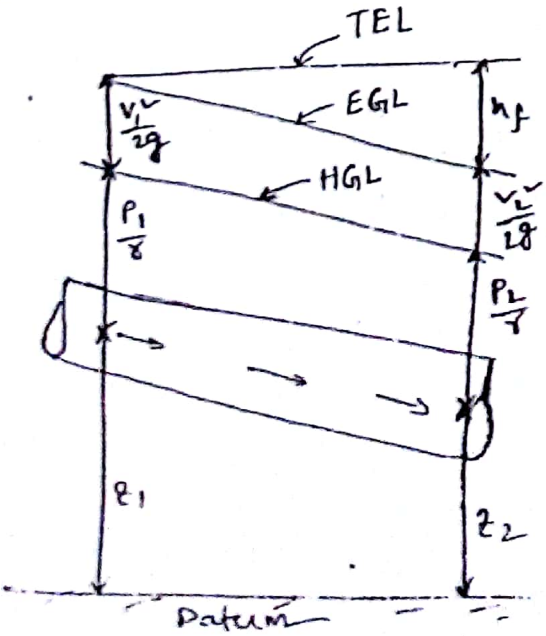


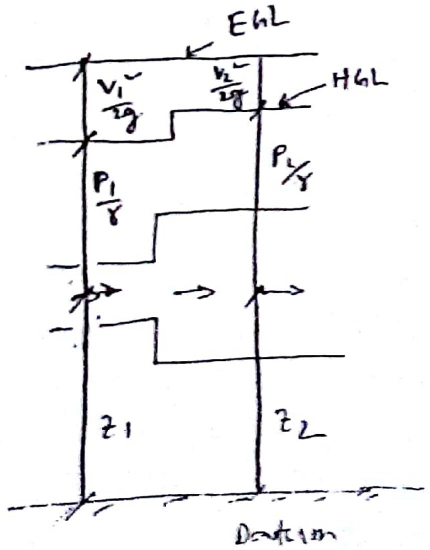
Soln:

① 

$EGL = z + \frac{P}{\gamma} + \frac{v^2}{2g}$

$HGL = z + P/\gamma$

② 

③ 

DESE 2015

1/ A coal power plant uses 10 ton coal which contains 1% of sulphur. Determine the mound of SO_2 emission.

Soln:

2/ DO_i = 3.6 mg/l, DO_5 = 2.6 mg/l, DF = 0.6. Find BOD_5, BOD remaining as ultimate BOD.

Soln.

$$BOD_5 = (DO_i - DO_5) * DF$$
$$= (3.6 - 2.6) * 0.6$$
$$= 0.6 \text{ mg/L} \quad \text{Ans.}$$

Let, $K = 0.1/\text{day}$.

$$BOD_5 = L_o(1 - e^{-kt})$$

$$L_o = \frac{BOD_5}{1 - e^{-0.1 \times 5}} = 1.53 \text{ mg/L} \quad \text{Ans.}$$

$$L_t = L_o e^{-kt}$$
$$= 1.53 \times e^{-0.1 \times 5}$$
$$= 0.93 \text{ mg/L} \quad \text{Ans.}$$

3/ Population of two individual years 1990 and 2000 is 200000 & 300000 respectively. Determine the population at 2010. Also. if one day demanded water disinfect in a volume of this water is 25 ml and amount of chlorine used in 0.396 mg/L. Determine amount of bleaching powder.

Soln.

$$r_2 = \sqrt[n]{\frac{P_2}{P_1}} - 1 = \sqrt[10]{\frac{3}{2}} - 1 = 0.0414$$

$$P_n = P_p(1+r)^n = 300000 + (1+0.0414)^{10} = 450088$$

4/ Water flows through a pipe having dia of 10", flow is in given pipe 50 m³/s, Find the water discharge in Litre/sec.

Soln:

$d = 10'' = 0.2541\ m$

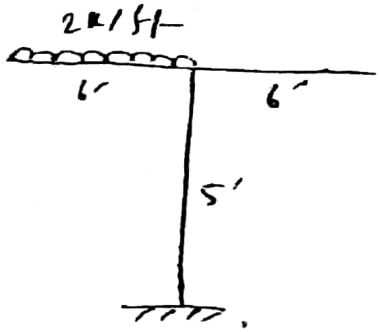
$$Q = av$$

$$= \frac{\pi}{4} \times (0.2541)^2 \times 50$$

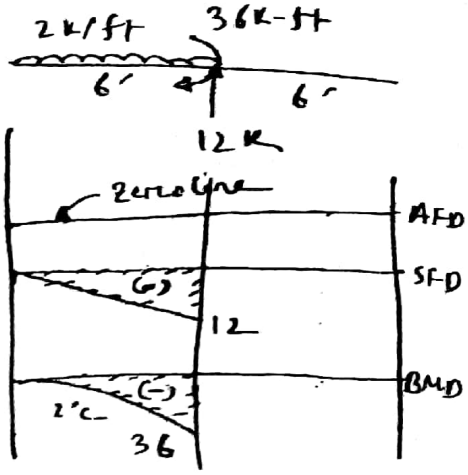
$$= 2.535 m^3/s$$

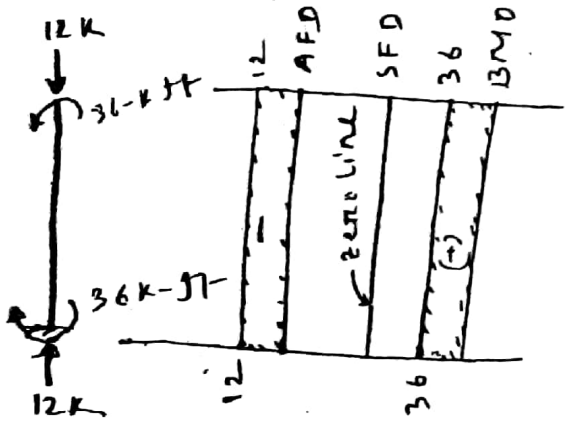
$$= 2535\ Lit/s$$ Ans.

5/ Draw AFD, SFD, BMD for the frame



Soln:





6/ Footing size 2m x 2m and having the depth of foundation is 1m, if take for c-φ soil, $c = 18\ KN/m^2$, $\gamma = 18 KN/m^3$, $\phi = 35°$, $N_c = 57.7$, $N_q = 14.4$, $N_\gamma = 42.4$. Find bearing capacity.

Soln:

$$q_u = 1.3 c N_c + q N_q + .4 \gamma B N_\gamma$$

$$= 1.3 \times 18 \times 57.7 + (18 \times 1) + 14.4 + .4 \times 18 \times 2 \times 42.4$$

$$= 2219.94\ KN/m^2$$

Ans.

7/ Determine the ultimate bearing capacity of a strip footing 1.2 m wide, depth of foundation is 1.5 m. take c-soil, $c = 30 KN/m^2$, $\gamma = 20 KN/m^3$, $\phi = 0$, $N_c = 5.14$, $N_q = 1.0$ & $N_\gamma = 2.4$

Soln: For c-soil, the third term $\frac{1}{2}\gamma B N_\gamma = 0$

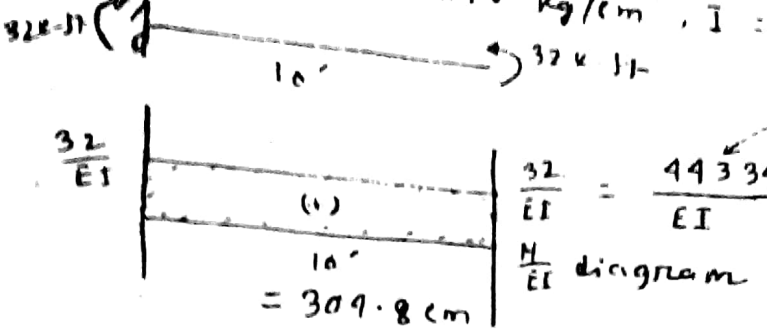
$$q_u = c N_c + q N_q$$

$$= 30 \times 5.14 + (20 \times 1.5) \times 1 = 184.2\ KN/m^2$$

Ans.

8/ Using moment Area method find deflection in a 10' cantilever beam. $E = 2 \times 10^6$ kg/cm², $I = 10^5$ cm⁴

Soln:



$$\therefore \delta_{max} = \frac{443345 \times 304.8 \times \frac{304.8}{2}}{EI}$$

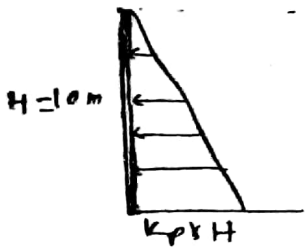
$$= \frac{2.06 \times 10^{10}}{2 \times 10^6 \times 10^5}$$

$$= 0.10298 \text{ cm}$$ Ans.

9/ Determine the passive pressure on a sheet pile 10m height if the soil retaining has following properties.
$\phi = 35°$, $\gamma = 19$ KN/m³.

Soln:

$$K_p = \tan^2(45 + \phi/2) = 3.69$$



$\therefore$ passive pressure $= \frac{1}{2} K_p \gamma H^2$

$= \frac{1}{2} \times 3.69 \times 19 \times 10^2$

$= 3505.5$ KN per m width of wall.

10/ An engineer checking the speed characteristics confidence level 95%, acceptable limit 1.0 KM/h. and 130 spot speed variance 25 (km/hr). Determine the sample size to conduct a survey

Soln:

$$N = Z^2 \frac{S}{e^2} = \frac{1.96^2 \times 25}{1^2}$$ | Z = 1.96 for 95%

$= 96$ Ans:

11/ A car saw a crash in front of it. If the drivers stopped the car 5m infront of the crash find the distance it has traveled. perception time = 2.5 sec.

12/ A rectangular beam has width of 12" and effective depth 17.5". It is reinforced with 4-#9 bars in one row. $f_y = 60$ ksi, $f'_c = 4$ ksi, what is the ultimate moment capacity of the beam? Also check what would be the ϕ value?

13/ Find the moment using moment distribution method.

EI = Constant

Sol^n:

Joint →	A	B
Member →	AB	BA
D.F →	0	1
F.E.M →	-12.5	12.5
B.M →	0	-12.5
COM →	-6.25	0
B.M. →	0	0
	Σ = -18.75	Σ = 0

$$M_{F_{AB}} = -\frac{wL^2}{12}$$
$$= -12.5 \text{ K-ft}$$

$$M_{F_{BA}} = \frac{wL^2}{12}$$
$$= 12.5 \text{ K-ft}$$

$\therefore M_A = -18.75$ K-ft

$= 18.75$ K-ft (↻)

IWBA - 2013

1/ What is pH ? Find the $[OH^-]$ concentration for pH = 10

Ans: pH : pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14

$$pH + pOH = 14 \Rightarrow pOH = 4$$

$$\Rightarrow -\log[OH^-] = 4$$

$$\Rightarrow [OH^-] = 10^{-4}$$

2/ Find Q when velocity 20m/sec and dia of pipe 18 cm. Ans.

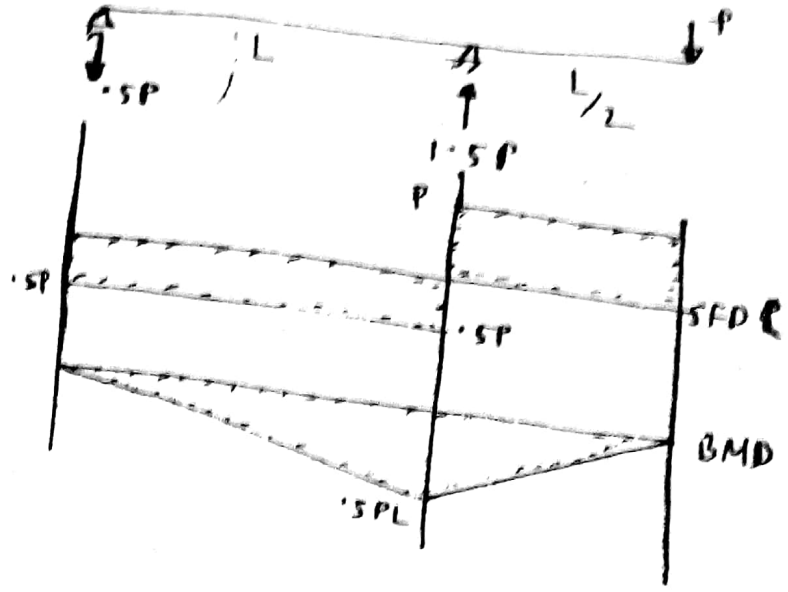
Soln:

$$Q = AV$$

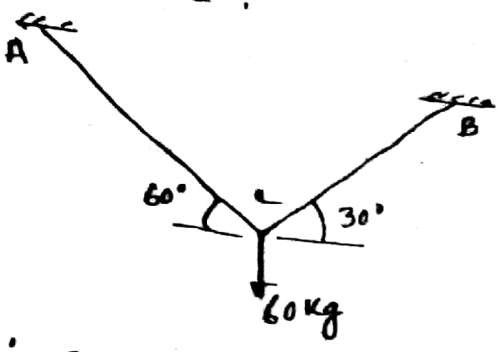
$$= \frac{\pi}{4}(0.18)^2 \times 20 = 0.51\ m^3/s$$ Ans.

3/ DRAW SFD and BMD for the following diagram.

Soln.



4/ Find the FAC & FBC.



Soln:

$F_{AC}\cos 60° = F_{BC}\cos 30° \Rightarrow F_{AC} = \sqrt{3}\, F_{BC}$

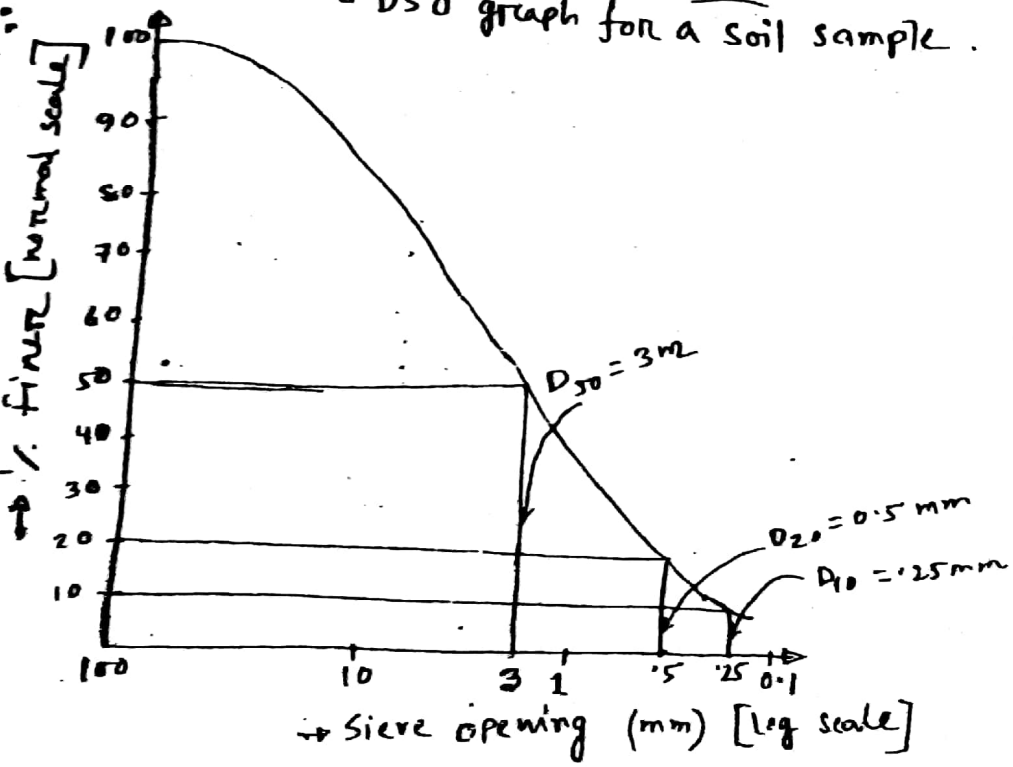
$F_{AC}\sin 60° + F_{BC}\sin 30° = 60$

$\Rightarrow \frac{3}{2} F_{BC} + \frac{1}{2} F_{BC} = 60 \Rightarrow F_{BC} = 30$ kg.

$\therefore F_{AC} = 51.96$ kg

5/ Draw D10, D20 and D50 graph for a soil sample. Ans.

Ans:



6/ Find the maximum stress of a rectangular beam having size 10" x 20" and bending moment of that beam 80 K-ft

Soln: $\sigma_{max} = \frac{Mc}{I} = \frac{80 \times \left(\frac{20}{2\times12}\right)}{\frac{\frac{10}{12} \times \left(\frac{20}{12}\right)^3}{12}} = 207.36 \text{ K/ft}^2$ Ans.

7/ Find the vertical effective stress and total stress in a depth of 8 m, where the unit wt of saturated soil 18 KN/m³ and unit wt of water 9.81 KN/m³

Soln:
$$\sigma' = (18 - 9.81) \times 8 = 65.52 \text{ KN/m}^2$$
$$\sigma = 18 \times 8 = 144 \text{ KN/m}^2$$

8/ Design a sedimentation tank for 3 hours concentration period with discharge 125 lit/hr. Where the ratio of height, breadth and length 1:1:3.

Soln:
$$T = \frac{V}{Q}$$
$$\Rightarrow V = QT$$
$$\Rightarrow 3H^3 = 0.125 \times 3$$
$$\Rightarrow H = 0.5 \text{ m}$$

So, length $= 3 \times 0.5 = 1.5$ m

Let,
Height = H
Breadth = H
Length = 3H
$Q = 0.125 \text{ m}^3/\text{hr}$

∴ Height x Breadth x length $= 0.5\text{m} \times 0.5\text{m} \times 1.5$ m Ans.

9/ Flow modulus of a city is given for 25% area is 2.84, for 50% area is 3.12, for 15% area is 1.342, for 10% area is 1.82. Find the combined flow modulus of the city.

Soln:

Combined flow modulus $= \frac{25 \times 2.84 + 50 \times 3.12 + 15 \times 1.342 + 10 \times 1.82}{100}$

$= 2.6533$

Ans.

10/ ADT = 20000 veh/day find design hourly volume assume K = 0.1.

Soln:

DHV = ADT × D × K

= 20000 × 0.55 × 0.1

= 1100 veh/hr

| D = Directional distribution factor = 55% to 80%

21/ Calculate the total settlement of compressible soil stratum 2m depth and Co-efficient of volume compressibility 0.2 cm²/kg under a pressure increment of 2 kg/cm².

Ans.

Soln:

$S = m_v \Delta P H$

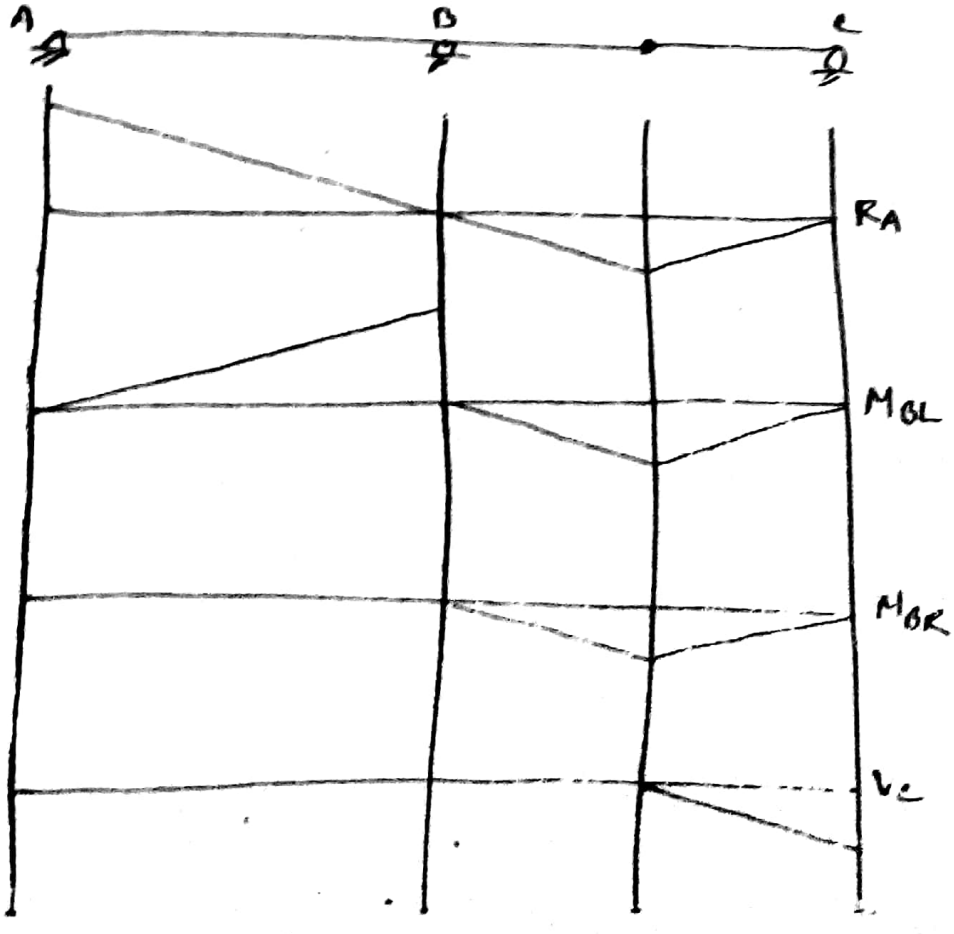
$= 0.2 \times 2 \times 200$

$= 80$ cm

| H = 2m = 200 cm

Ans.

12/ Draw a qualitative influence line of reaction at A. Moment at B and shear at e point.



14/ The dry density of a soil is 1.58 gm/cc. If the saturation water content is 50% then what would be it saturated density and submerged density.

soln: Let, $G_s = 2.7$

$$\gamma_d = \frac{G_s \gamma_w}{1+e} \Rightarrow e = \frac{G_s \gamma_w}{\gamma_d} - 1 \Rightarrow e = \frac{2.7 \times 1}{1.58} - 1 = 0.709$$

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e} = \frac{(2.7 + .709) \times 1}{1 + .709} = 1.99 \text{ gm/cc}$$

$$\gamma' = \gamma_{sat} - \gamma_w = 0.99 \text{ gm/cc}$$

15/ Calculate hydraulic head for a quick condition soil. Its thickness 1.5m, specific gravity = 2.67 and void ratio = 0.67?

Ans

soln:

16/ Write the sanitary significance of Fluoride & chloride.

Chloride:

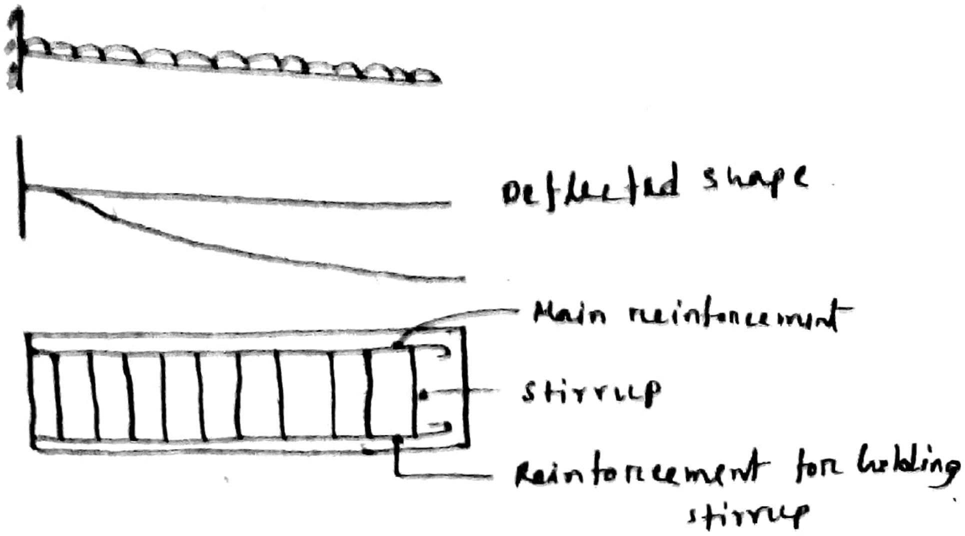
1) It gives salty taste to water.
2) High chloride concentrations are corrosive to metals.
3) It contributes to high blood pressure when present in excess.
4) Higher chloride content in water indicates sewage pollution.

Fluoride: (SI: 0.5~1.5 mg/L)

1) Fluoride content more than 4mg/L may cause bone disease.
2) It causes discoloration of teeth when present between 2~4 mg/L

DWASA - 2019

1/ Draw the deflected shape and show the reinforcement of the following beam.



2/ Compute the maximum tensile stress of the beam (I section with web (10"x10") and flange (20"x5")).

3/ Express the bearing capacity equation and describe the term.

Ans:

① Tarzaghi's equation: ② Meyerhof ③ Hansen's verie. - বা -

~~① ...~~

equation - গুলো বই থেকে দেখবে।

4/ void ratio and volume of soil is given 0.876 and $40\,cm^3$. Determine the amount of volume of void and volume of solids.

Soln:

void ratio, $e = \dfrac{V_v}{V_s}$ $\Rightarrow V_s = \dfrac{V_v}{.876}$

$V = 40\,cm^3$

$\Rightarrow V_s + V_v = 40\,cm^3 \Rightarrow \dfrac{V_v}{.876} + V_v = 40$

$\Rightarrow V_v = 18.68\,cm^3$. Ans.

$\therefore V_s = V - V_v = 21.32\,cm^3$

Ans.

5/ Determine the rain water availability for a roof area $5\,cm \times 5\,cm$, intensity 25 cm/yr and co-efficient of runoff 0.70.

Soln:

$Q = CIA = 0.70 \times 25 \times (5 \times 5)$

$= 437.5\,cm^3/yr$

Ans.

6/ Fill in the gaps:

① The ratio of volume of void and volume of total mass is called porosity.

② The ratio of inertia force and viscous force is called Reynold's Number.

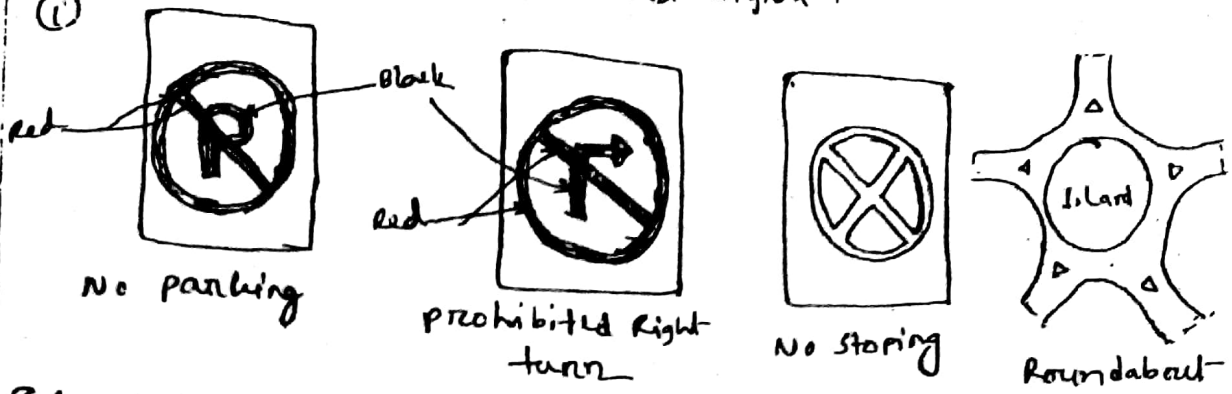
3) Distance between tube well & latrin ≥ 10 m.

4) Compressive strength of M15 concrete 15 MPa

5) If temperature increases the dissolved oxygen is decreases.

7/ Draw the following road signal.

①



8/ What is acid rain? Impact of acid rain.

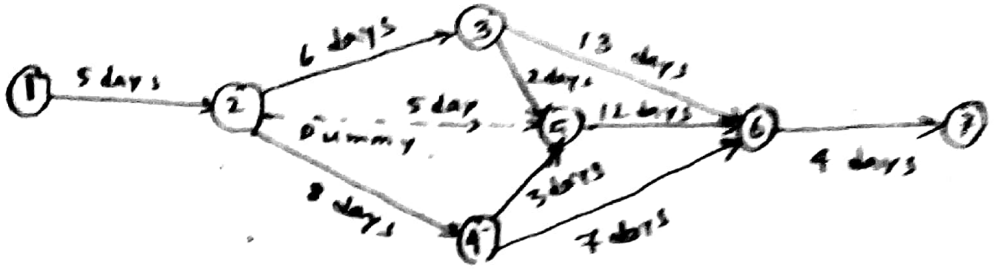
Ans: It is a broad term that includes any form of precipitation with acidic components such as H_2SO_4, HNO_3 that fall to the ground from the atmosphere. This is due to the emission of SO_2 and NO_2 into the atmosphere.

Impacts:

① It causes corrosion of metals.
② It makes the surface water acidic.
③ It causes headaches and irritations of nose, throat and eyes.
④ It decreases the pH of soil & water.
⑤ It kills plants & trees.

9/ Compute the Critical path for the given problem?

Soln:



Soln: path

1 - 2 - 3 - 5 - 6 - 7 , project completion = 29 days

1 - 2 - 3 - 6 - 7 , " " = 28 days

1 - 2 - 5 - 6 - 7 , " " = 26 days

1 - 2 - 4 - 5 - 6 - 7 , " " = 32 days

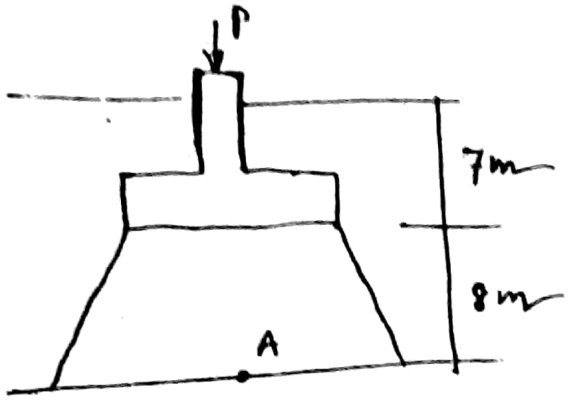
1 - 2 - 4 - 6 - 7 , " " = 29 days.

So, 1 - 2 - 4 - 5 - 6 - 7 is the critical path.

10/ Determine the sewage BOD_5 in the following data. A sample having 25 ml sewage water to dilute in 300 ml $D_i = 8.7$, $D_f = 3.7$ and the dilute water seed sample $D_i = 3.7$, $D_f = 2.69$

Soln:

11/ Compute the stress at a point 'A' which is 15m below the base of the single column foundation carrying P = 250K load and size = 10ft x 10 ft.



WRGCL – 14

1/ Fill in the gap.

i) Longitudinal bars required to control torsion and provided along _____ of the beam.

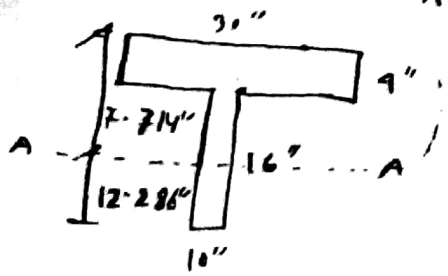
ii) In one way slab, loading are transferred in short direction.

iii) According to ACI #318-95 recommendation, wind load factor is taken equal to _____.

iv) If the crushing strength of concrete is 3780psi, its tensile strength approximately 378 psi. (10 এরপর 1 বসবে)

v) The equivalent length of a column of length L fixed at both end is 0.5L.

2/ Find the compressive stress of the bottom fiber of a T-beam subjected to a bending moment of 100 K-ft about its centroidal axis A-A.



Soln:

$$I = \frac{10\times16^3}{12} + (10\times16)(9.286)^2 + \frac{30\times9^3}{12} + (30\times9)(5.714)^2$$

$$= 10430.5 \text{ in}^4$$

$$M = 100\times12 = 1200 \text{ K-in}$$

$$c = 12.286''$$

$$\therefore \sigma = \frac{Mc}{I} = \frac{1200\times12.286}{10430.5} = 1.41 \text{ K/in}^2$$

Ans.

3/ Determine the maximum allowable axial compressive force for a 15"x20" tied column having 2.5% steel reinforcement. $f'_c = 4$ ksi, $f_y = 60$ ksi.

Soln: $A_g = 300\ in^2$, $A_{st} = \frac{2.5}{100} \times 300 = 7.5\ in^2$

$$P_{all} = \alpha\varphi[.85 f'_c (A_g - A_{st}) + f_y A_{st}]$$
$$= .80 \times .65 [.85 \times 4 (300 - 7.5) + 60 \times 7.5]$$
$$= 751.19 \text{ Kips}$$

Ans.

4/ Fill in the gap.

i) The dry density of moist soil is less than the bulk density.

ii) 10 m overburden had been removed from a site. The soil at this site is _____ consolidated

iii) Most suitable method for densification of 20 m deep loose deposit is _____

iv) Unit of force in SI unit is newton.

v) One method of reducing differential settlement of a building on sand is to _____ the size of the smallest footing

5/ a) Turbulent flow of water takes place at _____ velocities.

b) permissible limits of manganese in drinking water (ECR, 97) are _____.

c) The pH value of rain water is normally greater than 7.

d) A sewer for both storm water and sanitary sewage is called _____ sewer.

e) Recommended depth of water seal for sanitary water closets is _____ mm.

6/ A RCC footing is to be constructed 6 feet below the grade. If allowable soil pressure is 5 KSf & unit wt. of soil is 100 PCf what will be the effective soil pressure at the bottom of the footing. Footing depth is 20".

Soln:

Footing depth = $\frac{20}{12}$ = 1.67 ft.

pressure at 6' below grade = 1.67 X 150 + (6 - 1.67) X 100

= 683.5 PSf = .6835 KSf.

∴ Effective soil pressure = (5 - 0.6835)

= 4.3165 KSf. Ans.

7/ Calculate the ultimate capacity of a 24" dia pile with an embedment length of 30 feet in saturated clay. The unconfined strength of clay and the adhesion factor are 25 psi, 0.80 respectively.

Soln.

$Q_u = 9 C_u A_p + \alpha C A_{surface}$

$= 9 * \frac{25}{2} * \frac{\pi}{4} * (24)^2 + 0.8 * \frac{25}{2} * (\pi * 24 * 30 \times 12)$

= 322.33 Kips

Ans.

4.8/ Fill in the gap

i) Horizontal distance between any two contours is called horizontal equivalent.

ii) Line of collimation must be perpendicular to the axis of telescope.

iii) The top of ground on which the foundation of a road rests in called subgrade.

iv) A zebra Crossing is normally provided on a _____

v) standard size of brick 9·5"x4·5"x2·75".

BIFPCL-15

1/ In a sieve analysis the 30% of passing 4.75mm sieve and 2% passing in the 0.075mm sieve. Determine the percent of coarse, silt & clay.

soln:

Coarse aggregate = 70%

Silt & clay = 2%

2/ Determine the compressive strength of cube test having load 15 ton in 28 days. Is it satisfied the ASTM C150 specification.

soln:

$$\text{Compressive Strength} = \frac{15\times10^3\times2.20}{2\times2} = 8250 \text{ psi}$$

$$= 56.9 \text{ MPa}$$

According to ASTM C150 the value of compressive strength = 28 MPa at 28 day

so, it satisfies ASTM C150 specification.

BPDB – 15

1/ Fill in the gap.

(i) The horizontal distance between two contours is called horizontal equivalent.

(ii) The line of collimation must be perpendicular to the axis of the telescope.

(iii) primary function of sleeper is to support the rail and to distribute the loads on ballast.

(iv) Contour line is drawn through point of same RL.

(v) percentage of weare aggregate is determined by Loss Angles Abrarion Test.

(vi) permissible limit of iron in drinking water is 0·3 ~ 1 mg/L.

(vii) slump test of concrete is carry out to determine its workability.

(viii) When alum is added to water as coagulant its reduces the pH value.

(ix) Surface runoff is the quantity of water that seaked the _____

(x) A #40 slot size tube well will have an opening of $\left(\frac{40}{1000}\right)'' \times 25.4 \simeq 1\text{mm}$.

1/ True false.

(i) The upper [illegible] of the ground is called subgrade F

(ii) The allowable stress is less than breaking stress F

(iii) The maximum bending moment of simple supported beam with [illegible] load lies at point of loading T

(iv) [illegible] flexure [illegible] [illegible] only shear diagram F

2/ Calculate the SSD for highway design speed is 50 mph. Assume f = 0.42 and also assume [illegible] for [illegible] consideration.

Ans:

$SSD = 0.278\,V\,t + \frac{V^2}{254 f}$

$= 0.278 \times 80.5 \times 2.5 + \frac{80.5^2}{254 \times 0.42}$

$= 116.7$ m

Ans

We,

$t = 2.5$ s

$V = 50$ mph

$= 50 \times 1.61$

$= 80.5$ kmph

3/ Define fixture unit in plumbing system

Ans: A fixture unit is equal to one cubic foot of water drained in an $1\frac{1}{4}$ pipe over one minute. One cubic foot of water is roughly 7.48 gallons. A fixture unit is used in plumbing design for both water supply and waste water.

5/ Why removal of turbidity is essential to effective disinfection?

Ans:

Scanned by CamScanner

2/ True / False

① The upper part of the ground is called sub-grade. F

② The ultimate stress is less than breaking stress F

③ The maximum bending moment of simply supported beam with external load lies at point of loading. T

④ Contra flexure point occurs only shear diagram. F

3/ Calculate the SSD for highway design speed is 50 mp Assume, $f = 0.42$ and also required data assume for standardization.

Soln. $SSD = .278Vt + \frac{V^2}{254f}$

$= .278 \times 80.5 \times 2.5 + \frac{80.5^2}{254 \times .42}$

$= 116.7$ m Ans.

Let,
$t = 2.5$ s
$V = 50$ mph
$= 50 \times 1.61$
$= 80.5$ kmph

4/ Define fixture unit in plumbing system.

Ans: A fixture unit is equal to one cubic foot of wate drained in an $1\frac{1}{4}$ pipe over one minute. One cubic foot of water is roughly 7.48 gallons. A fixture unit is used in plumbing design for both water supply and waste water.

5/ Why removal of turbidity is essential to effectiv disinfection?

Ans:

6/ percent of void is 50%. If sp. gr of soil solid is 2. calculate submerged unit weight

soln:

$$\gamma' = \gamma_{sat} - \gamma_w$$

$$= \frac{(G_s + e)\gamma_w}{1+e} - \gamma_w \quad \Big| \; e = 0.5$$

$$= \frac{(2.1+0.5)*62.4}{1+0.5} - 62.4$$

$$= 70.72 \text{ lb/ft}^3$$

7/ Find FM and percentage of silt and clay.

Sieve size →	#4	#8	#16	#30	#50	#100	#200	pan
% of retain →	0	1	4	12	43	2	2	4
% Cum. retain →	0	1	5	17	60	62	x	x

soln:

$$\therefore \text{FM} = \frac{0+1+5+17+60+62}{100} = 1.45$$

$\therefore$ % of silt & clay = 4% [#200 passing]

8/ In an unconfined compression test sample of clay 8 cm long and 4 cm dia fails at a load 12 kg at 7% strain. Find un-drained shear strength of clay taking in account the effect of change in cross section of sample.

soln:

$$A = \frac{A_0}{1-\epsilon} = \frac{\frac{\pi}{4}*4^2}{1-0.07} = 13.51 \text{ cm}^2$$

$$q_u = \frac{12}{13.51} = 0.88 \text{ kg/cm}^2$$

$$c_u = \frac{q_u}{2} = 0.44 \text{ kg/cm}^2 \quad \text{Ans.}$$

9/ A wooden flume ($n = 0.012$) with a rectangular section of 2" wide, the flume discharge 3 ft^3/sec of water down 1% slope what is the depth of flow.

Soln:

$$Q = AV$$

$$\Rightarrow 3 = b \times y \times \frac{1.486}{n} R^{2/3} S^{1/2}$$

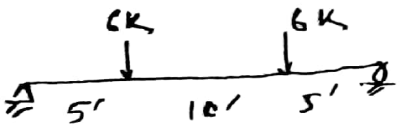
$$\Rightarrow 3 = 2 \times y \times \frac{1.486}{.012} \times \left(\frac{2y}{2+2y}\right)^{2/3} \times (.01)^{1/2}$$

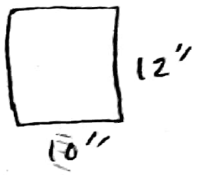
$$R = \frac{A}{P} = \frac{by}{b+2y} = \frac{2y}{2+2y}$$

$$\Rightarrow y = 0.315'$$

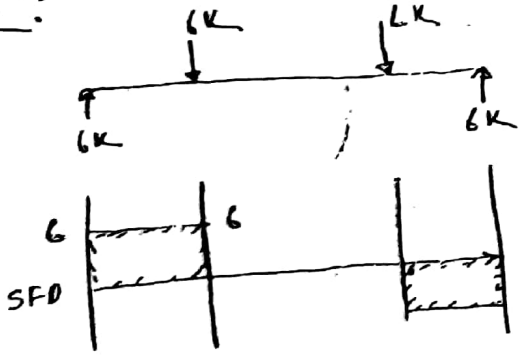
Ans.

10/ Design the shear reinforcement below the beam $f_y = 60$ ksi, $f'_c = 3$ ksi.





Soln:



$d = 12 - 1.5 = 10.5"$

$V_u = 6K$

$\phi V_c = \phi 2\lambda \sqrt{f'_c}\, b d$

$= .75 \times 2 \times 1 \times \sqrt{3000} \times 10 \times 10.5$

$= 8026$ lb

$= 8.63K$

$V_u < \phi V_c \rightarrow$ so, theoretically shear reinforcement is not required.

According to ACI code, shear reinforcement is provided for $\frac{\phi V_c}{2} = 4.3K$.

Excess shear $= 6 - 4.3 = 1.7K$.

$$\text{Spacing (\#3 bar) } s = \frac{\phi A_v f_y d}{\text{Excess shear}} = \frac{.75 \times 2 \times .11 \times 60 \times 10.5}{1.7}$$

$$= 61"$$

$s_{max} = d/2 = 5.5"$ ∴ provide #3 stirrup @ 5.5" c/c

BWDB - 18

1/ Why stratosphere is important for us? Name some harmful gases for ozone layer. Used is the obstacles in ground water exploration in Bangladesh.

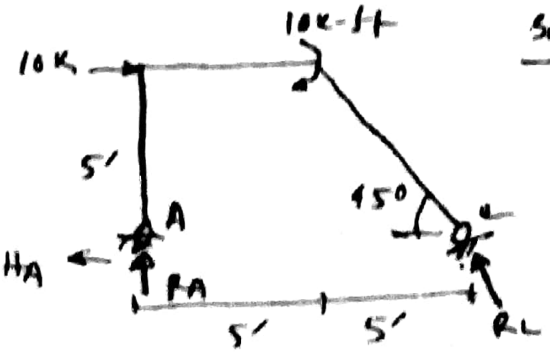
Ans: About 90% of the ozone in the Earth's atmosphere is found in the region called the stratosphere. Ozone and oxygen molecules in the stratosphere absorb ultraviolet light from the sun, providing a shield that prevents this radiation from passing to the earth surface.

Harmful gases: ①

Obstacles:

① Arsenic in ground water
② Excessive dissolved iron
③ salinity in coastal areas
④ Lowering of ground water level.
⑤ rock layer in hilly areas.

2/ Find the reaction



Soln:

$\Sigma M_A = 0$ (+ve)

$10 \times 5 + 10 - R_L \sin 45° \times 10 = 0$

$\Rightarrow R_L = 8.49K$ (↗)

$R_A = -8.49 \sin 45° = 6K$ (↓)

$H_A = 10 - R_L \cos 45°$

$= 4K$ (←)

BWDB - 18

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Ans: About 90% of the ozone in the Earth's atmosphere is found in the region called the stratosphere, Ozone and oxygen molecules in the stratosphere absorb ultra-violet light from the sun, providing a shield that prevents this radiation from passing to the earth surface.

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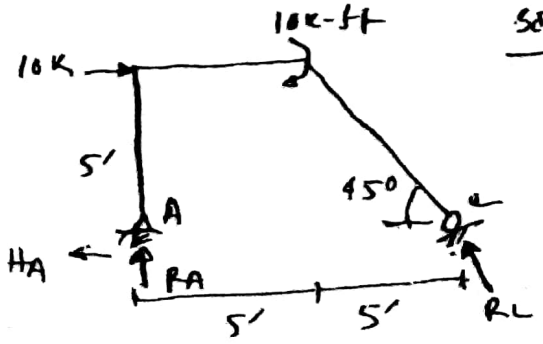


Soln:

$\Sigma M_A = 0$ (2+ve)

$10 \times 5 + 10 - R_L \sin 45° \times 10 = 0$

$\Rightarrow R_L = 8.49K$ (↗)

$R_A = -8.49 \sin 45° = 6K$ (↓)

$H_A = 10 - R_L \cos 45°$

$= 4K$ (←)

3/ A storm with 10 cm precipitation has direct runoff of 60000 m^3 in a 10 km^2 catchment area. calculate Effective rainfall and runoff co-efficient.

Soln.

Effective rainfall = $\frac{60000}{10 \times}$

4/ precipitation 9 cm, run-off 5 cm. Rainfall depth is give to five time

Time (hr)	1	2	3	4	5	6
Rainfall (cm)	.4	2.2	4	2.2	1.4	.9

Find ϕ index

Soln.

$$\phi = \frac{11.1 - 5}{6} = 1.017 \text{ cm/h}$$

For first 6 hour hour, the magnitude is less than 1.017 cm

$$\therefore \phi_{index} = \frac{11.1 - .4 - .9 - 5}{4} = 1.2 \text{ cm/h}$$

Ans.

5/ A wood of 5 kg weight floats in water, if the wood contains 60% of its volume at the time of floating. Find G_s

Soln.

Weight of wood = weight of water displaced by the immersed part of block

$$\Rightarrow V_{wood} \times \gamma_{wood} \times g = V_{water} \times \gamma_{water} \times g$$

$$\Rightarrow V_{wood} \times \gamma_{wood} = \frac{60}{100} V_{wood} \times \gamma_{water}$$

$$\Rightarrow \gamma_{wood} = \frac{60}{100} \times 1000 = 600 \text{ kg/m}^3$$

$$\therefore G_s = \frac{\gamma_{wood}}{\gamma_{water}} = \frac{600}{1000} = 0.6$$ Ans.

6/ Compressive strength test of mortar (2"x2" size)

Fill the table -

observed load (KN)	Actual load (KN)	Compressive Strength (psi)	Average (psi)
36.70	38.54	2166	2184
37.30	39.36	2209	

Soln:

(i) $2209 \times 4 = 8836$ lb $= \frac{8836 \times 9.81}{2.20 \times 1000} = 39.36$ KN

(ii) Load factor $= \frac{39.36}{37.38} = 1.05$

(iii) Actual load for 1st observation $= 36.7 \times 1.05$
$= 38.54$ KN

(iv) Comp. strength for 1st $= \left(\frac{38.54 \times 1000}{9.81} \times 2.20\right)/4$
$= 2166$ psi

GTCL-18

1. Find out the maximum loading duration of a pavement ~~and their highway~~ curve at a point if the radius of tyre = 150 mm moving at 60 km/h speed.

Soln:

$S = vt$

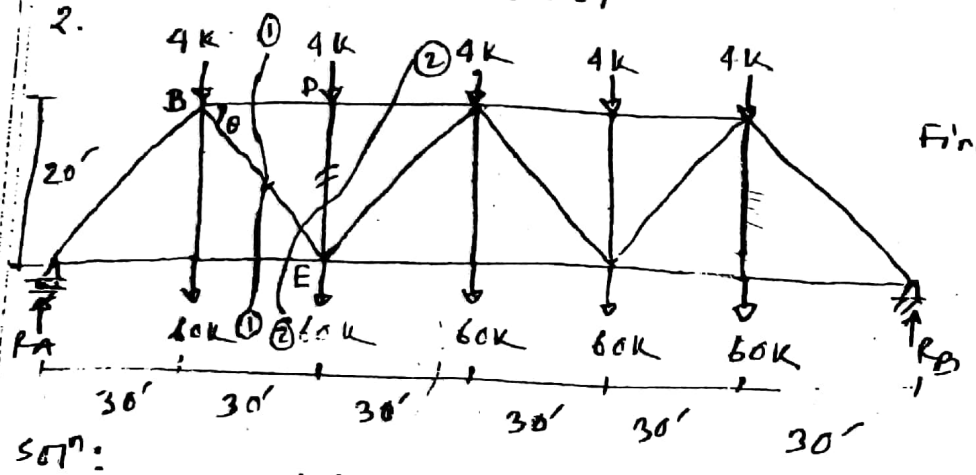
$\Rightarrow 2\pi r = vt$

$\Rightarrow t = \frac{2\pi r}{v}$

$v = \frac{60 \times 1000}{3600} = 16.667 \text{ m/s}$

$= \frac{2 \times \pi \cdot 150}{16.667} = 0.056547 \text{ sec}$ Ans.

2.



Find BE, DE

Soln:

$\theta = \tan^{-1}\left(\frac{20}{30}\right) = 33.69°$

$R_A = R_D = 160K$

$\Sigma V = 0 \ (\uparrow +) \rightarrow$ sec ①-① left

$160 - 60 - 4 - BE \sin 33.69 = 0$

$\Rightarrow BE = 173.1 \text{ K (T)}$

$\Sigma V = 0 \ (\uparrow +ve) \rightarrow$ sec ②-② left

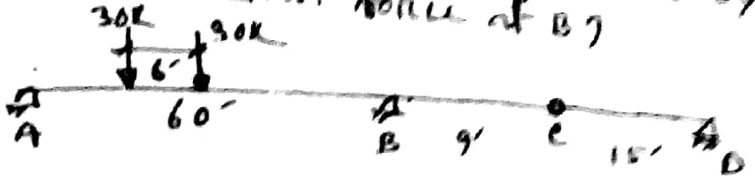
$160 - 60 - 4 - 4 - 173.1 \sin 33.69 - DE = 0$

$\Rightarrow DE = -4K$

$= 4K \ (c)$

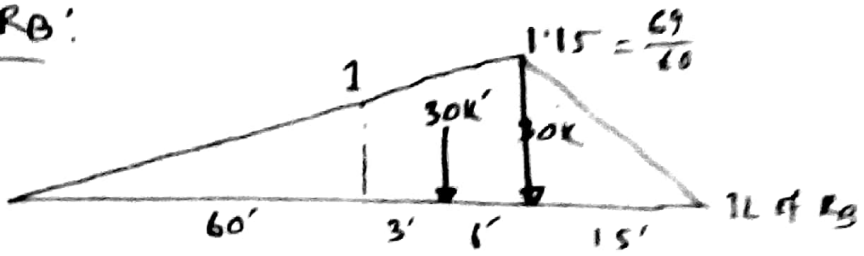
Ans.

3. If two dynamic load are moving apart by 6', find the maximum reaction force of B?



Soln:

IL of RB:

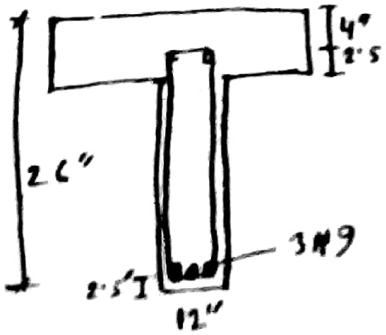


$\therefore R_B(max) = 30 \times 1.15 + \frac{1.15 \times 63}{69} \times 30$

$= 66\ K$

Ans.

4. The tennile zone X-section of a T-beam is shown. Find design capacity for tension zone only.



$f_y = 60$ ksi

$f'_c = 4$ ksi

Soln:

Effective flange width, $b = 16t + b_w = 16 \times 6.5 + 12 = 116"$

$a = \frac{A_s f_y}{.85 f'_c b} = \frac{(3\times1) \times 60}{.85 \times 4 \times 116} = .46"$, $c = a/\beta_1 = \frac{.46}{.85} = .54"$

$c < t$, it is a modified rectangular beam.

$\therefore M = \phi A_s f_y (d - a/2)$

$= .9 \times (3\times1) \times 60 (24 - \frac{.46}{2})$

$= 4174.74$ k-in

$= 347.895$ k-ft Ans.

5. Shrinkage limit = 25%, LL = 60% PL = 40%. If the volume is made from 1.53 ft^3 to 0.91 ft^3 then the water content reduces from LL to shrinkage limit. Find dry up gr. ?

Ans: Here, $\Delta w = 60 - 25 = 35\%$.

We know, $\Delta w = \frac{(v_i - v_f)\rho_w}{M_2}$

$\Rightarrow M_2 = \frac{(v_i - v_f)\rho_w}{\Delta w} = \frac{(1.53 - .91) * 62.4}{.35}$

$= 110.54$ lb.

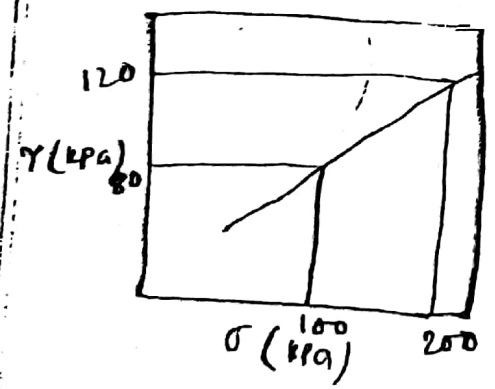
Again, $SL = \left(\frac{v_f \rho_w}{M_2} - \frac{1}{G_s}\right)$

$\Rightarrow 0.25 = \frac{.91 * 62.4}{110.54} - \frac{1}{G_s}$

$\Rightarrow \frac{1}{G_s} = 0.263 \Rightarrow G_s = 3.7$

Ans.

6.



Find c & φ

Soln:

$\tau_1 = c + \sigma_1 \tan\phi \Rightarrow 80 = c + 100 \tan\phi$ — ①

$\tau_2 = c + \sigma_2 \tan\phi \Rightarrow 120 = c + 200 \tan\phi$ — ②

② − ①

$40 = 100 \tan\phi \Rightarrow \phi = 21.8^\circ$ Ans.

$\therefore c = 40$ kPa

Ans.