TECH

6

Bashundhara

Exercise Book

Write Your Future

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Govt. Job (Technical-2)

Transportation Engineering

$SSD = Vt + \frac{V^2}{2gf}$ when, V = m/s.

For slopping,

$SSD = Vt - \frac{V^2}{2g(f \pm n)}$

For upgrade slope, n = +ve
" downgrade ", n = -ve

** $SSD = 0.278Vt + \frac{V^2}{254f}$, V = kmph, f = 0.35

** $SSD = 0.278Vt + \frac{V^2}{254(f \pm n)}$

(+ve) $OSD = d_1 + d_2 + d_3$ (For two lane two way)

$= V_b t + (V_b T + 2S) + VT$

$OSD = d_1 + d_2 = V_b t + (V_b T + 2S)$ (For two lane one way)

When, V = m/s

$OSD = 0.28 V_b t + (0.28 V_b T + 2S) + 0.28 VT$ [For two lane two way]

$OSD = 0.28 V_b t + (0.28 V_b T + 2S)$ [For two lane 1 way]

When, V = kmph.

* $T = \sqrt{\frac{4S}{a}}$

V_b = speed of overtaken vehicle
V = speed of overtaking vehicle
f = 2s
V = design speed.

The speed of overtaking and overtaking vehicles are 70 and 40 kmph respectively. On two way traffic road. If the acceleration of overtaking vehicle is 0.99 m/s².

a) Calculate safe overtaking distance.

b) Mention the minimum length of overtaking zone.

c) Draw a neat sketch of the overtaking zone and show position of sign of posts.

Solution:

a) overtaking sight distance for two way traffic

$= d_1 + d_2 + d_3$.

Assume, the speed of overtaking vehicle = A.

$V = 70$ kmph

$v = \frac{70}{3.6} = 19.4$ m/s.

$V_b = \frac{40}{3.6} = 11.1$ m/s.

$a = 0.99\ m/s^2$

$t = 2s$

$d_1 = V_b t = 11.1 * 2 = 22.2$ m

$d_2 = V_b T + 2s =$

$s = (0.7 V_b + 6) = (0.7 * 11.1 + 6) = 13.8$ m

$T = \sqrt{\frac{4s}{a}} = \sqrt{\frac{4 * 13.8}{0.99}} = 7.47s$.

$\therefore d_2 = 11.1 * 7.47 + 2 * 13.8 = 110.5\ m.$

$\therefore d_3 = VT = 19.4 * 7.47 = 144.9 m.$

$\therefore OSD = d_1 + d_2 + d_3 = 22.2 + 110.5 + 144.9$

$= 277.6 \approx 278 m.$ (Ans).

(b) Minimum length of overtaking zone =

$= 3 * OSD$

$= 3(d_1 + d_2 + d_3)$ for two way traffic.

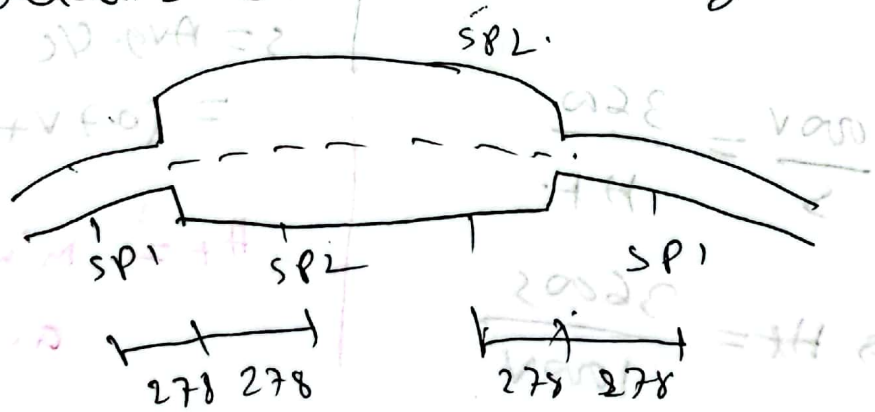
$= 3 * 278$

$= 834 m.$

$\therefore$ Desirable length of overtaking zone

$= 5 * OSD = 5 * 278 = 1390 m$

c) The details of the overtaking zone are shown



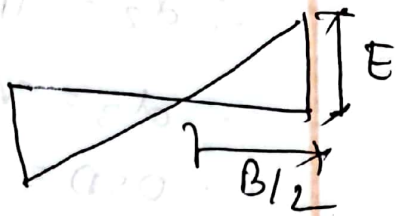
SP1 = 'Sign post overtaking zone ahead'.

SP2 = " " " End of " " ".

Rising of outer edge w.r. to E

$$e = \frac{E}{B/2}$$

$$\Rightarrow E = \frac{Be}{2}.$$



Rising of outer edge w.r. to Edge.

$$e = \frac{E}{B}$$

$$\Rightarrow E = Be.$$

Determination of theoretical capacity.

$$\# \quad C = \frac{1000V}{S}$$

$$\# \quad C = \frac{3600}{Ht.}$$

$$\therefore \frac{1000V}{S} = \frac{3600}{Ht.}$$

$$\Rightarrow Ht = \frac{3600S}{1000V}$$

$$= 3.6\frac{S}{V}.$$

Here,

C = Capacity of single lane (Vch/hr)

V = Speed of traffic (km/hr)

S = Avg. c/c spacing of vehicles

= (0.7V + L) meter.

Ht = Minimum time headway (second).

Prob: The mean free speed on a road way is found to be 80 kmph under condition, the avg. spacing between vehicle is 6.9 m. Determine the capacity of flow.

Soln:

$V_{sf} = 80$ kmph.

Jam density, $K_j = \frac{1000}{S} = \frac{1000}{6.9} = 145$ vehicle/metre.

$\therefore Q_{max} = \frac{1}{4} * V_{sf} * K_j = \frac{1}{4} * 80 * 145$

$= 2900$ veh/

#

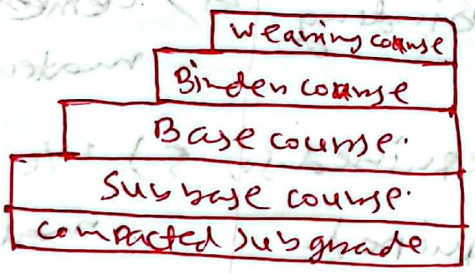


Fig: Flexible pavement.

Q. Difference between flexible pavement & rigid Pavement.

Ans:-

Flexible	Rigid.
1) Design stress is considered for 20 years.	1) ..... for 40 years.
2) Load distribution is non-uniform.	2) ... is uniform.
3) Intensity of load is very high because load distribute over a relatively small area of soil.	3) ..... low, because ..... over a wide area of soil.
4) Bitumen is the binding agent.	4) cement is the binding materials.
5) water not required. so, w/c ratio not required.	5) w/c ratio must be maintained.
6) Example: Bitumen road.	6) Example: C.C & R.C.C. road.
7) Figure.	7) Figure.

Percent Compaction: It is defined as the ratio of dry density in the field to the maximum dry density ~~of~~ in the lab by Standard Proctor test (SPT) or modified Proctor test (MPT).

$$\% \text{ compaction} = \frac{(\rho_d)_{\text{field}}}{(\rho_d)_{\max \text{ in the lab}}}$$

Water bound Macadam road:

The broken stone of base course and surface course are bounded by some stone dust in presence of water is called WBM.

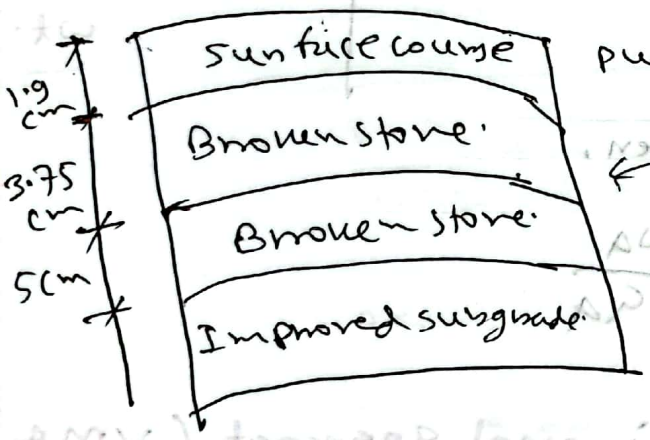


Fig: WBM

WBM = Coarse aggregate + Screening materials + Binding materials + Water

(Crushed agg. Broken stone. Oversized bricks.)

(Small agg. of coarse aggregate)

(lime, dust, stone, dust. PI < 6)

Formula:

$$G_t = \frac{100}{\frac{w_1}{g_1} + \frac{w_2}{g_2} + \frac{w_3}{g_3} + \frac{w_4}{g_4}}$$

Here, w_1, w_2, w_3 and w_4 are the percent weight of C.A., F.A., Fillers and Bitumen respectively.

g_1, g_2, g_3, g_4 are the sp. gr. respectively.

Percent air void

$$V_v = \frac{g_t - g_m}{g_m} * 100$$

g_m = Bulk density.

$$= \frac{\text{wt. in air}}{\text{wt. in air} - \text{wt. in water}}$$

Volume of bitumen,

$$V_b = g_m * \frac{w_4}{g_4}$$

Percent void in mineral aggregate (VMA).

$$VMA = V_v + V_b.$$

Percent void filled with bitumen (VFB)

$$VFB = 100 * \frac{V_b}{VMA}$$

.1

Given data:

W_1 = C.A = 52.5 %

W_2 = F.A = 35.3 %

W_3 = Filler = 6.8 %

W_4 = Binder = 5.1 %

& $G_1 = 1.37$, $G_2 = 2.78$,

$G_3 = 2.71$, $G_4 = 9.02$. $G_m = 1.07$.

Find,

$G_t = ?$

$V_v = ?$

$V_b = ?$

VMA = ?

VFB = ?

Soln:

$$G_t = \frac{100}{\frac{W_1}{G_1} + \frac{W_2}{G_2} + \frac{W_3}{G_3} + \frac{W_4}{G_4}}$$

$$= \frac{100}{\frac{52.5}{1.37} + \frac{35.3}{2.78} + \frac{6.8}{2.71} + \frac{5.1}{9.02}}$$

$$= 1.85$$

$$\therefore V_v = \frac{1.85 - 1.07}{1.07} \times 100 = 72.89\ \%$$

$$\therefore V_b = G_m \times \frac{W_4}{G_4} = 2.37 \times \frac{5.1}{9.02} = 1.34\ \%$$

$$\therefore \%\ VMA = V_v + V_b = 72.89 + 1.34 = 74.23\ \%$$

NOW, $VFB = 100 * \frac{V_b}{V_{MA}}$

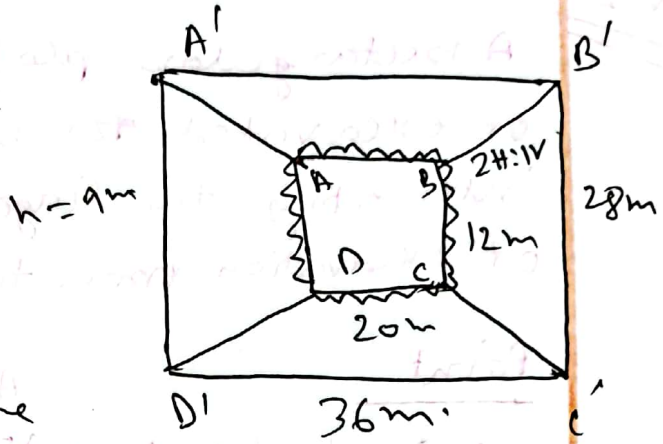
$= 100 * \frac{1.39}{16.99}$

$= 8.13\%$

Surveying

An excavation is to be made for a reservoir 20m long 12m wide at the bottom, having the side of the excavation slope 2H to 1V. Calculate the volume of excavation if the depth is 4m. The ground surface is level before excavation.

Soln:



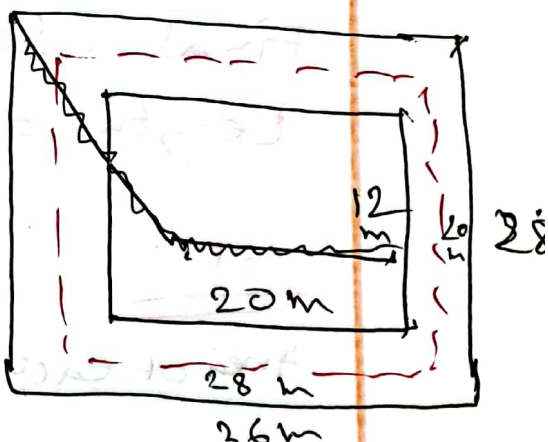
Length of reservoir at the top = L + 2sh

= 20 + 2 * 2 * 4

= 36m.

width of reservoir at the top = B + 2sh = 12 + 2 * 2 * 4

= 28m



Length of reservoir at mid height = $\frac{20+36}{2}$ = 28m.

Width a " " " height = $\frac{12+28}{2}$ = 20m.

∴ Area of bottom, A_1 = 20 * 12 = 240m²

" " top, A_2 = 36 * 28 = 1008m²

" " mid, A_m = 28 * 20 = 560m²

Apply Prismoidal rule.

$$V = \frac{h}{6}\left[A_1 + 4A_m + A_2\right]$$

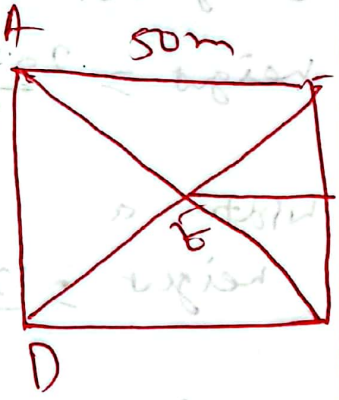
$$= \frac{4}{6}\left[240 + 4 * 560 + 1008\right]$$

$$= 2325\ m^3 \quad (Ans).$$

A rectangular plot ABCD forms the plo of excavated for road work. E is point intersecting the diagonals. Calculate the vol of excavation from the following data:

Point	A	B	C	D	E
Original level →	45.2 →	49.8 →	51.2 →	47.2 →	5
Final level →	38.6 →	39.8 →	42.6 →	40.8 →	

Length of AB = 50m & BC = 80m.



Solⁿ:

Area of each triangle $= \frac{1}{2} * 50 * 40$

$= 1000\ m^2$

Depth of cutting →

At "A" = 45.2 − 38.6 = 6.6m.

At "B" = 49.8 − 39.8 = 10.0m.

At "C" = 51.2 − 42.6 = 8.6m.

At "D" = 47.2 − 40.8 = 6.4m.

At "E" = 52.0 − 42.5 = 9.5m.

For triangular prism ABE, $h = \frac{6.6+10.0+9.5}{3}$

$= 8.7m.$

" " " BEC, $h = \frac{10+8.6+9.5}{3}$

$= 9.367m.$

" " " CDE, $h = \frac{8.6+6.9+9.5}{3}$

$= 8.167m.$

" " " DAE, $h = \frac{6.4+6.6+9.5}{3}$

$= 7.5m.$

$V = V_1 + V_2 + V_3 + V_4$ [$V = hA$]

$= (8.7 + 9.367 + 8.167 + 7.5) \times 1000$

$= 33734m^3$ (Ans).

A railway embankment is 10m wide with side slopes 1.5 : 1. Assuming the ground to be level in a direction transverse to the centre, calculate the volume contained in a length of 120m, the centre heights at 20m intervals between in metres - 2.2, 3.7, 3.8, 4.6, 3.8, 2.8, 2.5.

Soln:

$$A = (b + sh)h$$

$A_0 = (10 + 1.5 * 2.2)2.2 = 29.26 m^2$.

$A_1 = (10 + 1.5 * 3.7)3.7 = 57.59 m^2$.

$A_2 = (10 + 1.5 * 3.8)3.8 = 59.66 m^2$.

$A_3 = (10 + 1.5 * 4.6)4.6 = 64.00 m^2$.

$A_4 = (10 + 1.5 * 3.8)3.8 = 59.66 m^2$.

$A_5 = (10 + 1.5 * 2.8)2.8 = 39.76 m^2$.

$A_6 = (10 + 1.5 * 2.5)2.5 = 34.37 m^2$.

Trapezoidal rule:

$$V = d\left[\frac{A_0 + A_n}{2} + A_1 + A_2 + \cdots + A_{n-1}\right]$$

$$= 20\left[\frac{29.26 + 34.37}{2} + 57.59 + 59.66 + 64 + 59.66 + 39.76\right]$$

$\therefore V = 6258.9\ m^3$.

Prismoidal rule:

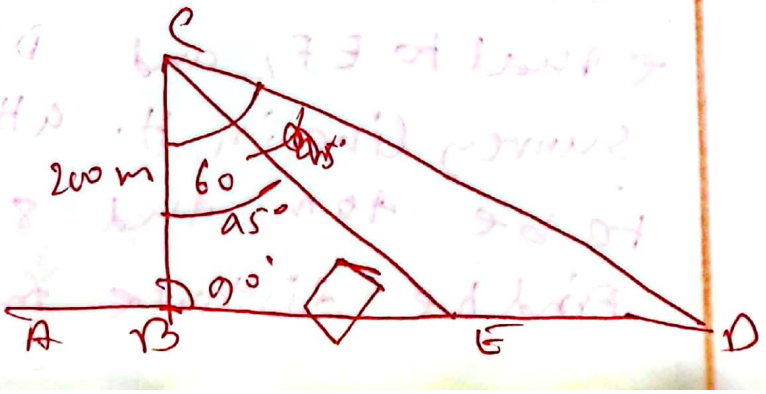
$$V = \frac{d}{3}\left[(A_0+A_n)+4(A_1+A_3+\cdots+A_{n-1})+2(A_2+A_4+\cdots+A_{n-2})\right]$$

$$= \frac{20}{3}\left[(29.26+34.37)+4(57.5+64+39.76)+2(59.6+59.66)\right]$$

$$= 6316.5\ m^3.$$

Prob-9 To contour a survey as shown in figure – BC 200m long was set out perpendicular to AB and hence Angles BCD and BCE were set out of 60° and 45° respectively. Determine the lengths which must be chained off along CD and CE in order that ED may be in AB produced. Also determine the obstructed length BE:

Soln:



From, $\triangle BCD$, $\cos 60^\circ = \frac{BC}{CD}$

$\Rightarrow CD = \frac{200}{1/2} = 400\text{m}.$

From, $\triangle BCE$, $\cos 45^\circ = \frac{BC}{CE}$

$\Rightarrow CE = \frac{200}{1/\sqrt{2}} = 282.84\text{m}$

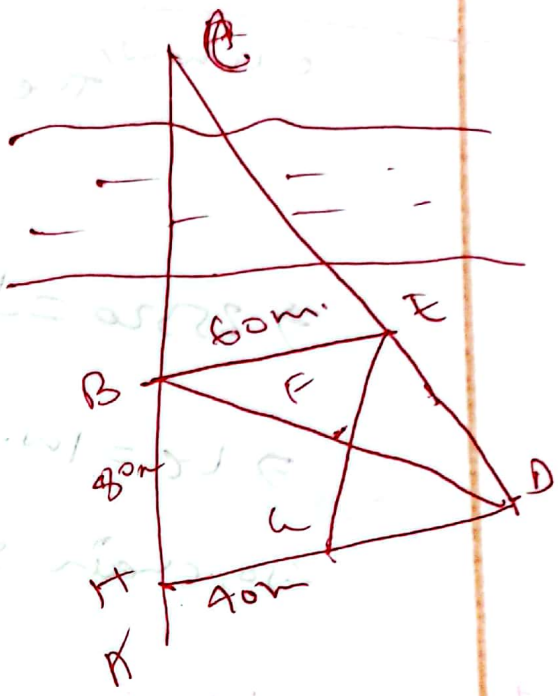
$\tan 45^\circ = \frac{BE}{BC}$

$\Rightarrow BE = 200 \times 1 = 200\text{m}.$ (Ans)

Problems

A survey line "ABC" cuts the banks of a river at B & C, and to determine the distance BC, a line BE, 60m long was set out roughly parallel to the river. A point D was then found in CE produced and middle point F of DB Determined. EF was then produced to G, making FG equal to EF, and DG produced to cut the survey line in H. GH and HB were found to be 40m and 80m long respectively. Find the distance from B to C.

Solution:



$FG = EF$

$BF = FD$

$HD = 40 + 60 = 100$ m.

From similar triangle:

CBE and CHD

$$\therefore \frac{CB}{CH} = \frac{BE}{HD}$$

$$\Rightarrow \frac{CB}{CB + BH} = \frac{BE}{HD}$$

$$\Rightarrow \frac{CB}{CB + 80} = \frac{60}{100}$$

$$\Rightarrow CB = 120$$

Prob 6 The road from Dhaka to Mirpur is actually 25 3·20′ long. This distance was measured by an engineering defective Chain and was found to be 25270′. How much correction does the chain need?

Solution:

We know, The correct length, $L = \frac{L_e}{L_c} \times$ measured length in corr.

$\Rightarrow 25320 = \frac{L_e}{100} \times 25270$.

$\Rightarrow L_e = 100.197'$

∴ So, chain should be shortened by 0.197' (Ans)

Prob-7 → The length and breadth of a plot of land were measured by an Engineers chain exactly 100' in length at the beginning. But it was found to be 100.3' long at the end of survey work. The area of the plot drawn to a scale 1" = 100'. was 25.60 in². What was the area of the plot.

Soln:

we know,

The correct area, $A = \left(\frac{L_e}{L_c}\right)^2 \times$ measured in corr. area.

$$\therefore A = \frac{(100.3)^2}{100^2} * 25.60.$$

$$= 25.70 \text{ in}^2.$$

From scale on the map.

$$1'' = 100'$$

$$\therefore 1 \text{ in}^2 = 100^2 \text{ ft}^2$$

$$\Rightarrow 25.7 \text{ in}^2 = 100^2 * 25.7 = 257000 \text{ ft}^2$$

Prob 8 A steel tape of 100' length standardized at 25 lb pull, was used in the field with a pull of 35 lbs. The cross sectional area of the tape is 0.025 in^2. Take $E = 30 * 10^6$ psi. Calculate the correction for excess pull.

Soln:

$$C_p = \frac{L(P_f - P_s)}{AE} = \frac{100(35-25)}{0.025 * 30 * 10^6} = 0.0134' \text{ (too)}$$

prob-9 The length, breadth and depth of a pond were measured by an incorrect 66 metre chain. The volume of the pond was calculated to be 1600 m^3. The chain was tested at the end of the measurement and found

Soln:

True Volume, $V = \left(\frac{Le}{Lc}\right)^3 *$ measured in Conv. Volm.

$= \left(\frac{65.8}{66}\right)^3 * 16000$

$= 15920 \text{ cft.}$

Prob-10

A steel tape of 100' length weighing 1.2 lb, was pulled with a force of 20 lbs. in the field to measure a certain distance. Calculate the correction for Sag.

Soln:

$$C_s = \frac{W^2 L}{24 F_f^2} = \frac{1.2^2 * 100}{24 * 20^2} = 0.15' \text{ (+ve)}$$

Transportation Engineering.

Modulus of subgrade reaction (k):- It may be defined as the pressure sustained per unit deformation of subgrade at specified deformation or pressure level. using specified plate size.

$$k = \frac{P}{\Delta} \text{ kg/cm}^2/\text{cm} \quad (\text{kg/cm}^3)$$

$$= \frac{P}{0.125} \text{ kg/cm}^3$$

The standard plate size for finding k value is 75 cm diameter. But in some case a smaller plate of diameter is allowed.

what are the types of traffic islands).

Ans! These are four types:

i) ~~Channelizing~~ Divisional islands → To seperate opposing flow of traffic on a highway with 4 or more lane.

ii) Channelizing Islands → To guide the traffic in to proper channel through the intersection.

iii) Pedestrian loading Islands → are provided at regular stops & similar places for the protection of passengers.

iv) Rotary Islands.

Q. California Bearing test (CBP) test:

This is a penetration test developed by California division of highways, as a method for evaluating the stability of soil subgrade and other flexible pavement materials.

The CBR test may be conducted in the lay on at on a prepared specimen in a mould on in-situ in the field.

~~Apparatus~~:

Test specifications:

Penetration rate = 1.25 mm/min.

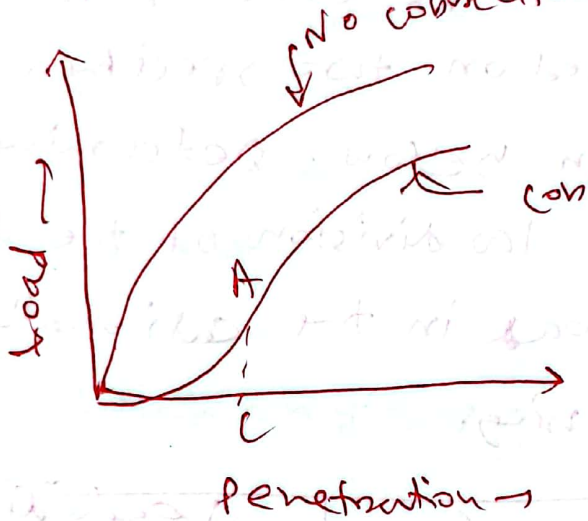
The load values for 2.5 mm and 5.0 mm. Penetration are recorded.

The standard load value:

Penetration	load value	
2.5 mm.	→ 1370 kg	→ 70 kg/cm²
5.0 mm	→ 2055 kg.	→ 105 kg/cm².

The load values are noted corresponding to penetration values of 0.0, 0.5, 1.0, 1.5, 2, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm.

The load penetration graph is plotted. Alternately, the load values may be converted to pressure values and plotted against the penetration values.



$CBR(\%) = \frac{\text{Load or pressure sustained by the specimen at 2.5 or 5.0 mm penetration}}{\text{Load or pressure sustained by standard aggregates at the corresponding penetration level.}}$

* $CBR_{2.5mm} > CBR_{5mm}$ (Generally)

If $CBR_{5mm} > CBR_{2.5mm}$, test should be repeated for checking. If the check test gives similar results, the higher value obtained at 5.0mm penetration is reported as CBR value.

Problem -1

The load penetration values of CBR test conducted on two specimens of a soil sample are given below. Determine CBR value of soil. If 1 div of the load dial represents 190 kg load in the calibration chart of the proving ring.

Penetration of Plunger (1mm)	Load dial reading, div.	
	Specimen-1	Specimen-2
0.0	0.0	0.0
0.5	8.0	0.5
1.0	15	1.5
1.5	23	2.5
2.0	29	6.0
2.5	34	13.
3.0	37	20
4.0	43	30

5.0 → 48 → 38.

7.5 → 57 → 50

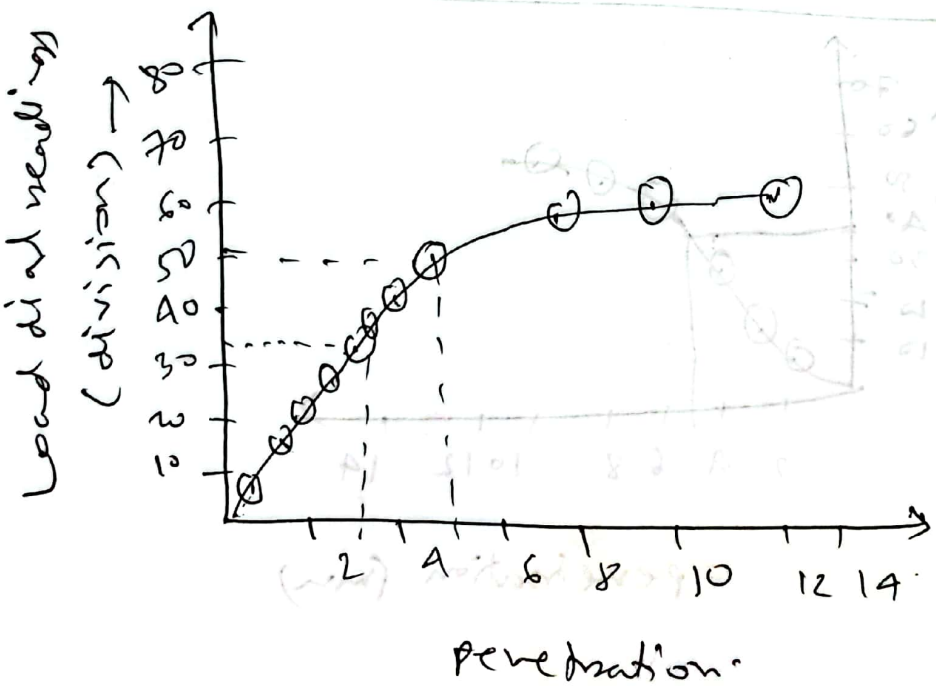
10.5 → 63 → 58.

12.5 → 67 → 63.

Soln:

The penetration value are plotted against the load dial reading. (Instead the load dial reading may all be converted either to load values in kg or load per unit area of cross section of the plunger in kg/cm² and plotted on y-axis)

For specimen-1



The load penetration curve for specimen-1 is ~~Continuous~~ consistently convex throughout and need no correction.

From fig:

For 2.5mm penetration, load dial reading = 34 divisions.

Load at 2.5 mm penetration = $\frac{34 * 190}{10} = 64.6$ kg

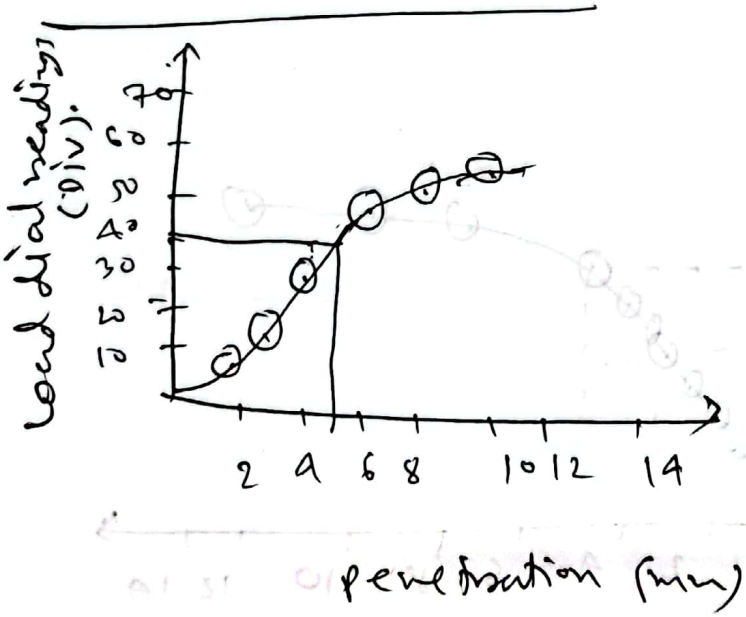
$\therefore CBR_{2.5mm} = \frac{64.6}{1370} * 100 = 4.7\%$

similarly.

$CBR_{5mm} = \frac{48 * 190 * 100}{100 * 2055} = 4.4\%$

$\therefore$ CBR value of specimen no.1 = 4.7%

For specimen no. 2.



The curve is initially concavity, so correction is required. A tangent AC drawn from the steepest portion of A of the curve to intersect the x-axis at C. which is the corrected origin for this specimen.

The penetration value are measured from this origin C.

$$CBR_{2.5} = \frac{32.5 * 190 * 100}{100 * 1370} = 4.5\%$$

$$CBR_{5mm} = \frac{47 * 190}{2055} = 4.3\%$$

∴ CBR vale of specimen no. 2 = 4.5%

∴ Mean CBR (%) = $\frac{4.7 + 4.5}{2} = 4.6\%$ (Ans).

PMS-2

Penetration (mm)		Specimen (Load dial readings)
2.5	⟶	38
5	⟶	55

100 divisions of the load dial represent 2 kN load. Calculate the CBR value.

Soln:

$$CBR = \frac{\text{load carried by specimen of soil (2.5 mm or 5 mm Penetration)}}{\text{standard load}}$$

$\therefore$ Load $= \frac{210 * 38}{100} = 79.8$ kg.;

& Load $= \frac{210 * 55}{100} = 115.5$ kg.

$\therefore CBR_{2.5} = \frac{79.8 * 100}{1370} = 5.82.$

$\therefore CBR_5 = \frac{115.5 * 100}{2055} = 5.62.$

$\therefore (CBR_{2.5}) CBR_5$ (OK)

$\therefore CBR = 5.82 \simeq 6\%$

"Environmental Engineering"

- Population 20000 per capita demand is 150 lit/d. The disinfectant used for chlorination is bleaching Powder which contains 30% of available chlorine. Determine, how much bleaching powder is required actually at the water works if 0.30 ppm of chlorine dose is required for disinfection.

Soln:

Avg. daily demand = 20000 * 150 lit = $3*10^6$ lit.

∴ Chlorine contain = $3\times10^6\times0.3$ mg = 0.9×10^6 mg = 0.9 kg

∴ 30 kg chlorine contain bleaching powder of 100 kg

∴ 0.9 " " " " " = $\frac{100\times0.9}{30}$ kg

= 3 kg.

∴ Annual demand of bleaching powder

= 3 * 365

= 1095 kg.

- pH value of incoming and outgoing water is 7.2 & 8.4. Determine the avg. pH of water.

Soln:

$pH_1 = -\log[H_1^+] \Rightarrow H_1^+ = 10^{-7.2}$.

~~$\Rightarrow 7.2 = \log$~~ & $H_2^+ = 10^{-8.4}$.

$\therefore$ Avg. value $= \frac{10^{-7.2} + 10^{-8.9}}{2} = 3.35 \times 10^{-8}$

$\therefore pH = -\log [3.35 \times 10^{-8}] = 7.92.$

Prob:3 A settling tank 3m deep, 60m long, what is the flow velocity of particle size = 0.025m. at 25°C. specific gravity = 2.65, kinematic viscosity of water, $\gamma = 0.01 m^2/s$.

$\rightarrow V_s = \frac{g}{18}(G_s - 1)\frac{d^2}{\gamma}$

$= \frac{9.81}{18}(2.65 - 1) * \frac{0.025^2}{0.01}$

$= 0.056 m/sec.$

$H = 3m.$

Free board = 20% of H

$\therefore h = 2.5m.$

$\therefore \frac{V}{V_s} = \frac{L}{h}$

$\Rightarrow V = \frac{60}{2.5} \times 0.056 = 1.35 m/sec.$

Prob:4 A circular sedimentation tank 3.5×10^6 ml/day of raw water if detention period is 5 hrs and depth of tank 3.5m. What should be the dia of tank.

Soln:

Capacity $= \frac{3.5 \times 10^6 \times 5}{24} = 7.29 \times 10^5$ lit

Now,

$$V = d^{\sim}(0.011d + 0.785H)$$

$$\Rightarrow 729 = d^{\sim}(0.011d + 0.785 \times 3.5)$$

$$\therefore d = 16.79 \lesssim 17\text{m}.$$

Prob-5

Design an oxidation pond for treating sewage from a hot climate residential colony having a population of about 5000 persons. The contribution of sewage is at a rate of 120 lpcd. and the 5 day BOD is 300 mg/litre.

Soln:

Quality of sewage treated per day $= 5000 \times 120$
$= 6 \times 10^5$ lit/day
$= 2500\text{m}^3$.

BOD content $= 300 \times 10^{-6} \times 600000 = 180$ kg.

Surface area $= \frac{180}{300} = 0.6$ hectare $= 6000\text{m}^2$.

$L \times B = 6000$

$\therefore 2B \times B = 6000$

$\therefore B = 54.77 \approx 55\text{m}$.

$\therefore L = 2 \times 55 = 110\text{m}$.

Assume,
organic loading $=$
300 kg/ha. per day

Assume, depth $= 1.2\text{m}$ (0.9–1.5m)

$\therefore$ capacity $= 110 \times 55 \times 12 = 7260\text{m}^3$

$\therefore$ Detention time $= \frac{\text{Capacity}}{\text{sewage flow per day}}$

$= \frac{7260}{600} = 12.1 \simeq 12$ hr

Assume, velocity $= 0.9$ m/sec and daily flo

$\therefore$ Discharge $= \frac{600}{8 * 60 * 60} = 0.021 \text{ m}^3/\text{sec}.$

$\therefore$ Area $= \frac{\text{Dis } Q}{V} = \frac{0.021}{0.9} = 0.023$

$\Rightarrow \frac{\pi}{4} d^2 = 0.023$

$\therefore d = 200$ mm.

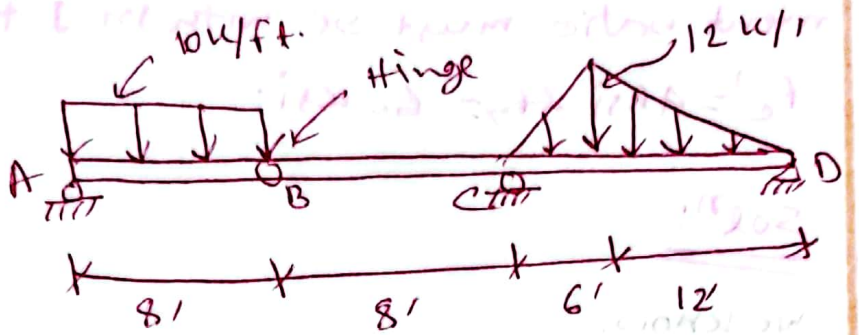
$\therefore$ Dia. of inlet pipe $= 200$ mm.

$\therefore$ " " outlet " $= 200 * 1.5 = 3$

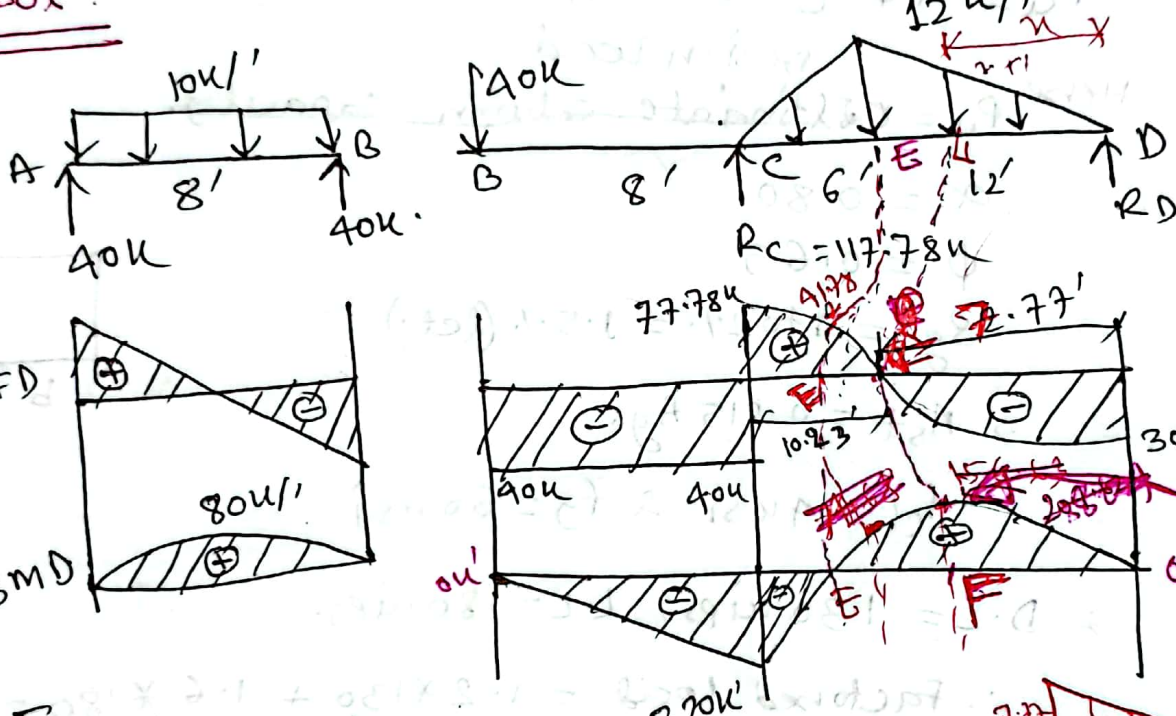
Job Questions & solutions.

Janata Bank-2016 (30.12.2016)

Draw shear force diagram & Bending moment diagram for the following beam.



Soln:



12' → 12k/ft.
1' → 12k/12 = 1k/ft.

[Reactions: $\Sigma M_C = 0$;

$\Rightarrow -40*8 + \left(\frac{1}{2}*6*12\right)*\frac{2*6}{3} + \left(\frac{1}{2}*12*12\right)*\left(6+\frac{12}{3}\right) + R_D*18 = 0$

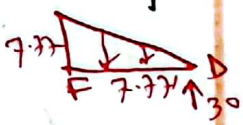
$\therefore R_D = 30.22k.$

$\therefore R_C = 40 + \frac{1}{2}*12*18 - 30.22 = 117.78k.$

$\Sigma M_E = 0$;

at, x from right support. Shear V = 0.

$V + 30.22 = \frac{1}{2}*x*x \Rightarrow x = 7.77'$ (Ans.



$\Sigma M_F = 0$;

$\Rightarrow 30.22*7.77 - \frac{1}{2}*7.77*\frac{7.77}{3} = 156.63k$

Janata Bank-2016

Q.2 Design a square tied column to support dead load of 130 kips & live load of 180 kips. Reinforcement ratio must be with in 1 to 2%. Assume, $f_c' = 4$ ksi & $f_y = 60$ ksi.

Soln:

We know,

$$P_u = \alpha \phi \left[0.85 f_c' (A_g - A_{st}) + A_{st} f_y\right] \quad \text{——— (1)}$$

Design load.

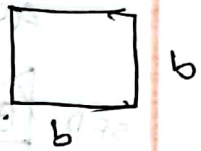
Here, P_u = ~~Ultimate column capacity~~.

$\alpha = 0.80$

$\phi = 0.65$

ρ_g = 1 to 2% = 1.5% (let.)

$\Rightarrow A_{st} = 0.015 A_g$.



$f_c' = 4$ ksi & $f_y = 60$ ksi

$\therefore$ D.L = 130 kips, L.L = 180 kips.

$\therefore$ Factored load = $1.2 * 130 + 1.6 * 180 = 444$ kips

$\therefore$ from eqn (1)

$$444 = 0.80 * 0.65 \left[0.85 * 4 (A_g - 0.015 A_g) + 0.015 A_g * 60\right]$$

$$\Rightarrow 853.85 = 4.249 A_g.$$

$\therefore A_g = 200.95$

$\therefore b * b = 200.95$

$\therefore b = 14.18$ in. $\therefore$ size = $14.18'' * 14.18''$ (Ans).

$\therefore A_{st} = 0.015 * 200.95 = 3.01425$ in^2 = 10 #16 mm bars.

Janata Bank - 2016

Q.3 Define virgin consolidation curve. Which one do you prefer as a soil engineer in between laboratory consolidation curve & virgin consolidation curve? Explain with necessary diagram & examples.

Soln:

Virgin consolidation curve is plotted from the results of fully undisturbed soil in the field which has never gone under consolidation even. laboratory consolidation curve is also for the soil which has not experienced consolidation before but slight disturbance of soil happen when collecting the soil.

So, virgin consolidation curve is preferable obviously.

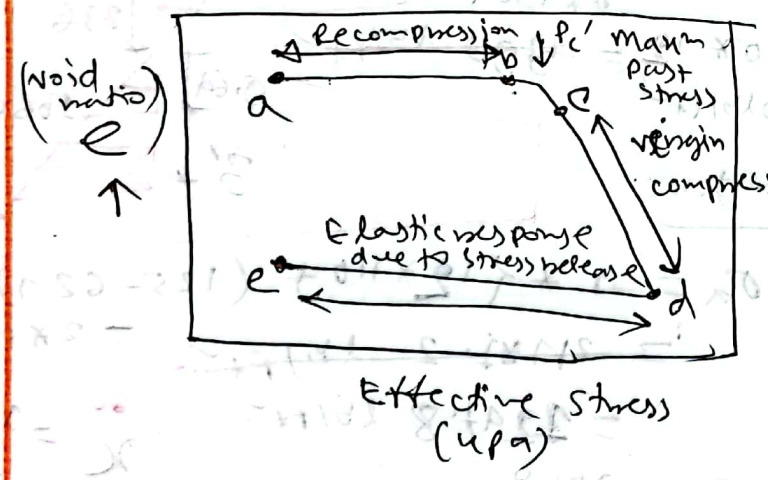
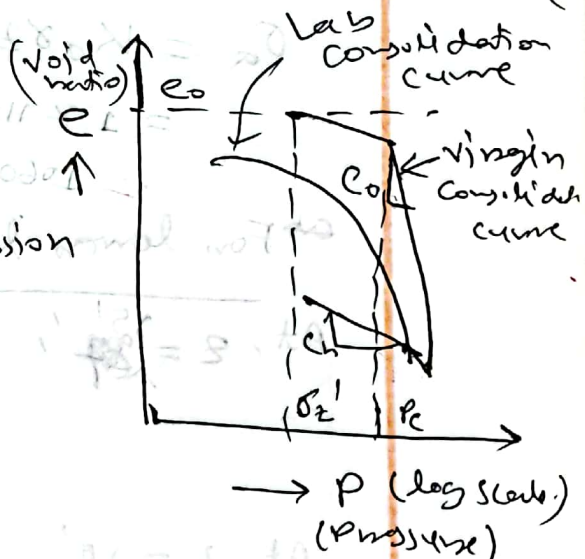


Fig: virgin consolidation curve.



C_r = Compression index

Fig: e-log P curve for over consolidated soil.

Janata Bank - 2016

Q.4 A retaining wall has to support 15' soil above its base level & the water table is 12' below the ground level. The back fill material is pure clay having $\gamma = 110$ lb/ft3 & $\gamma_{sat} = 125$ lb/ft3. If the volume of cohesion, $C = 130$ lb/ft3. determine the stresses at different location & draw the pressure diagram.

Soln:

$$K_a = \frac{1-\sin\phi}{1+\sin\phi} = 1$$

For upper layer:

At, $z = 0$, $\sigma_a = 0$.

$\therefore \sigma_a = 0 - 2*130\sqrt{1} = -260$ lb

At, $z = 12'$,

$$\sigma_a = K_a \gamma z - 2c\sqrt{K_a}$$
$$= 1 * 110 * 12 - 2*130\sqrt{1}$$
$$= 1060 \text{ lb/ft}^2$$

For lower layer:

At, $z = 15'$, $\sigma_a = 1 * \{12*110 + (125-62.4)*3\} - 2*130\sqrt{1}$

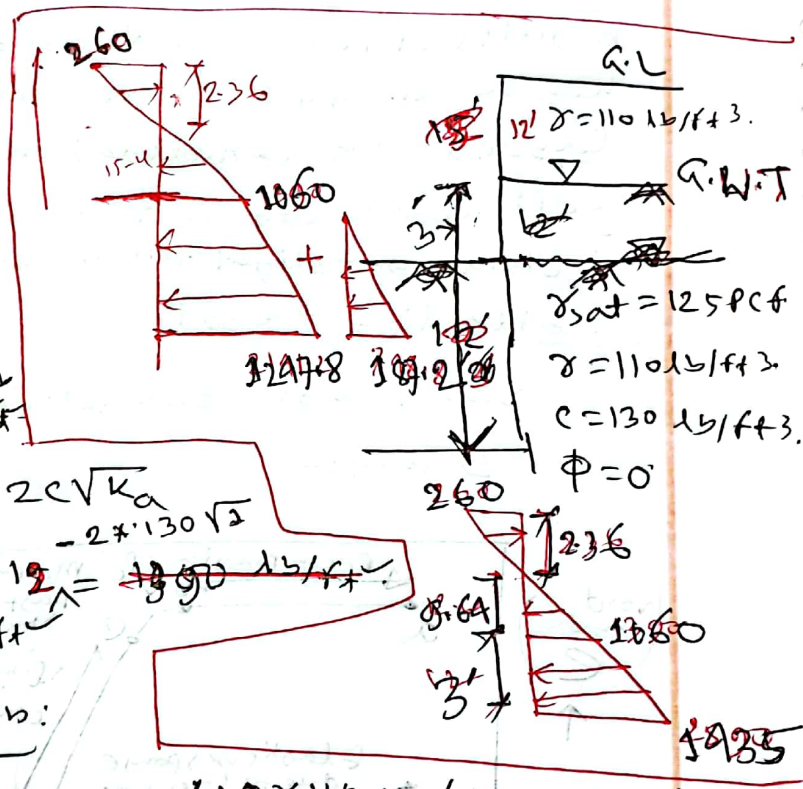
$= 1247.8$ lb/ft^2

At, $z = 12'$, $\sigma_a = 1060$ lb/ft^2

At, $z = 0$, $\sigma_a = -260$ lb/ft^2

$\therefore$ Pore water pressure, $U = \gamma_w z$

$= 62.4 * 3 = 187.2$ lb/ft^2

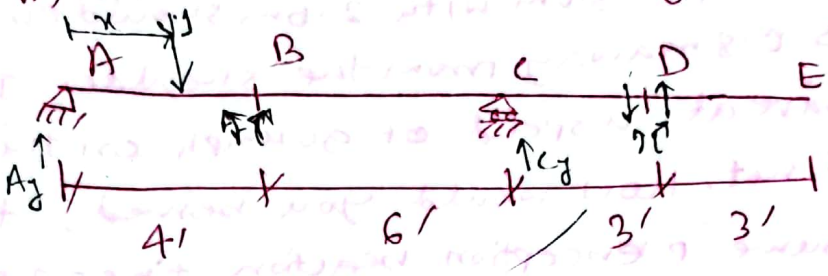


$$\frac{260}{x} = \frac{1060}{15-x}$$

$\therefore x = 2.36$

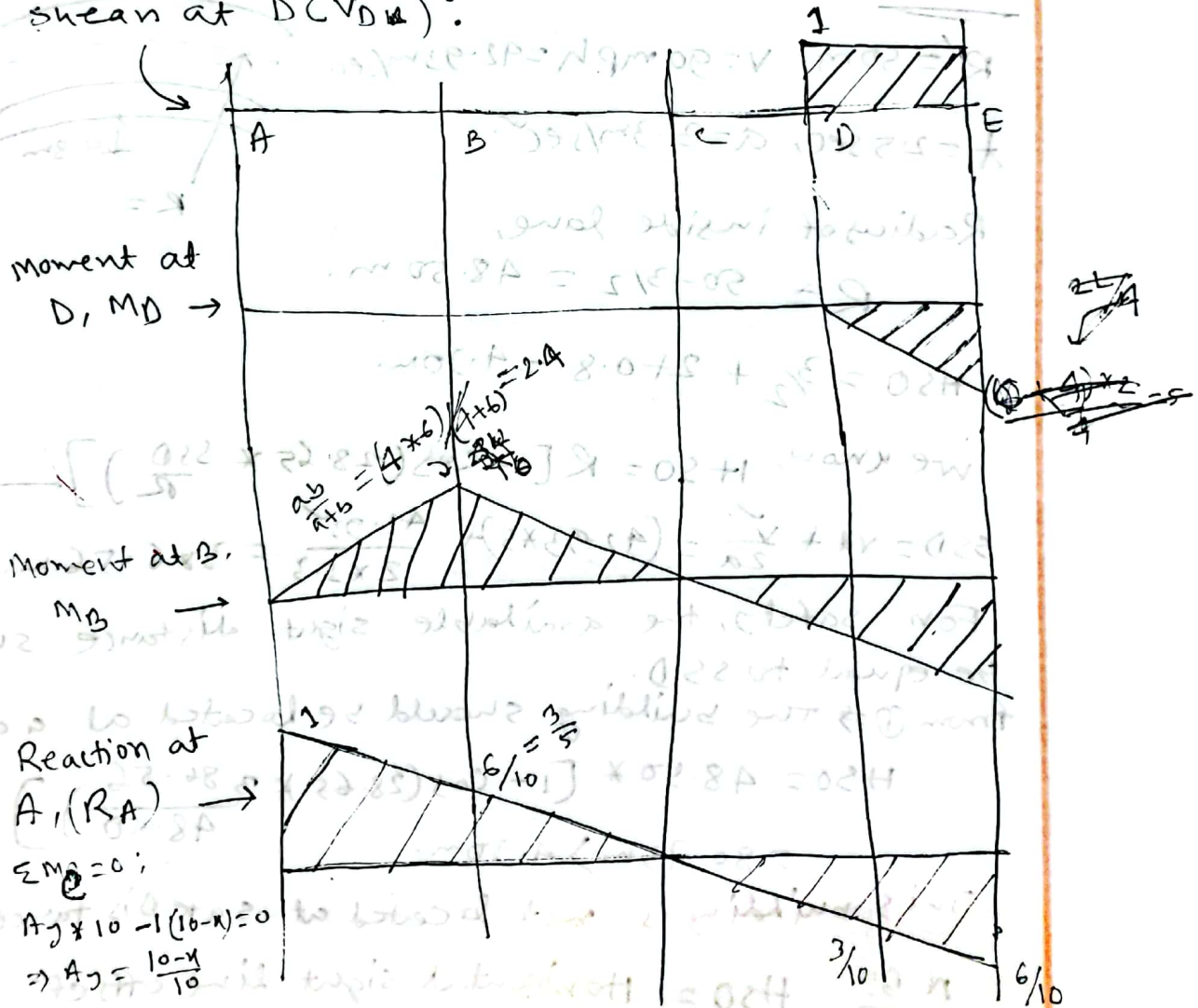
Janata Bank-2016

Q.5 Draw influence lines for shear at D(V_D), Bending Moment at D(M_D) & B(M_B) and support reaction at A(R_A) of the beam in the figure below:



Soln:

Shear at D(V_D):



$\Sigma M_C = 0$;

$A_y \times 10 - 1(10-x) = 0$

$\Rightarrow A_y = \frac{10-x}{10}$

Janata Bank - 2016

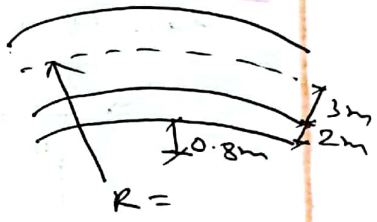
Q.6 The corner of a Building is situated next to inner side of a two-lane level horizontal curve with a radius of 50m on a rural highway. Each lane is 3.0m with 2.0m shoulder. The corner is 0.8m away from the shoulder. Is it safe to drive at a speed of 90 kmph on this curve? If not, how would you remedy the problem? Assume, perception reaction time = 2.5 sec & deceleration rate = 3.3 m/sec².

Q.7

Soln:

$R' = 50m$; $V = 90 mph = 92.93 m/sec$.

$t = 2.5 sec$, $a = 3.3 m/sec^2$.



Radius of inside lane,

$$R = 50 - 3/2 = 48.50 m.$$

$$HSO = 3/2 + 2 + 0.8 = 4.30m.$$

we know, $HSO = R\left[1 - \cos\left(28.65 \times \frac{SSD}{R}\right)\right]$ ——— ①

$$SSD = Vt + \frac{V^2}{2a} = (42.93 \times 5) + \frac{42.93^2}{2 \times 3.3} = 386.56 m.$$

For safety, the available sight distance should be equal to SSD.

from ① ⇒ The building should be located at a distance

$$HSO = 48.50 * \left[1 - \cos\left(28.65 \times \frac{386.56}{48.50}\right)\right]$$

$$= 80.73m > 4.30m.$$

This building is not located at safe Distance (m).

N.B: HSO = Horizontal sight line offset.

Janata Bank - 2016

Q.7 Let, there is a community with a population of 35,000. The solid waste generation rate is 6.5 lb/capita-day. There is a necessity to design a landfill for that community. Estimate the required landfill area. Consider that, the compacted specific weight of solid wastes in landfill is 800 lb/yd3. and avg. depth of compacted solid waste is 20'.

Soln:

Given, Population = 35000

Total solid waste = 35000 * 6.5 = 227500 lb/day

Sp. Wt. of solid waste = 800 lb/yd3

$$= \frac{800\,lb}{3^3\ ft^3}$$

$$= 29.63\ lb/ft^3.$$

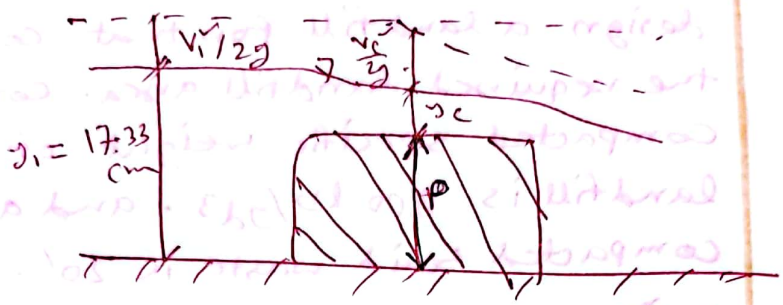
avg. depth = 20'.

$$\therefore \text{Area of land fill} = \frac{227500}{29.63 * 20}\left(\frac{lb}{day} * \frac{ft^3}{lb} * \frac{1}{ft}\right)$$

$$= 383.9\ ft^2$$ (Ans).

Janata Bank - 2016

Q.8 Determine the weight of broad crested weir (P) from given data. width of flume = 25 cm, actual discharge = 7020.5 cm^3/s. Ignore head loss.



Soln:

~~Theoretical discharge, $Q_t = B y_c \sqrt{g(y_1 - y_c)}$~~

~~Here, $y_1 = 3/2\, y_c$~~

~~$\therefore Q_t = 25 \times y_c \sqrt{2g(y_1 - y_c)}$~~

~~$\therefore Q_t = 25 \times (17.33 - P)$~~

~~$\Rightarrow y_1 = 3/2 \times (17.33 - P)$~~

$\Rightarrow 17.33 = 3/2\, y_c$

$\therefore y_c = 11.55$

Here,
B = 25 cm.
$y_c = y_1 - P$
$= 17.33 - P$
$g = 9.8\ m s^{-2}$

$\therefore P = y_1 - y_c = 17.33 - 11.55 = 5.78$ cm.

$V_1 = \frac{Q}{y_1 B} = \frac{7020.5}{17.33 \times 25} = 16.25$ cm/s. (Ans)

$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{7020.5}{981 \times 25}} = 4.32$ cm

$V_c = \frac{Q}{B y_c} = \frac{7020.5}{25 \times 4.32} = 65.16$

$\Rightarrow P + y_c + \frac{V_c^2}{2g} = y_1 + \frac{V_1^2}{2g} \Rightarrow P = 17.33 + \frac{16.2^2}{2 \times 981} - 4.32 - \frac{65.16^2}{2 \times 981}$

$= 10.99$ cm (Ans).

Q.9

Janata Bank - 2016

Q.9 The following consecutive staff readings were taken using a dumpy level: 0.705, 1.655, 0.890, 3.015 & 1.655. The first reading was taken on a benchmark whose RL is 150.605 m. Calculate the reduced levels of the stations by the rise & fall method.

Soln:

Staff Readings		Reduced Level (m)
0.705	—	150.605
1.655	—	148.95
0.890	—	148.06
3.015	—	145.045
1.655	—	143.39

[N.B.: Dumpy level means fall of level]

Back Reading	Int. Reading	For. Reading	Rise (+)	Fall (−)	R.L
0.705	—				150.605
	1.655	—	—	0.95	149.655
	0.890	—	0.765	—	150.42
	3.015	—	—	2.125	148.295
		1.655	1.36	—	149.655

Others

Q.1 Two lane Two way highway steect having ADT 4000. If the commercial vehicle is 95.1 & loads 27 kip then calculate the ESAL for commercial vehicle in one direction.

Soln:

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

$$= 4556.25$$

Q.2 ~~Sieve Ao~~

Q.2 Determination of F.M. of ~~fine~~ aggregate portion only from a sieve analysis result. Also determine the percentage of coarse aggregate & silts & clay

19mm	12.5mm	4.75mm	2.36mm	1.18mm	0.6mm	0.3mm
175	125	100	50	20	10	10

0.15mm	0.075mm	Pan
4	4	2.

Soln:

Sieve Size (mm)		Retained (gm)	% Retained	Cumulative %
(3/4")	19	175	35	35
	12.5	125	25	60
(#4)	4.75	100	20	80
(#8)	2.36	50	10	90
(#16)	1.18	20	4	94
(#30)	0.6	10	2	96
(#50)	0.3	10	2	98
(#100)	0.15	4	0.8	98.8
(#200)	0.075	4	0.8	99.6
	Pan	2	0.4	100
		Total → 500		

∴ F.M of fine aggregate = $\frac{80 + 90 + 94 + 96 + 98 + 98.8}{100}$

$= 5.57$

∴ % of coarse aggregate = % of passing through #200 sieve.

= % of retained on #4 sieve

= 35 + 25 + 20

= 80 %

∴ % of silt & clay = % of passing through 200 no. sieve

= 0.4 %

Janata Bank – 2016

Q.10 Determine the no. of bolts to transmit a dead load force of 25 kips & a live load force of 75 kips through two L8*8*1 Concrete to a gusset plate (1" thick). All materials are A36 steel. The bolts are 1/2 inch dia A325 steel in a bearing type connection with threads excluded from shear plane. Use three lines of bolts across the wey of the channel and consider $F_y = 30$ ksi. Apply USD method.

Soln:

No. of bolt:

Area of each bolt, $A_b = \frac{\pi}{4} * (1/2)^2 = 0.196 in^2$ (dia = 1/2")

$F_y = 30$ ksi ; $P = 25 + 75 = 100$ kip.

$\therefore$ No. of bolt $= \frac{100}{30 * 0.196 * 2} = 8.5 \simeq 9$ nos. $\rightarrow \left(\frac{P}{A_b * F_y * n}\right)$

Check bearing capacity of angle & gusset plate:

Allowable B.C., $F_p = 1.2 F_u = 1.2 * 58 = 69.6$ ksi

[$\because F_u = 58$ ksi for $F_y = 30$ ksi]

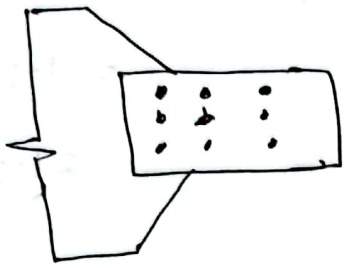
R_p (angle) $= F_p dt *$ No. of bolt * no. of bearing surface

$= 69.6 * \frac{1}{2} * 1 * 9 * 2 = 626.4 k > 100 k.$

R_p (Gusset plate) = $d * t * F_p$ * No. of bolt.

$= \frac{1}{2} * 1 * 69.6 * 9$

$= 313.24 > 1$ cw.



Others

Q.3 Water is flowing through a pipe of 70 mm dia. under a guage pressure of 3.5 kg/cm² & with a mean velocity of 1.5 m/sec. The pipe is 7m above the datum line. Neglecting friction. Determine total head of water.

Soln.

$$\text{Total head} = h + \frac{v^2}{2g} + \frac{p}{\gamma_w}$$

$$= 7 + \frac{(1.5)^2}{2*9.81} + \frac{3.5*10^4}{1000}$$

$$= 42.114 \text{ m of water.}$$

Q.4 A trapezoidal channel has a bottom width of 6m & side slope 1:1. The depth of flow is 1.5 m at a discharge of 15 m³/sec. Determine the sp. energy in terms of head of water.

Soln.

$$\text{Area} = (b + sh)h$$

$$= (6 + 1*1.5)1.5 = 11.25 \text{ m}^2$$

Q.6

velocity, $v = Q/A = \frac{15}{11.25}$ m/sec. $= 1.33$ m/sec.

$\therefore$ head of water, $h = 1.5$ m.

$\therefore$ specific energy, $E = h + \frac{v^2}{2g}$

$= 1.5 + \frac{1.33^2}{2 \times 9.81}$

$= 1.59$ m of water.

Q.5 Determine the i) water content ii) Dry Density iii) Bulk Density iv) void ratio & v) Degree of saturation, Given sample diameter 3.81 cm, sample height = 7.62 cm, wet wt. = 166.8 gm. Oven dry wt. = 140 gm. Sp. gr. = 2.70.

Soln:

Vol^m of sample $= \frac{\pi}{4} d^2 h = \frac{\pi}{4} * (0.0381)^2 * 0.0762$

$= 86.87 * 10^{-6}$ m3

$= 86.875$ cm3.

$\therefore$ wt. of solid, $W_s = 140$ gm.

$\therefore$ wt. of water, $W_w = 166.8 - 140 = 26.8$ gm.

i) Dry density, $\rho_d = \frac{W_s}{V} = \frac{140}{86.875} = 1.61$ gm/cm3. (Ans).

ii) Bulk density, $\rho_{bulk} = \frac{W_{total}}{V} = \frac{166.8}{86.875} = 1.92$ gm/cm3 (Ans)

iii) $\rho_d = \frac{G_s \rho_w}{1+e} \Rightarrow e = \frac{2.7 * 1}{1.61} - 1 = 0.68$ (Ans)

iv) $Se = wG_s \Rightarrow S = \frac{wG_s}{e} = \frac{0.19 * 2.7}{0.68} = 0.76 = 76\%$ (Ans)

v) w = water content, $= \frac{W_w}{W_s} = \frac{26.8}{140} = 0.19 = 19\%$ (Ans)

Q.6 True/False:

i) The layers of road foundation just above the existing ground level is wearing coarse. (F)

ii) stopping sight distance only depends on vehicle speed (F)

iii) The speed of a vehicle instaneous 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 underdeveloped areas, meter gauges are used (T)

vi) In Bd, the ballast used is mainly broken stone (T)

vii) The track from which the train directs 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 fogue is green light. → (F)

The average daily consumption per capita in a town of 80,000 population is 45 gallon for domestic purposes. 30 gallon for industrial & commercial purposes, 12 gallons for Public purposes, 25 gallons for loss & waste. Calculate the avg. daily consumption, neglecting consumption for fires.

Soln:

Total consumption = (45 + 30 + 12 + 25) * 80000

= 8.96 mgd

= 9 mgd. (Ans.)

Compute the stress at a point 15' below the base of a single column foundation carrying 250k load and size 10ft * 10 ft.

Soln:

[Let, γ = 110 pcf = 0.11 kcf]

$$\text{Pressure} = \frac{P}{A} + \gamma D_f$$

$$= \frac{250}{10 * 10} + 0.11 * 15$$

$$= 4.15 \text{ K sf.}$$

2.9 A canal exerts waste water in a river at 55000 m³/d. BOD of the waste water is given 110 mg/L. What is the total amount of BOD exerted in the river. If the treatment plant is treating the waste water to remove 70% BOD, what is the amount of BOD exerted now?

Soln:

BOD of the waste water = 110 mg/L

∴ BOD exerted in a river = 55000 * 1000 * 110

= 6.05 * 10⁹ mg/day

= 6050 kg/day.

∴ BOD exerted after treatment = 6050 * (1-0.7)

= 1815 kg/day.

2.10 ~~Design~~

V_u = 30k, f_c' = 4000 psi. What will be the minm (Ans). cross section of beam if it controlled by shear. No web rein. is required.

Soln.

Here, V_u = 30k. & f_c' = 4000 psi

Ultimate shear stress, $v_{ult} = \frac{V_u}{bd} = \frac{30 * 10^3}{bd}$ lb.

we know, Design shear stress, $\phi v_c = 2\phi\sqrt{f_c'}$

$= 2 * 0.75 \sqrt{4000}$

$= 94.87$ psi

Q.13 For 100 m^3 R.C.C. work 1% rod is needed find out the quantity of rod.

Soln:

Generally we consider 100 kgs steel per m^3 of concrete. For calculation which will give the nearer quantity of steel. It may varies depending upon the dia of rod.

Let, this estimation is for R.C.C. Column

0.85 kg [0.5 ft + 6 ft]

0.85 kg [0.5 ft + 6 ft]

0.85 kg [0.5 ft + 6 ft]

$\therefore$ Quantity of rod = 1% * 100 m^3 *

we know, the unit wt. of steel = 7850 kg/m^3.

$\therefore$ Total Quantity of rod = $7850 * 100 * \frac{1}{100}$

= 7850 kg.

(Ans).

Q.19 Dry unit wt. of sand is 110 lb/ft^3 & Sp. gr. 2.7. Findout the saturated unit wt.

Soln:

$\gamma_d = 110 lb/ft^3$

$G.S = 2.7$

$\gamma_{sat} = ?$

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

$\Rightarrow e = \frac{2.7 * 62.4}{110} - 1$

$= 0.53$

$\therefore \gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e} = \frac{(2.7+0.53)62.4}{1+0.53}$

$= 131.73 lb/ft^3$

Since, No web rein. is required ; $V_{ac} \leq \phi V_c$

$\therefore V_{ac} = \phi V_c$ [for max^m cross section for beam]

$\therefore \frac{30*10^3}{bd} = 94.87$ | we know, $b = 4/2 = \frac{d+2.5}{2}$

$\Rightarrow d30*\left(\frac{d+2.5}{2}\right) = 316.22$

~~$\Rightarrow d = 629.94$~~

$\Rightarrow d = 23.93''$.

$\therefore b = \frac{23.93+2.5}{2} = 13.21''$

$\therefore h = 23.93 + 2.5 = 26.43''$ (Ans).

Q.13

Q.11 Calculate No. of brick for 100 m^3 brick work.

Soln:

We know,

1 m^3 brick work = 410 Nos. brick.

$\therefore$ 100 m^3 " " = 410*100

= 41000 Nos. brick.

Q.12 Find the load of column 30 * 12 inch 12 No. 20mm dia bars. $f_y = 60$ ksi, $f_c' = 3$ ksi.

Soln:

Allowable load of column:

$P_n = \phi\{0.85 f_c' (A_g - A_{st}) + A_{st} f_y\}$ | $A_{st} = \frac{\pi}{4} * 20^2$ ~~= 0.0034 in²~~ $= 0.49 in^2$

$= 0.8\{0.85 * 3(30*12 - 12*0.49) + 12*0.49*60\}$

N.B.: For Allowable axial compression

[then, $f_c = 0.45 f_c'$, $f_s = 0.4 f_y$]

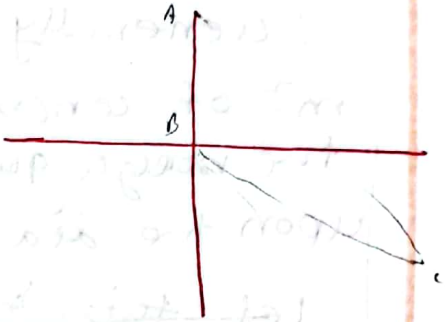
$= 1004.64$ kip.

USD: Tied → $P = 0.85 A_g [0.25 f_c' + \rho_g f_s]$

spiral → $P = A_g [0.25 f_c' + \rho_g f_s]$ [$\rho_g = \frac{A_{st}}{A_g}$]

Q.15 The bearing of a line AB is 152° & Angle ABC is 124° find the bearing of BC.

Soln:



Q.16 Factors which affects the bearing capacity of shallow foundation.

Ans:

1) Nature of soil & its physical & engineering properties.
2) Nature of found ation & other details such as size, shape, depth below the ground surface & rigidity of the structure.
3) Total & differential settlements
4) Location of ground water table.
5) Initial stresses.

Q.17 a) The safe bearing capacity of a building

$$= \frac{\text{allowable bearing pressure}}{\text{F.S.}}$$ (F) [Allowable net b.c. = $\frac{Q_{ult}}{F.S}$]

b) In case of wall footing the lowermost wall will be twice of the width of the wall.

c) Width of stair is 75 cm. (T)

d) After 28 days concrete gain strength upto 100%. (T)

e) Height of instrument = RL of BM + fore sight reading. F (H.I. = R.L + Back sight reading)

f) In well planned city grid iron system is used in distribution of pipe. (T)

g) Avg. traffic is used in design purpose. (T)

h) In road transverse joint is used @ 90° along length. (T)

i) 12 cross conflict point are serve if both are two way road. (F)

j) if slenderness ratio < 100 column is called short. (F) [Corr. Ans: S.R < 50 is short column]

Q.28

a) Avg. value of C_d 0.60

b) Berms are provide additional strength to Banks & Canals section.

c) silt has little or no scouring.

d) For saturated soil degree of saturation is 1.0

e) Footing wt. is considered 10% of column wt.

f) For continuous slab maximum bending moment $\frac{wl^2}{9}$.

g) If bar dia D then anchorage value of hook will be 16d.

h) width of stair 3'-6" (standard)

i) NaCl makes water salty.

j) Sp. Gr. of sand 2.65 to 2.67

k) The binder of HMA surface course of a flexible pavement is usually Asphalt cement.

l) A pressure conduit is a conduit which is flowing full.

m) If F.S. = 3, then margin of safety = 2.

Q.19 ~~Determine the i) water content ii) Dry~~

Estimate "F" for a slope having H = 20m, β = 25°, γ = 19kN/m³, C_u = 50kPa.

Soln:

We know,

$$F_s = \frac{C}{\gamma H \cos\beta \tan\beta} + \frac{\phi \tan\phi}{\gamma H \tan\beta}$$

$$= \frac{50}{19 * 20 * \cos 25^\circ \tan 25^\circ} + \frac{\tan\phi}{\tan\beta}$$

$$= 0.343 \quad \text{(Ans.)}$$

For undrained condition, $\phi = 0$.

C_u = 50kPa (given)

H = 20m

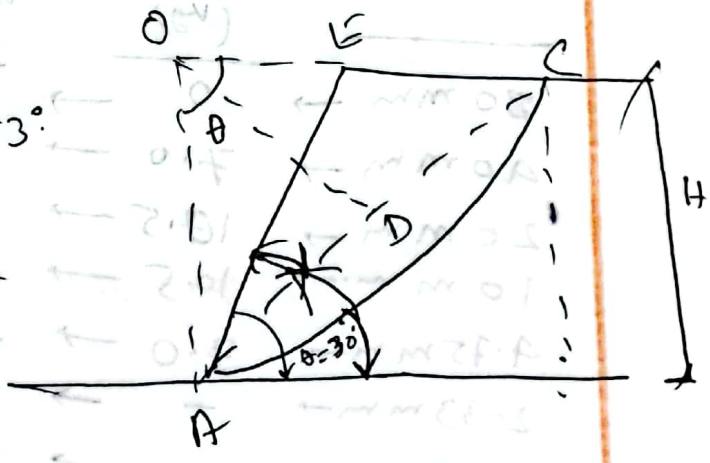
β = 25°

Q.20 Find the centre of the critical circle for β = 25°, H = 60 ft, & D = 18' & to circle failure.

Soln:

Since, slope angle, β = 75° > 53°

∴ Critical circle is a toe circle.



$$\therefore \gamma = \frac{DC}{\sin\theta/2}$$

$$\left[\sin\theta/2 = \frac{DC}{\gamma}, \text{ From } \triangle ODC\right]$$

Again, $DC = \frac{AC}{2}$

$\therefore DC = \frac{H_{cn}}{2\sin\alpha}$ [From ΔACF]

$\therefore \gamma = \frac{H_{cn}}{2\sin\alpha \sin\theta/2}$

$= \frac{60}{2 * \sin 41.8 * \sin\left(\frac{51.8}{2}\right)}$

$= 130.04 ft$ (Ans)

Given,

$H_{cn} = 60'$

$\beta = 75°$

$D = 18'$

For, $\beta = 75°$

$\alpha = 41.8°$

$\phi = 51.8°$

[From fig. 15.13 B.M Das Page-592]

Calculate the FM of fine aggregates & coarse aggregates:

Prob+sol^n:

Coarse Aggregates:

IS sieve No.	Wt. retained (kg)	Cumulative wt. retained (kg)	Cumulative % retained	
80 mm →	0	→ 0	→ 0	→ 3"
40 mm →	7.0	→ 20	→ 20	→ 3/2"
20 mm →	17.5	→ 30	→ 50	→ 3/4"
10 mm →	10.5	→ 30	→ 80	→ 3/8"
4.75 mm →	7.0	→ 20	→ 100	→ #4
2.33 mm →	–	→ 0	→ 100	→ #8
1.18 mm →	–	→ 0	→ 100	→ #16
600 mm →	–	→ 0	→ 100	→ #30
300 " →	–	→ 0	→ 100	→ #50
150 " →	–	→ 0	→ 100	→ #100
<150 " →	–	→ 0	→ ~~100~~	

Total = 35kg → F.M → $\frac{750}{100} = 7.5$

Fine Aggregates

IS sieve No.	Wt. retained in kg	cumulative % wt. retained	Cumulative % of wt. passing
80mm		—	—
40 "		—	—
20 "		—	—
10 "		—	—
4.75 "	30	6	6
2.33 "	60	12	18
1.18 "	100	20	38
600 µm	120	24	62
300 "	125	25	87
150 "	40	8	95
<150 "	25	5	—
Total = 500 kg		→	306

$= \frac{306}{100} = 3.06$ (Ans.

If the soil has liquid limit 67 & the plastic limit 45 and the void ratio in oven dry condition is 0.265, then what will be the shrinkage limit?

Soln:

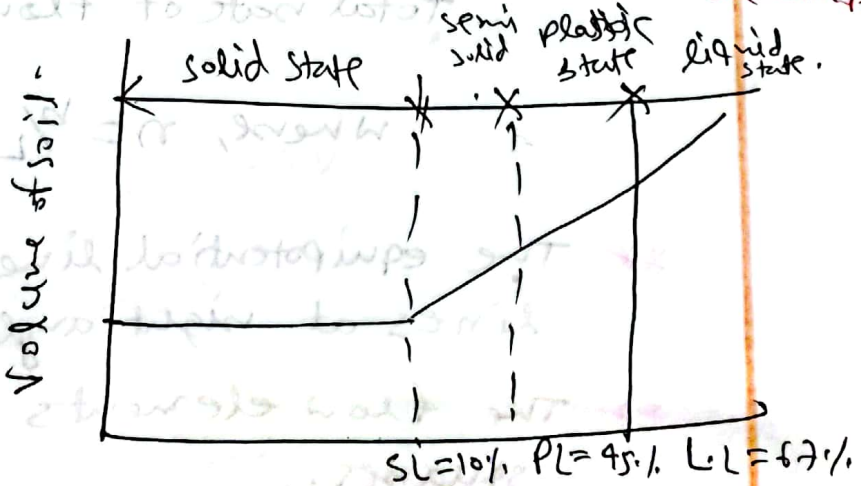
We know,

$e = wG$

$\Rightarrow w = \frac{e}{G}$

$= \frac{0.265}{2.67}$

$= 10\%$ (Ans.



Assume, $G_s = 2.67$.

Q.23 A seepage flow net has 50m height and 2m free board. The No. of head drop is 24. Find out the discharge. The co-efficient of permeability is 300 m/day.

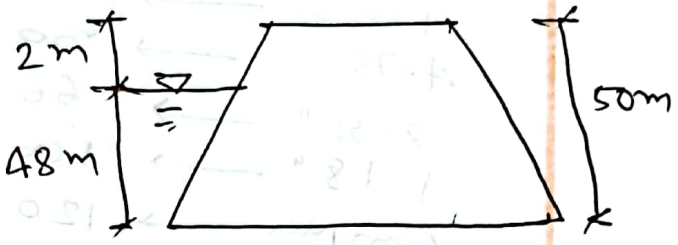
Soln:

We know, Rate of seepage through channel →

$$\Delta q = \frac{KH}{N_d} \frac{\Delta f}{\Delta d}$$

$$= \frac{300 * 48}{24}$$

$$= 600 \text{ m}^3/\text{day/m} \quad \text{(Ans).}$$



Here,

$N_d = 24$

$K = 300 \text{ m/day}$

$H = 48 \text{ m}$

N.B.: Rate of seepage, $\Delta q = K \frac{H}{N_d}$ → Per channel

↳ (For square)

Total rate of flow, $q = K \left(\frac{H N_f}{N_d} \right) n$

where, $n = b/L$ [For square, $n = 1$

∴ Rectangular cases Problems]

** The equipotential lines intersects the flow lines at right angles.

** The flow elements formed are approx. squares.

West Zone Power distribution →

Q.29 Calculate size of footing. Column size is 20" * 20" & load 200 kip. Also calculate the depth of footing considering only punching shear.

Soln:

Column size = 20" * 20" = (X * Y)

Load on column = 200 kip.

∴ Factored load of column + footing wt. = 200 * 1.5 * 1.1

= ~~49.5 kip.~~

= 330 kip.

∴ f_y = 60 ksi
& f_c' = 3 ksi } (let)

soil pressure = ~~2.5 ksf (let)~~ q_a = 2 ksf (let)

~~∴ self wt. 10% = $\frac{L * B * t * 150}{12 * 1000}$~~

= 5

∴ Total Load on Footing = Load on column + 10% of Footing wt

= 200 + 0.1 * 11 * 11 (assuming Footing size = 11' * 11')

= 212.1 k.

∴ Area of footing req. = $\frac{212.1}{2}$ = 106.05 sft.

∴ size of footing = ~~106.05~~ = 10.3 * 10.3 (L * B)

≅ 10.5 * 10.5

[Hence, OK]

Punching shear check:

Allowable punching shear $= 4\phi\sqrt{f_c'}$

$= 4 * 0.75 \sqrt{3000}$

$= 164.32 \text{ psi} = 0.164 \text{ ksi}$

Method-1: (Trial & Error)

Now, assumed depth of footing = 12".

$\therefore$ Punching shear force $= \dfrac{q_u * \{10.5 * 10.5 * 144 - (12+12)^2\}}{144}$ (L, B, d, d)

$= \dfrac{3 * 14852}{144}$ ~~$= 318.75$ kip~~

$= 309.42$ kip

[N.B.: Ultimate pressure

$q_u = \dfrac{330}{10.5 * 10.5}$

$= 3$ ksf]

$\therefore$ Punching shear area $= \{(\text{depth}_{\text{of col}^n} + 12)^2 * 4\} * 12$ (depth of footing)

$= \{(12+12)^2 * 4\} * 12$

$= 1536 \text{ in}^2$.

$\therefore$ Punching shear $= \dfrac{\text{Punching shear force}}{\text{Punching shear area}}$

$= \dfrac{309.42 * 1000}{1536}$

$= 201.45 \text{ psi} >$ Allowable punching shear.

Hence not ok.

So, depth should be increased.

Method: 2 (Equation solution)

Shear Force, $SF = \left[L*B - \frac{(d+1)^2}{144} \right] * 3 * \text{soil pressure}$

$\Rightarrow SF = \left[10.5*10.5 - \frac{(d+20)^2}{144} \right] * 3$

[N.B.: Ultimate soil pressure $= \frac{330}{10.5*10.5} = 3\text{ksf}$]

$\therefore SF = 330.75 - 0.02(d+20)^2$

$\therefore$ Punching stress $= \frac{SF}{\text{Punching Area}}$

$= \frac{330.75 - 0.02(d+20)^2}{4(20+d)*d}$

Now, Punching stress = Allowable punching shear

$\Rightarrow \frac{330.75 - 0.02(d+20)^2}{4d(20+d)} = 0.164$

$\Rightarrow 330.75 - 0.02(d+20)^2 = 0.1657\, d(20+d)$

$\therefore d = 13.84'' \approx 14''.$

Q.25 If a square footing size 4m * 4m is resting on the surface of deposit clay. Calculate the ultimate bearing capacity of footing by Terzaghi Formula.

Soln:→

For square Foundation —

$$q_u = 1.3cN_c + qN_q + 0.4\gamma B N_\gamma$$

$$\therefore q_u = 1.3cN_c + \gamma D_f N_q \quad \text{—— (1)}$$

Now, $$N_q = \frac{e^{2\left(\frac{3\pi}{4} - \frac{\phi}{2}\right)\tan\phi}}{2\cos^2(45 + \phi/2)}$$

$$= \frac{1}{1}$$

$$= 1.$$

$$\therefore N_c = (N_q - 1)\cot\phi = 5.70$$

~~$= (1-1)\times 0$~~

Now, From eqn (1)

$$q_u = 1.3 * 15 * 5.70 + 18 * 4 * 1$$

$$= 183.15 \text{ kN} \quad (\text{Ans}).$$

For clay,
$\phi = 0$,
$N_\gamma = 0$
Let,
$\gamma = 18 \text{ kN/m}^3$.
$D_f = 4\text{m}$.
$c_u = 15 \text{ kN/m}^2$.

Total density of soil mass = 22 kN/m3, w = 10%. What is bulk density?.

Soln:

we know,

$$\rho_{bulk} = \frac{(1+w) G_s \rho_w}{1+e} \quad \text{——(I)}$$

$$\rho_d = \frac{G_s \rho_w}{1+e} \quad \text{——(II)}$$

(I) ÷ (II)

$$\frac{\rho_{bulk}}{\rho_d} = (1+w)$$

$$\Rightarrow \rho_{bulk} = (1+0.1) * 22 = 24.2 \text{ kN/m3}.$$

What is the relation between test load of pile & working load?.

Ans:

Q.28 PDB-11

If a pile 500 mm has driven 15 m. Undrained shear strength at top is 10 kN/m² and at base is 150 kN/m². If adhesion factor 0.4 & F.S. is 3. Then calculate safe load.

soln:

i) Ultimate skin friction, $Q_s = \alpha c_u A_s$

$\therefore Q_s = 0.4 * 10 * \pi * d * l$

$= 4 * \pi * 0.5 * 15$

$= 94.25$ kN.

Here,
$\alpha = 0.4$
$c_{u_t} = 10$ kN/m²
$c_{u_b} = 150$ kN/m²
F.S = 3.
d = 500 mm
= 0.5 m
l = 15 m.

ii) Ultimate End bearing capacity:

$Q_p = 9 c_u A_p$

$= 9 * 150 * \frac{\pi}{4} * 0.5^2$

$= 265.07$

∴ Ultimate load capacity of pile:

$= 94.25 + 265.07$

$= 359.32$ kN.

∴ safe load $= \frac{359.32}{3}$

$= 119.78$ kN.

2.29 How can we improve ground surface?

Ans:

2.30 What is the allowable differential settlement for sandy soil?

Ans: For sands:

Max^m total settlement = 40mm for isolated footings
= 40 to 65 mm " rafts
= 25 mm between adjacent columns

Clays:

= 65 mm for isolated footings.
= 65 to 100 " rafts.
= 40mm " adjacent columns.

Write down rules for corner reinforcement.

Ans: (i) Spiral rein. shall be provided at extension corner in both bottom & top of the slab, from the corner equal to 1/5th the longer span of the corner panel.

(ii) Corner rein. at the top of the slab will be parallel to a line bisecting the angle of the relevant corner.

(iii) The corner rein. at the bottom of the slab will perpendicular to a line bisecting the angle at the relevant corner.

(iv) The corner rein. of top & bottom shall be of size & spacing = Max^m (+ve) moment in the panel.

Find the vertical stress & total stress in a depth of 8m where the unit wt. of saturated soil is 18 kN/m^3 & unit wt. of water is 9.81 kN/m^3.

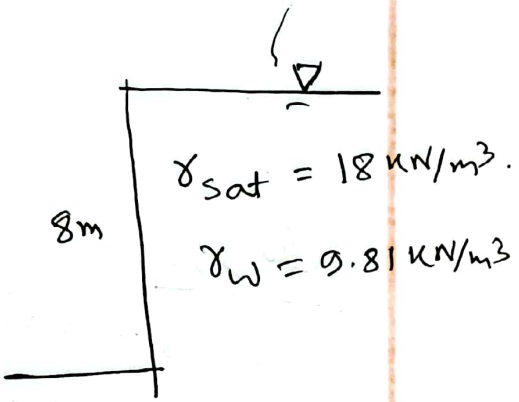
Soln: Effective stress

$\sigma_v' = \gamma' H$

$= (\gamma_{sat} - \gamma_w) H$

$= (18 - 9.81) * 8$

$= 65.52$ kN/m^2.



$\sigma_T = \sigma_v = 65.52$ kN/m^2.

$\sigma_T = \gamma_{sat} H = 18 * 8 = 144$ kN/m^2 (Ans)

$\sigma_v = 144$ kN/m^2 (Ans)

Write down the six points of Bus Rapid Transit.

Soln:

1) Give buses their own lanes.
2) Run buses very frequently.
3) Having traffic signals factors in buses.
4) Make boarding quick.
5) Make getting to bus stops safe & easy.
6) Give bus system a cool brand.
7) Use big buses with extra features.

Define claim? Difference between contractual & extra contractual claim.

Soln:

Claim: A claim is defined as any application by the contractor to the engineer pursuant to any relevant clause of the contract for any additional payment extension of time or damages for any alleged breach of duty by the employer, the engineer or any other party in connection with the contract.

Extra Contractual claim: arising from common law entitlement but without any specific basis in the contracts

Contractual claim: Arising from specific cla. in the contract..

A wide channel having $n = 0.026$, $S_0 = 0.0028$ calculate the normal depth and velocity of flow if the channel discharges $30 m^3/sec$.

Soln:

Normal depth,

$$h_n = \left(\frac{nq}{\sqrt{S_0}}\right)^{3/5}$$

$$= \left(\frac{0.026 * 30}{\sqrt{0.0028}}\right)^{3/5}$$

$$= 5.02 \text{ m} \quad \text{(Ans)}.$$

Here,
$n = 0.026$
$q = Q = 30 m^3/sec$.
$S_0 = 0.0028$
$A = h_n * = R$ For wide channel.

& velocity of flow, $V = \frac{Q}{A}$

$$= \frac{30}{h}$$

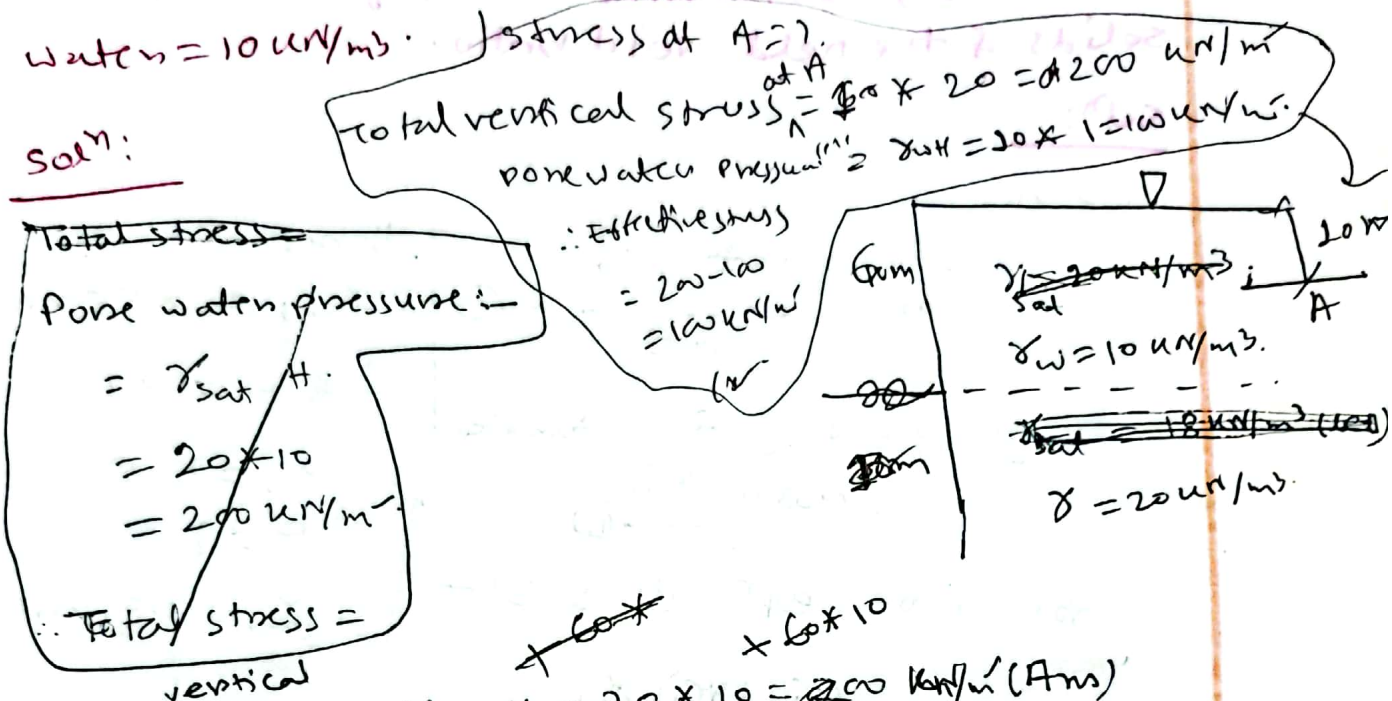
$$= \frac{30}{5.02}$$

$$= 5.98 m s^{-1}$$

(Ans).

Find the effective stress & total vertical stress at 10m below of a river, where the depth of river is 60m. Unit wt. of soil = 20 kN/m³ & unit wt. of water = 10 kN/m³.

Soln:



Total Stress = $\gamma_{sat} H = 20 \times 10 = 200$ kN/m² (Ans)

Pore water pressure = $\gamma_w \cdot H = 10 \times 10 = 100$ kN/m² (Ans)

∴ Effective stress = 200 - 100 = 100 kN/m² (Ans).

N.B.: Allowable axial compressive force:

$$P = \alpha \phi \{0.85 f_c' (A_g - A_{st}) + A_{st} f_y\} = \alpha \phi P_n$$

(× Design capacity curve)

Ultimate axial compressive force:

$$P_u = \phi \{0.85 f_c' (A_g - A_{st}) + A_{st} f_y\} = \phi P_n$$

Nominal strength / ~~Design strength~~ :

$$P_n = 0.85 f_c' (A_g - A_{st}) + A_{st} f_y.$$

(Design strength = $\alpha \phi P_n$)

Here, $\alpha = 0.8$ & $\phi = 0.65$ (for tied column)

$\alpha = 0.85$ & $\phi = 0.75$ (" spiral ")

Q.37 The saturated unit wt. and the water content in the field are found to be 18.55 kN/m3 & 33% respectively. Determine the sp. gravity of the soil solids & the field void ratio.

Soln:

We know,

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e} \quad \text{—(I)}$$

& $e = wG_s$ (for saturated soil)

$= 0.33 G_s$ —(II)

Now from eqn (I) & (II) —

$$\gamma_{sat} = \frac{(G_s + wG_s)\gamma_w}{1 + wG_s}$$

$$\Rightarrow 18.55 = \frac{(G_s + 0.33G_s) * 9.81}{1 + 0.33 G_s}$$

$$\Rightarrow G_s = 2.68 \quad \text{(Ans)}$$

Now, from eqn (II)

$$e = 0.33 * 2.68 = 0.88 \quad \text{(Ans)}.$$

Here,

$\gamma_{sat} = 18.55$ kN/m3.

& $w = 33\%$.

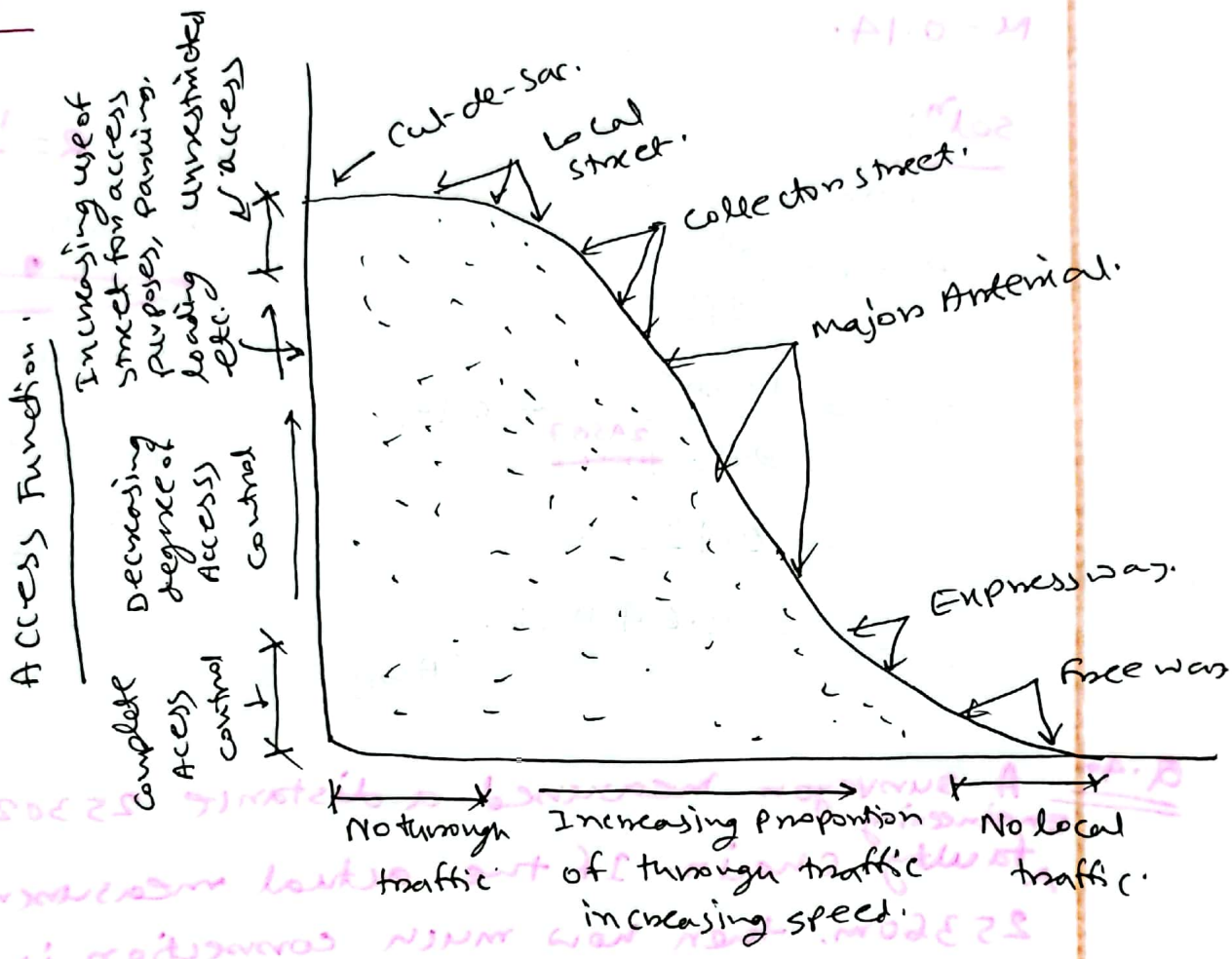
$G_s = ?$

$e = ?$

$\gamma_w = 9.81$ kN/m3.

Q.38 Schematic Relationship Between Access & movement functions of streets. / Show diagramatic relationship betn local roads & highway transportation system.

Ans:



Q.39 Determine the superelevation in inches. A road is 24' wide. Design speed is 50 kmph. The degree of curvature is 7°. Coefficient of friction is $\mu = 0.14$.

Soln:

We know,

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

$$\Rightarrow e = \frac{13.89^2}{9.81 \times 245.57} - 0.14$$

$$= 0.12 \text{ m}$$

$$= 4.64 \text{ inch.}$$

(Ans).

Here, $R = \frac{1719}{D} = \frac{1719}{7} = 245.57$ m

$B = 24'$

~~$R = \frac{1750}{D} = \frac{1780}{7} = 250$ m~~

~~$= 7622$ m~~

$\mu = 0.14 = f$

$V = 50$ kmph

$= \frac{50 \times 1000}{3600}$ m/s

$= 13.89$ m/s.

Q.40 A surveyor measured a distance 25302 m by an Engineering ^faulty chain. If the actual measurement is 25360 m, then how much correction is required).

Soln:

We know, True length $= \frac{\text{Wrong scale}}{\text{Correct scale}} \times$ Measured length.

$$\Rightarrow 25360 = \frac{L_e}{L_c} \times 25302$$

$$\Rightarrow L_e = \frac{25360}{25302} * 30.49$$

[Here, for Engineering chain, $L_c = 100'$ $= 30.49$ m]

$\therefore L_e = 30.56$ m.

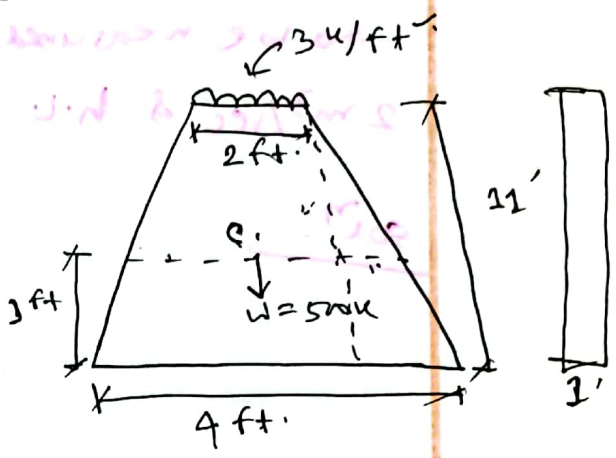
$\therefore$ So, chain should be shortened by $= 30.56 - 30.49$

$= 0.07$ m (Ans).

Q.41 DPDC

Find out the stress at point, C, on Find out the stress above 1ft from base of the Pile?.

soln: For Circular section—



Dia at top = 2'

Dia at bottom = 4'.

Dia at $C = 2 + 2 * \frac{10}{11} * \left(\frac{4-2}{2}\right)$

$= 2 + 1.82$

$= 3.82$ ft.

$\therefore$ Load at section $C = \frac{3\pi * 2^2}{4} = 9.425$ k.

$\therefore$ Area at $C = \frac{\pi * (3.82^2)}{4} = 11.46$ ft².

$\therefore$ stress at $C = \frac{500 + 9.425}{11.46} = 44.45$ k/ft².

For Rectangular section:

$\therefore$ cross sectional area, at C = $3.82 * 1 = 3.82$ ft².

$\therefore$ Total load at $C = 3 * 2 * 1 = 6$ k.

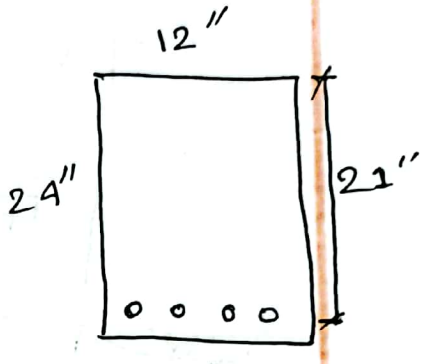
$\therefore$ Stress $S = P/A = \frac{500 + 6}{3.82} = 132.46$ k/ft².

The value of pressure, elevation & dia of a point P in a pipe section are given. Another point is Q whose elevation & dia are given, pressure has to be measured. given discharge from P to Q is $2\ m^3/sec$ & h.l. = 1 m.

Soln:

The width, effective depth & reinforcement of a beam section is given. $f'_c = 3000$ psi & $f_y = 60000$ psi. Find if the tension control section is provided & the design strength.

Soln:



Q.44 Draw a typical rein. details of column, beam joint, cantilever beam; slab panel surrounding by four peripheral beam.

Rajuu V Thapa
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-16

Ans:

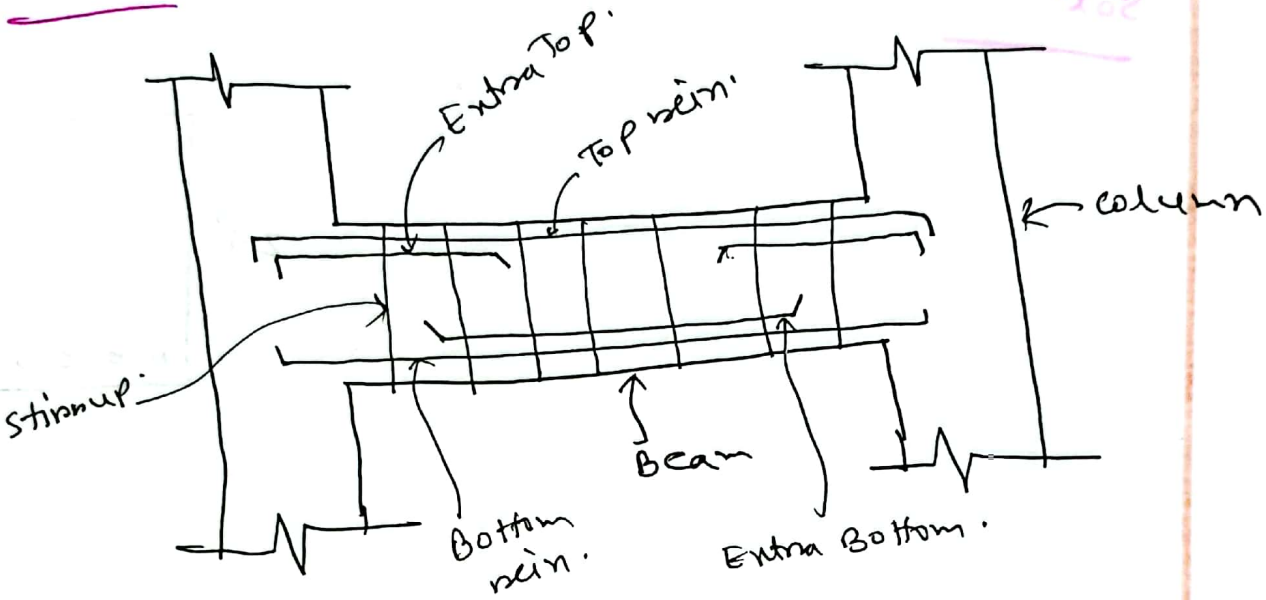


Fig: column beam joint details.

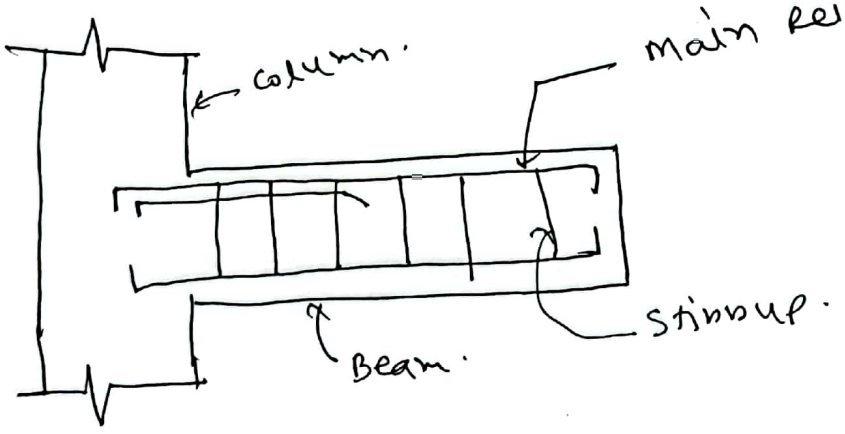
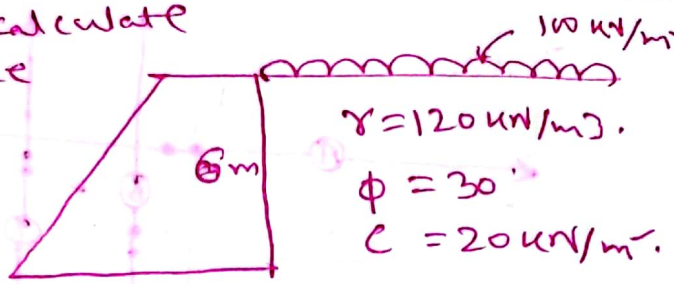


Fig: Cantilever Beam.

Q.45 Determine the active earth pressure at bottom. Also calculate the active force & $\bar{y}$.



Soln:

For Active earth pressure, we know—

$$\sigma_a' = K_a \sigma_o' - 2c\sqrt{K_a} \quad \text{—①}$$

Here, $K_a = \frac{1-\sin\phi}{1+\sin\phi} = \frac{1-\sin 30'}{1+\sin 30'} = 0.33$

At, $z = 0$, $\sigma_o' = 100\ kN/m^2$.

$\therefore \sigma_a' = 0.33 * 100 * 2 * 20\sqrt{0.33} = 10.02\ kN/m^2$.

$= 55.98\ kN/m^2$.

At, $z = 6m$, $\sigma_o' = 100 + 120 * 6 = 820\ kN/m^2$

$\therefore \sigma_a' = 0.33 * 820 - 2 * 20\sqrt{0.33}$

$= 247.63\ kN/m^2$. (Am).

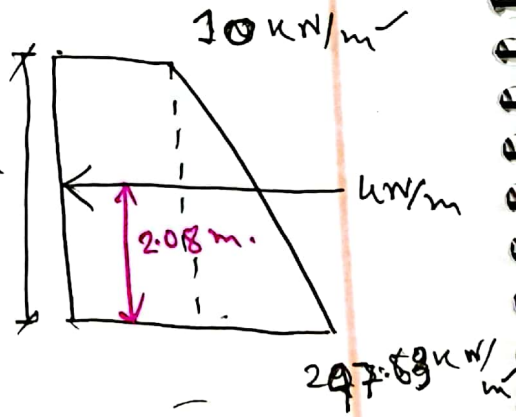
$\therefore$ Lateral active force—

$P_a = 10 * 6 + \frac{1}{2} * 6 * (247.63 - 10)$

$= 772.89\ kN/m$

$\therefore \bar{y} = \frac{10 * 6 * 3 + (247.63 - 10) * 6 * \frac{1}{2} * \frac{6}{3}}{772.89}$

$= 2.08m$



A pipe is lying at head of 525 m one end P and other end Q elevation is 580. Diameter of P & Q is 50 cm & 75 cm respectively. Discharge from P to Q is 0.02 m^3/sec. If pressure at P is 1000 kN/m^2. Determine the pressure at Q. Head loss is 1 m.

Soln:

$$V_P = \frac{0.02}{\frac{\pi}{4} \times 0.5^2} = 0.1 \text{ m/s}$$

$\therefore Z_P = 525$ m.

$\therefore P_P = 1000$ kN/m^2.

$$V_Q = \frac{0.02}{\frac{\pi}{4} \times 0.75^2} = 0.045 \text{ m/s}$$

$Z_Q = 580$

$P_Q = ?$

$h_L = 1$ m.

$$\therefore Z_P + \frac{V_P^2}{2g} + \frac{P_P}{w} = Z_Q + \frac{V_Q^2}{2g} + \frac{P_Q}{w} + h_L$$

$$\Rightarrow 525 + \frac{0.1^2}{2g} + \frac{1000}{9.81} = 580 + \frac{0.045^2}{2g} + \frac{P_Q}{9.81} + 1$$

$\therefore P_Q = 450.64$ kN/m^2.

Write short note on — a) PPM b) Modulus of rigidity.

Ans:

i) PPM: ppm or parts per million usually describes the concentration of something in water or soil. 1 PPM is equivalent to 1 mg of something per liter of water (mg/l) or 1 mg of something per kg soil (mg/kg).

ii) Modulus of of Rigidity: Modulus of rigidity or shear modulus is defined as the ratio of shear stress to the displacement per unit sample length (shear strain)."

$$G = \frac{\text{shear stress}}{\text{shear strain}}.$$

Modulus of Elasticity = $\frac{\text{linear stress}}{\text{linear strain}}$

Poissons ratio = $\frac{\text{lateral strain}}{\text{longitudinal strain}}$

Hooks law = stress α strain.

What is water Hammer? what is it effects?

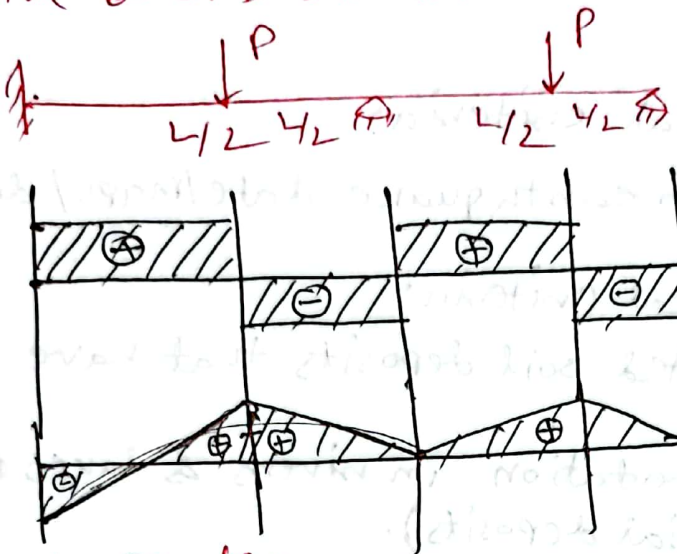
Ans: Water Hammer (or more generally, fluid hammer) is a pressure surge or wave caused when a fluid (usually a liquid but sometimes also a gas) in motion is forced to stop or change direction suddenly (momentum change).

Effects: This pressure wave can cause major problems from noise & vibration to pipe collapse. It is possible to reduce the effects of water pulses with accumulators, expansion tanks, surge tanks & other features.

48 BMA

~~Solved Problems~~

Qualitative SFD & BMD:



Causes of Earthquake.

Ans:

→ Earthquake occur when energy stored in elastically strained rocks is suddenly released.

→ This release of energy causes intense ground shaking in the area near the source of the earthquake (Focus) and sends waves of elastic energy, called seismic waves, in all directions throughout Earth.

→ Earthquakes can be generated by bomb blasts, volcanic eruptions, and sudden slippage along faults.

→ Earthquakes are definitely a geologic hazard for people liven in earthquake regions; but the seismic waves generated by earthquakes are invaluable for studying the interior of the earth.

Criteria of Liquefaction.?

Ans:

A.) Historical criteria:
- earlier earthquake date/maps/documents available

B) Geological Criteria:
- Saturated soil deposits that have been created by
  - sedimentation in rivers & lakes (fluvial or alluvial deposits).
  - deposition of debris or eroded materials (colluvial deposits).
  - or deposits formed by wind action (Aeolian deposits) can be very liquefaction susceptible.

C) Compositional Criteria:
- Soil types clay/sand/silt.
- Composition of soils.

What is the light weight concrete).

Ans:

Light weight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities and lessened the dead weight. It is lighter than conventional concrete.

Difference between plan & planning.

Ans:

→ Planning is an active ongoing process, while plans are the documentation of that discussion at one point of a time.

→ Planning aims to mitigate problems & changes; yet bells in mind that the only constant in life is change.

→ Planning does not guarantee success; yes its absolutely necessary.

→ planning is the process to create plan.

Difference between Determinate & Indeterminate structures.

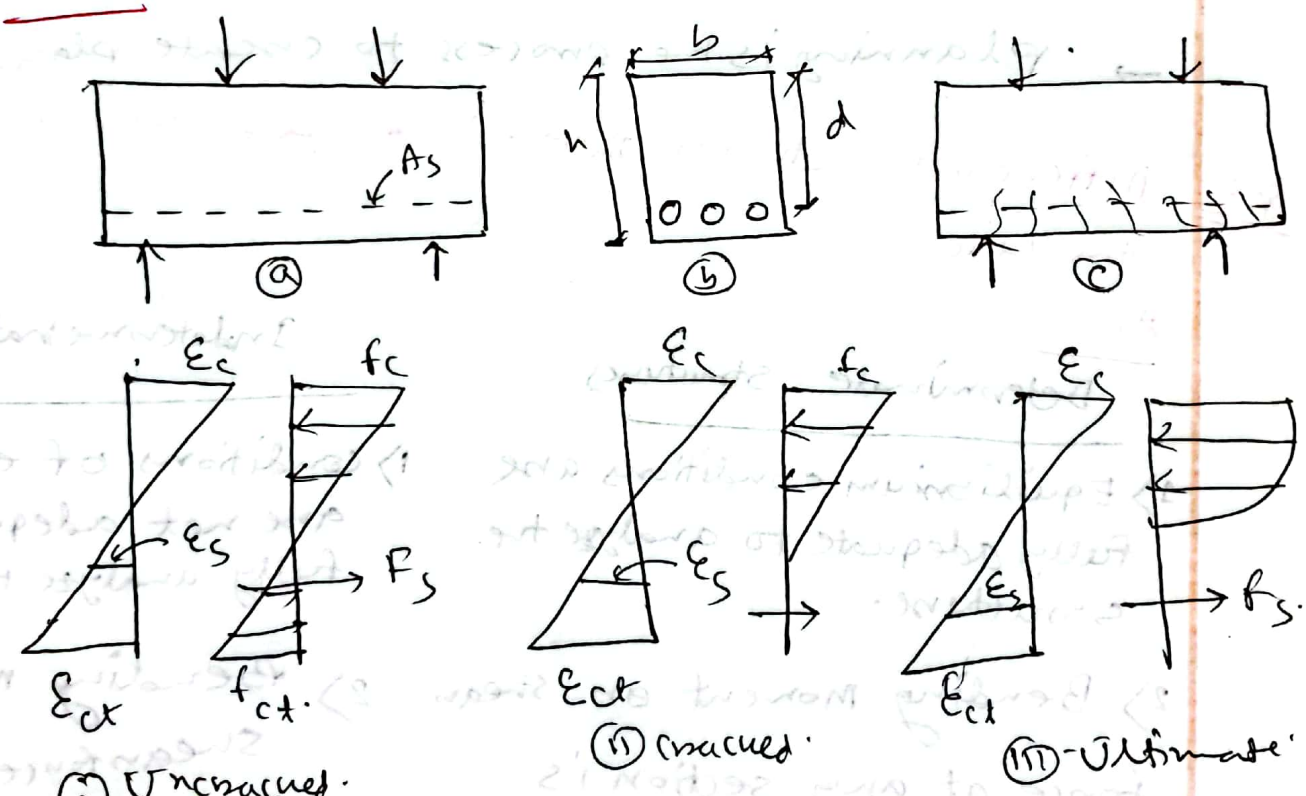
Ans:

Determinate structures	Indeterminate structures
1) Equilibrium conditions are fully adequate to analyze the structure.	1) conditions of equilibrium are not adequate to fully analyze the structure.
2) Bending moment or shear force at any section is independent of the material property of the structure.	2) Bending moment or shear force at any section depends upon the material property.
3) No stresses are caused due to lack of fit.	3) Stresses are caused due to lack of fit.

D.S	I.S
4) BM and SF at any section is independent of the cross section or moment of Inertia.	4) The BM on SF at any section depends upon the cross section or moment of Inertia.
3) Temperature variations do not cause stresses.	5) Temperature variations cause stresses.

Q.10 Draw Stress strain diagram (i) Uncracked (ii) cracked & for (iii) Ultimate condition.

And:



Q.11 What is cellular coffer dam ? Its effect ?.

Ans:

The cellular coffersdam is made of steel sheet piles. It is mostly used for de-watering large areas in places where the depth of water may be of the order of 18 to 21 m.

There are two types of :

a) circular type of cellular coffersdam.

b) Diaphragm type " "

Effects:

i) suitable for moderate to large heights.

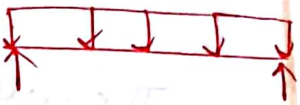
ii) generally used to provide a water barrier.

Q.12 From dynamic compaction, a weight of 18 tonnes drop from a height 2 m. what is compaction depth.

Soln: see in Ques. No. 75.

Q.13 Draw SFD & BMD:

a) 

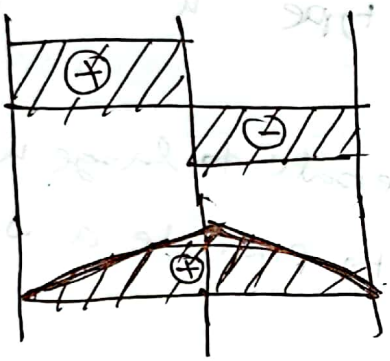
b) 

c)

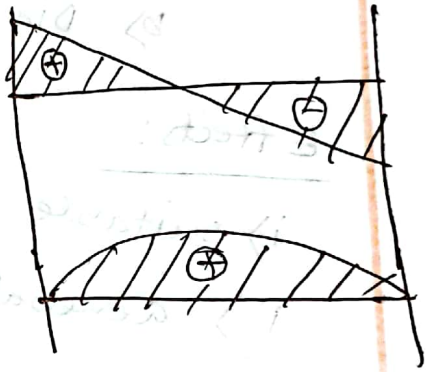
d) 

Soln:

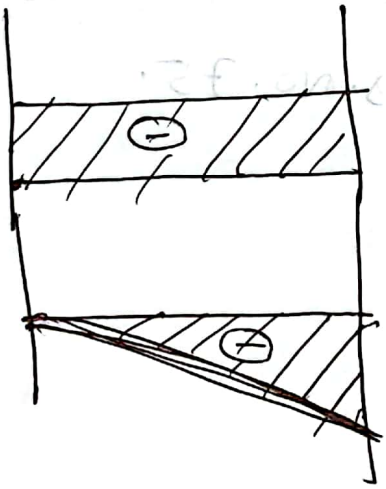
a) 

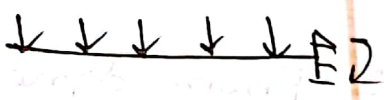
SFD → BMD → 

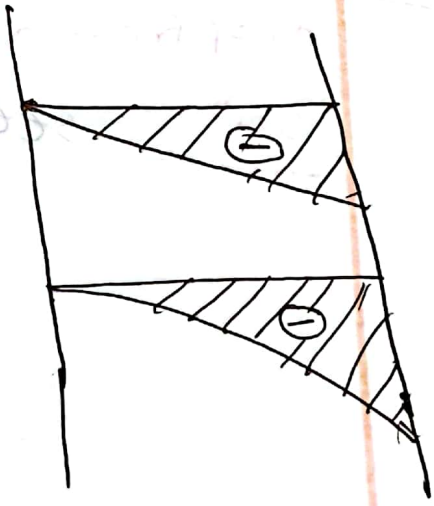
b) 



c) 

SFD → BMD → 

d) 



What is gravity dam? which loads are carried by gravity dam?

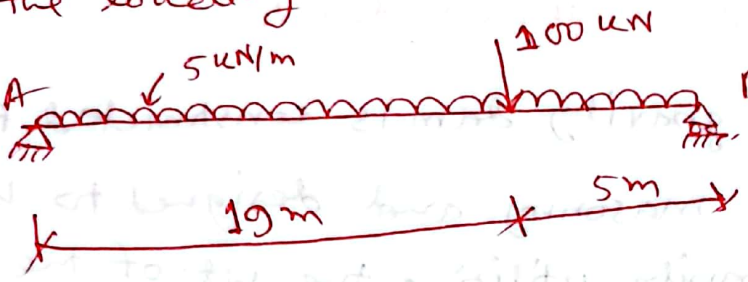
Ans: A gravity dam is constructed from concrete or stone masonry and designed to hold back water by primarily utilizing the wt. of the materials alone to resist the horizontal pressure of water pushing against it.

Loads carried by gravity dam:

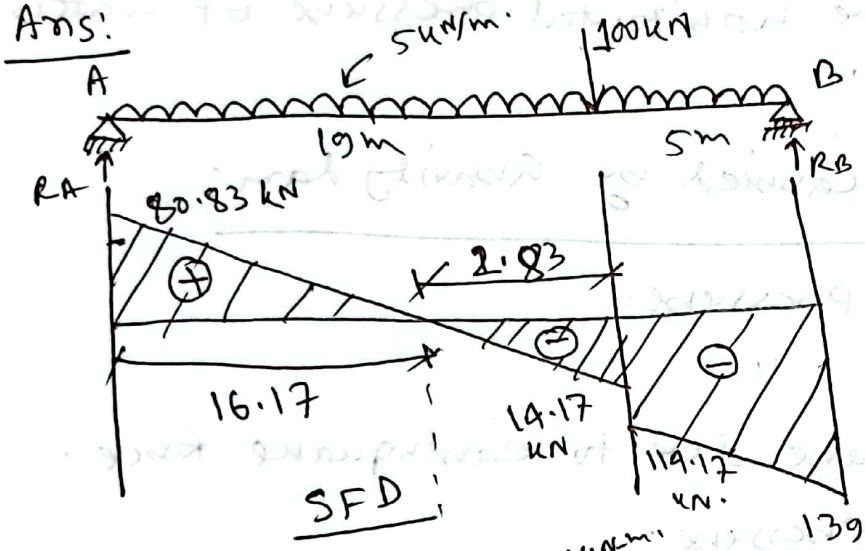
i) water pressure.
ii) Uplift "
iii) pressure due to earthquake force.
iv) silt pressure.
v) wave "
vi) Ice "
vii) The stabilizing force is the wt. of the dam itself.

PSC NON Cadre Question & Solutions.

Draw the SFD & BMD of a simple supported for the loading shown below:



Ans:



SFD

$\Sigma M_A = 0$;

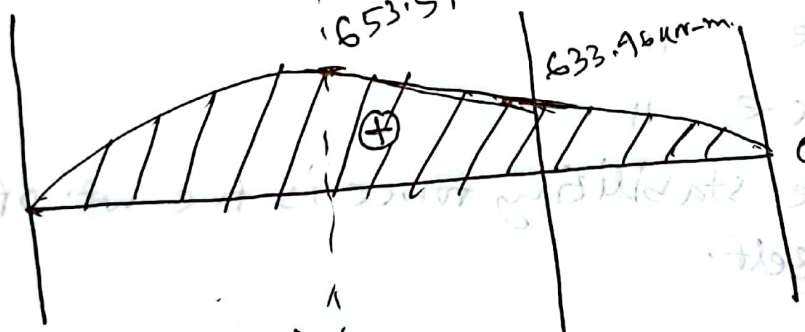
$\Rightarrow 100*19 + 5\frac{*19}{2} + .5*5(19+5/2) = R_B * 24$

$\Rightarrow R_B = 139.17$ kN

$\Sigma F_y = 0$;

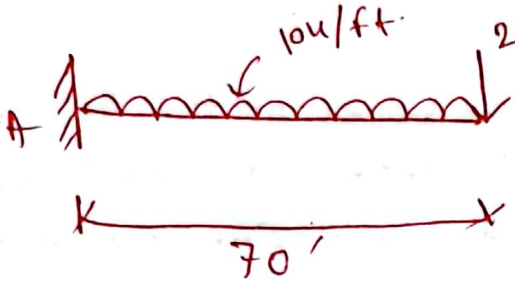
$R_A + R_B = 100 + 120$

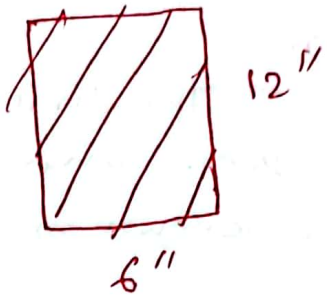
$\therefore R_A = 80.83$ kN.



BMD

Find out the deflection of the cantilever beam AB at a point B. Assume, $E = 12 * 10^6$ PSI





Soln:

Here, $b = 6''$

$h = 12''$

$\therefore I = \frac{6 * 12^3}{12} = 864 in^4 = 41.67 * 10^{-3}$ ft^4

we know,

Deflection of the cantilever beam with uniformly distributed load —

$$\Delta = \frac{WL^3}{3EI} + \frac{WL^4}{8EI} + \frac{WL^3}{3EI}$$

$$= \frac{10 * 70^4 * 10^3}{8 * 12 * 10^6 * 864} + \frac{10 * 70^3}{3 * 1.73 * 10^6 * 41.6 * 10^3}$$

$= 2.89$ inch.

Here, $E = 12 * 10^6$ PSI

$= 1.73 * 10^6$ ksf.

N.B.:

$\Delta = \frac{WL^3}{3EI}$

$\Delta = \frac{WL^4}{8EI}$

$$\therefore \Delta = \frac{10 * 70^4}{8 * 1.73 * 10^6 * 41.67 * 10^{-3}} + \frac{10 * 70^3}{3 * 1.73 * 10^6 * 41.6 * 10^{-3}}$$

$= 416.33 + 15.89 = 432.22$ ft. [which is practically impossible]

Q.3 ⓐ What is meant by Cant or superelevation on railway curves).

Ans:

The difference of the level of the inner rail (higher) and outer rail (lower) of the turn out is known as negative superelevation or Cant.

ⓑ A train will move at a speed of 70 km/hour on a ~~4th~~ 4° curve in meter gauge rail line. Determine the equilibrium superelevation on this line.

Ans:

We know,

$$S = \frac{v^2 G}{gR}$$

$$= \frac{19.44^2 * 1}{9.81 * 436.63}$$

$$= 0.0882 \text{ m}$$

$$= 3.47 \text{ inch}.$$

Here,

$G = 1$ m for meter gauge.

$g = 9.81 \text{ ms}^{-2}$

$R = \frac{1746.5}{D}$

$= \frac{1746.5}{4} = 436.63$ m

$S = ?$

$V = 70$ km/hr

$= 19.44 \text{ ms}^{-1}$

Q.4 A R.C.C. tied column is supposed to carry an axial load of 250 metric ton. Find out the diameter and amount of reinforcement for design. Given effective length of column is 3.50 m, $f_c' = 200 kg/cm^2$, $f_y = 3500 kg/cm^2$, $n = 9$.

Soln:

We know,

Allowable axial compressive force of a column —

$$P_u = \phi \{0.85 f_c' (A_g - A_{st}) + A_{st} * f_y\}$$

$$937.5 = 0.8 * 0.65 \{0.85 * 2.84 (A_g - 9A_s) + 9A_s * 49.67\}$$

$$\Rightarrow 1802.88 = 2.41 A_g - 21.73 A_s + 447.03 A_s$$

$$\Rightarrow 1802.88 = 2.41 * 240 - 21.73 A_s + 447.03 A_s$$

$$\Rightarrow 1224.48 = 425.3 A_s$$

$\therefore A_s = 2.88 in^2$. [which is greater than 1% rein. Hence ok.]

$\therefore$ 10 Nos. 16 mm ϕ is required.

$\therefore$ Amount of rein. $= \frac{d^2}{162.2} * 3.50 * 10 *$

$= \frac{16^2}{162.2} * 3.5 * 10$

$= 55.24 kg$ (Ans).

Given,

$P = 250$ m.ton

$= \frac{250 * 1000 * 2.2}{2 * 1000} = 625 k$

$= 113636.36 lb.$

$= 113.64 kip.$

$P_u = 1.5 * 625 = 937.5 kip$

$d = ?$

$A_s = ?$

$L = 3.50$ m.

$f_c' = 200 kg/cm^2$

$= \frac{200 * 2.2}{(\frac{1}{2.54})^2 * 1000}$

$= 2.84 ksi$

$f_y = 3500 kg/cm^2$

$= 49.67 ksi$

$n = 9$

Let, #16 mm.

$b = 12''$

$h = 20''$

$\therefore A_g = 240 in^2$

Find out the volume of brick chips, sand and cement of a R.C.C. roof slab of 15cm thickness having 4m * 7.5 m in size of ratio 1:2:4.

Soln:

Volume of slab = $4 * 7.5 * \frac{15}{100}$

= 4.5 m3

= 158.79 cft.

∴ For 1:2:4 ratio →

$x(1+2+4) = 1.5 * 158.79$ [Dry wt. = 158.79 cft. Wt. wt. = 1.5 * 158.79 cft.]

$\Rightarrow x = 34.03$ cft.

∴ cement = 34.03 cft $= \frac{34.03}{1.25} = 27.22 \approx 28$ bag.

∴ sand = 2 * 34.03 = 68.06 cft.

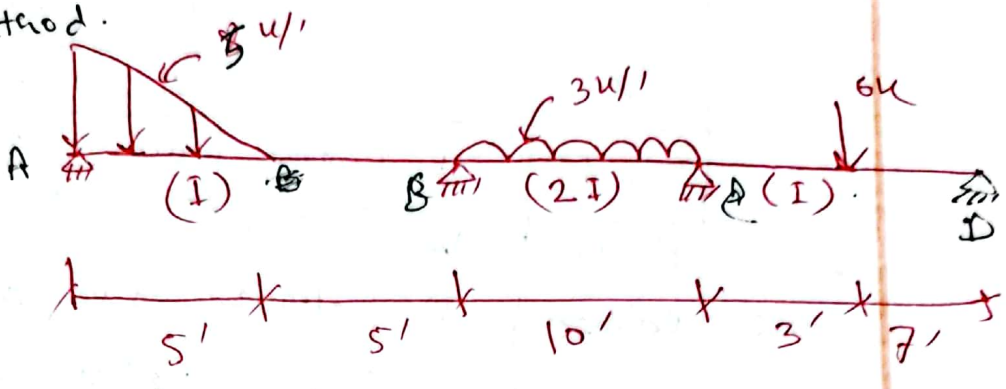
∴ Brick chips = 4 * 34.03 = 136.12 cft.

Ans.

MOMENT DISTRIBUTION METHOD

Q.1 Draw SFD & BMD of the following figure, using moment distribution method.

Soln:



Relative stiffness, $k = \frac{I}{L}$

$K_{AB} = \frac{1}{10} = 1$

$K_{BC} = \frac{2}{10} = 2$

$K_{CD} = \frac{1}{10} = 1$

Fixed End moment: FEM

$M_{AB} = \frac{23wL^2}{960} = \frac{23*5*10^2}{960} = 12\ k'$

$M_{BA} = -\frac{7wL^2}{960} = \frac{7*5*10^2}{960} = -3.6\ k'$

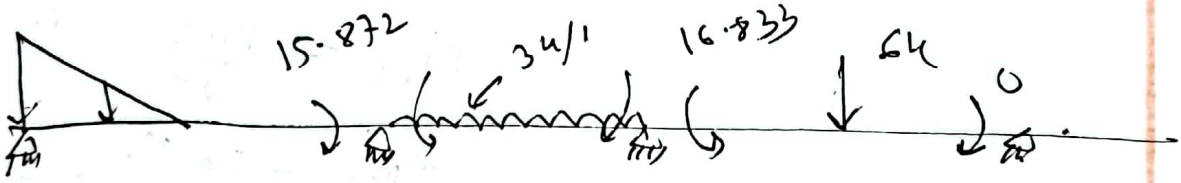
$M_{BC} = \frac{wL^2}{12} = \frac{3*10^2}{12} = 25\ k'$

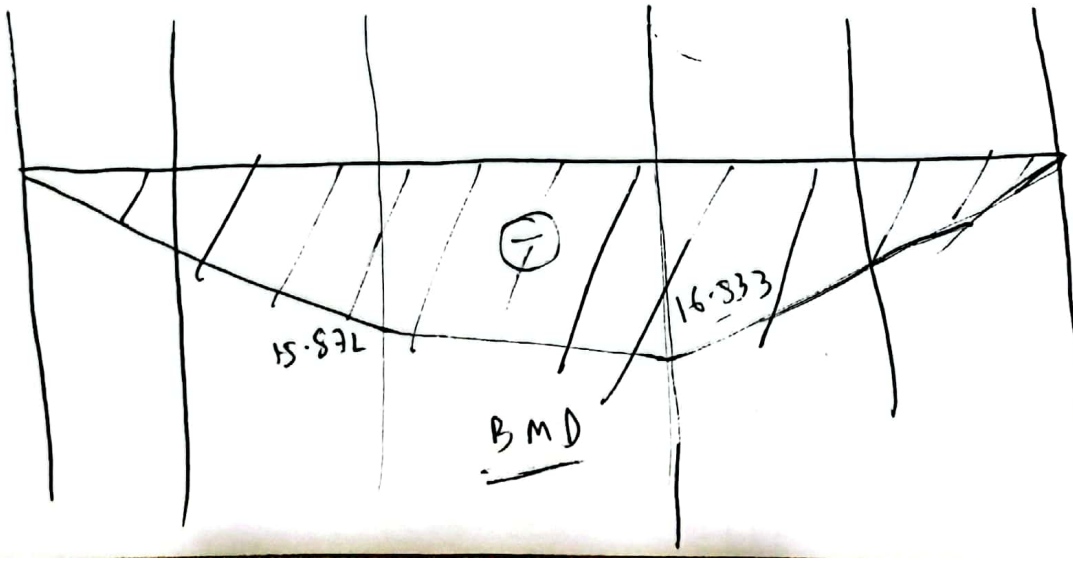
$M_{CB} = -\frac{wL^2}{12} = -\frac{3*10^2}{12} = -25\ k'$

$M_{CD} = \frac{Pab^2}{l^2} = \frac{6*7^2*3}{10^2} = 8.82\ k'$

$M_{DC} = -\frac{Pa^2b}{l^2} = -\frac{6*3^2*7}{10^2} = -3.78\ k'$

	Joint	A	B		C		D
	Member	AB	BA	BC	CB	CD	DC
	K	1	1	2	2	1	1
	D.F	1	0.33	0.67	0.67	0.33	1
1st cycle.	FEM	12	-3.6	25	-25	8.82	-3.78
	Balance.	-12	-7.062	-14.338	10.84	5.34	3.78
2nd cycle	CO	-3.531	-6	5.421	-7.169	1.89	2.67
	Balance	3.531	0.1991	0.388	3.537	1.742	-2.67
3rd cycle.	CO	0.096	1.761	1.769	0.194	-1.335	0.871
	Balance	-0.096	-1.167	-2.368	0.764	0.377	-0.871
	Total	0	-15.872	15.872	-16.833	16.833	0





Q.47 On a 2-way traffic road the speed of overtaking and overtaken vehicles are 65 and 40 kmph respectively. Take, perception reaction time 2.5 sec and deceleration 0.92 m/sec². Determine safe Overtaking sight distance?

Ans:

we know, safe overtaking sight distance for a two way traffic = $d_1 + d_2 + d_3$

Here, V_a = 65 kmph = 18.05 m/s

V_b = 40 kmph = 11.1 m/s.

a = 0.92 m/sec²

t = 2.5 sec.

Now, $d_1 = V_b t = 11.1 * 2.5 = 28$ m

$d_2 = V_b T + 2S$

$= 11.1 * 7.74 + 2 * 13.77$

$= 113.45$ m.

$d_3 = V_a T = 18.05 * 7.74 = 139.71$ m

$\therefore OSD = d_1 + d_2 + d_3$

$= 28 + 113.45 + 139.71$

$= 281.16$

$\simeq 282$ m (Ans).

$S = 0.7 V_b + 6$

$= 0.7 * 11.1 + 6$

$= 13.77$ m.

$T = \sqrt{\frac{4S}{a}}$

$= \sqrt{\frac{4 * 13.77}{0.92}}$

$= 7.74$ s

Q.96

96-BMA

Fill in the Blanks!

a) 1 kN = 101.94 kg.

b) 1 MPa = 145 PSI

c) Distribution of various size of particles is called Grading / Sieving.

d) Standard width of a single lane road is 3.75 m.

e) Maximum dry density is obtained at optimum moisture content.

f) For standard proctor tests the dia of mould is 4" (100mm).

g) Unit wt of concrete is 150 pcf

h) Marshall test % of ....

PACB-15

Q.97

True/False:

1) ACV test is done for weaker aggregates particle.

→ False.

Corr. Ans: For stronger aggregate [less ACV value, indicates more stronger aggregate, ACV ≤ 45% for base course and ACV ≤ 30% for surface course [Khanna-410]

2) The aggregate sample for AIV test has to be oven dried for 24 hours - False.

Corr. Ans: .... dried for a period of 4 hours - (Gupta-78).

Q.3 Cycle time is obtained by adding the loss time with effective green. Tbell.

Ans: Cycle time $\Sigma ax+b$ [where, a & b are constant]

$\therefore X = \frac{L}{1-S}$ | L = Loss time. S = Degree of saturation flow rate.

Degree of saturation flow rate (S) : The no. of vehicle that can be moved in one lane in one hour assuming the signal to be green always.

4) Level of service indicates approaching unstable flow condition → False.

Con. Ans: E → Unstable Flow, operating at capacity
D → Approaching unstable flow.

5) Most ~~Road~~ Round Particle have most → minimum amount of intergranular voids. → False.

Con. Ans: Rounded Agg. → 32 to 33%, Partially rounded → 35 to 37%, Angular → 38 to 45%.

6) Theodolite instrument can be used as level. → False.

Con. Ans: measuring angles in horizontal & vertical ~~dir~~ direction.

Q.48 A rapid sand filter operating at 2 gpm per sq. ft needs washing after 24 hrs of operation. The filter has an area of 350 sq. ft and it needs washing at the rate of 15 gpm per sq. ft for 5 min. What percent of water that is filtered will be required for wash water?

Ans:

Obtained filter water = 2 gpm * 24 hrs * 60 min * 350 ft²
= 1008000 gallons.

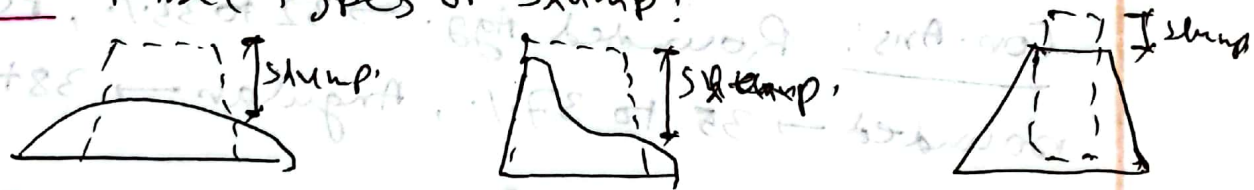
water required for washing purpose = 15 * 5 * 350
= 26250 gallons.

So, % filter water required = $\frac{26250}{1008000}$ * 100.

= 2.6 % (Ans).

Q.49 What is the indication of true slump, shear slump and collapse slump.

Soln: Three types of slump:



(a) Collapse slump (b) Shear slump (c) True slump

fig: Diff^n types of slump.

Values of slump: i) R.C.C. Footing → 20mm - 80mm.
ii) Beam → 20mm - 100mm.
iii) Column → 20mm - 100mm.
iv) Pavement or slab → 20 - 80mm
v) Canal → 20mm - 80mm.

Q.50 Desco -15

A car saw a crash in front of it. If the driver stopped the car 5m in front the crash, find the distance, it has travelled. given Perception time = 2.5sec.

Soln:

We know, Stoping sight distance (SSD) = $Vt + \frac{V^2}{2gf}$.

$\therefore$ SSD = Lag distance (Vt) + breaking distance

$\Rightarrow 5 = V*2.5 + \frac{V^2}{2*9.81*0.37}$ | Let, $f = 0.37$

$\therefore V = 1.82 m/s$

$\therefore$ Lag distance = Vt.

$\therefore$ SSD = Lag distance + $\frac{V^2}{2gf}$.

$\Rightarrow 5 = \frac{1.82^2}{2*9.81*0.37} + $ Lag distance

$\therefore$ Lag distance = 4.54m. (Ans).

N.B.: Lag distance = Distance travelled during reaction time.

Q.51 What are the dead loads for which structural member shall be assessed?.

Ans:

i) The lengths of the material at which a structure is competent.

ii) The wt. of permanent equipments such as gas or water pipes, or electrice cables etc.

Q.52 What is the information to be included in a building plan while submitting for approval of competent authority?.

Soln:

According to building control regulations 2003.

i) Building plans.

ii) Detailed structural plans and design calculations

iii) site formation plans and pile layout plans.

iv) where applicable, civil defence shelter plans.

v) where applicable, underground building works plans.

FM calculation:

Sieve size	% Retain	% Cumulative Retained
1.18 mm	25	25 ✓
0.6 mm	25	50 ✓
0.428	25	75
0.3	25	100 ✓

Total = 250

$$\therefore F.M = \frac{25 + 50 + 100}{100} = \frac{175}{100} = 1.75 \text{ (Ans)}$$

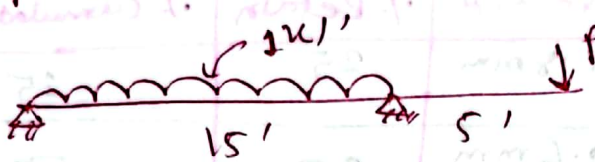
FM Calculation:

Sieve No.	Dia (mm)	wt. retained.	% wt. retained	Cumulative % retained.
4	4.75	9.7	$\frac{9.7 * 100}{472.1} = 2.05$	2.05 ✓
10	2.00	39.5	8.37	10.42
20	0.84	71.6	15.17	25.59
40	0.41	129.1	27.35	52.94
60	0.25	107.4	22.75	75.69
100	0.15	105.0	22.24	97.93 ✓
200	0.075	8.5	1.8	99.73
Pan		1.3	0.27	100

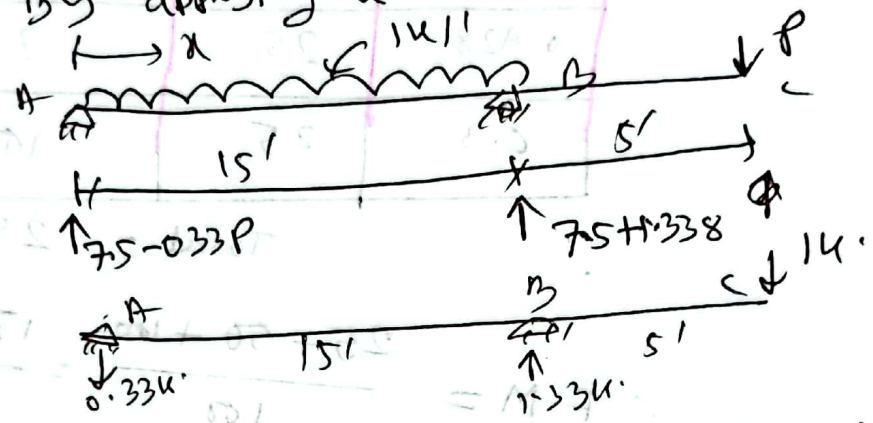
Total = 472.1 Total = 100

$$\therefore Fm = \frac{2.05 + 97.93}{100} \simeq 0.99 \text{ (Ans).}$$

Q.55 Determine the value of P for which deflection under 'P' will be zero for the beam.



Soln: By applying unit load method —



Portion	origin	Limit	M (K-ft)	m (K-ft)
AB	A	0-15	$(7.5-0.33P)\frac{x}{2}$	$-0.33x$
BC	C	0-5	$-Px$	$-x$

$\Delta = \int \frac{Mm}{EI} dx$.

$EI\Delta = \int_0^{15} [(7.5-0.33P)x - 0.5x](-0.33x)dx + \int_0^5 Px\,dx$

$= -4941.56 + 165.42P = 0 \Rightarrow P = 30$ K. (Ans)

Q.56 What are the environmental significance of BOD & COD? Mention with reasons the type of treatment system you would prefer for the following industries:

W/W Parameter	Industry-I	Industry-II
pH	8.0	12.0
BOD, mg/L	2500	250
COD, mg/L	3000	5000.

Soln:

For Industry-1:

Here,

$$\frac{COD}{BOD} = \frac{3000}{2500} = 1.2 < 2$$

Given,
pH = 8.0
BOD (mg/L) = 2500
COD (mg/L) = 3000

Since the ratio below 2.

So the material in industry-1, is biodegradable organic types.

So, measurement of biodegradable organics is usually done by the BOD test.

For Industry-2:

$$\frac{COD}{BOD} = \frac{5000}{250} = 20$$

COD >> BOD, so, non-biodegradable organic.

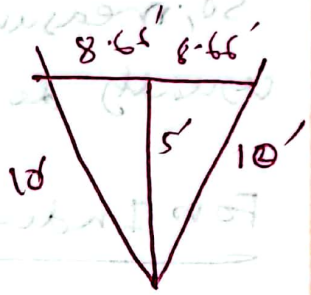
Measurement of non-biodegradable organic is usually done by COD test.

A sewer with an isosceles (two sides equal) triangular section having side of 10' with $n=0.015$ is laid on a grade of 0.018, i) what is the capacity of the sewer when the depth of flow is 5 feet). ii) what will be the velocity when the depth of flow is 3' & the section is circular with a diameter of 3/4 of the triangular same side).

soln:

i) According to Manning's formula –

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



$$R = A/P = \frac{\frac{1}{2} * 17.32 * 5}{10+10} = 2.165'$$

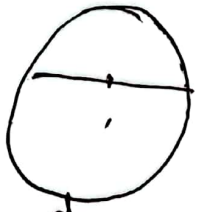
$$\therefore V = \frac{1}{0.015} * (2.165)^{2/3} \cdot (0.018)^{1/2}$$

$$= 14.968 \text{ ft/s}.$$

$$\therefore Q = AV = 14.968 * \frac{1}{2} * 17.32 * 5 = 648.1145 \text{ ft}^3/\text{s}.$$

ii) $V = \frac{1}{0.015} * (1.875)^{2/3} * (0.015)^{1/2}$

$$= 13.6 \text{ ft/s}.$$



$R = \frac{d}{4}$

$d = 3/4 * 10$

$= 7.5'$

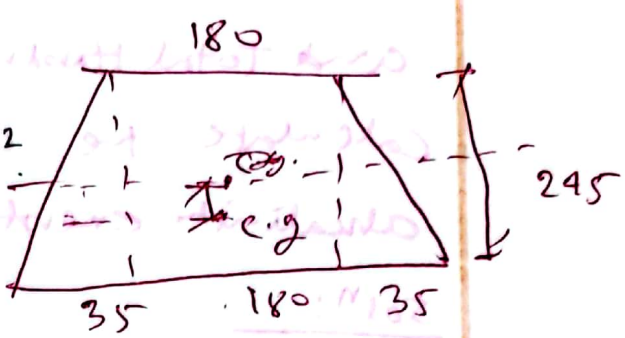
$R = \frac{d}{4} = \frac{7.5}{4} = 1.875$

Q.58 ~~Center of Gravity~~ moment of inertia calculation w.r.to to base & center

Soln.

$$\bar{y} = \frac{49100 * \frac{245}{2} + (0.5 * 35 * 245) * 2 * \frac{245}{3}}{49100 + 8575}$$

$$= 115.85 \text{ m. from top.}$$



$$I_{XX\ (\text{w.r.to c.g})} = \frac{180 * 245^3}{12} + \frac{1}{2} * 70 * 245 * (122.5 - 163.33)^2 + 70 * \frac{245^3}{12}$$

$$= 263.47 * 10^6 \text{ mm}^4$$

$$= 26347 \text{ cm}^4.$$

Q.59 A slow sand filters produces 1 million litre of water per day. How much bleaching powder with 28% available chlorine will be required per week to treat this water with chlorine of 0.5 mg/l

Soln:

Total requirement of water = $1 * 10^6$ litre/day.

∴ Quantity of chlorine required = $0.5 * \frac{1 * 10^6}{10^6}$ kg/da

= 0.5 kg/day.

∴ " " Bleaching powder required

$$= \frac{0.5}{28} * 100 \text{ kg/day}$$

= 1.79 kg/day.

Q.60 A water sample with pH = 9 had a caustic alkalinity of 70 mg/L total alkalinity of 230 mg/L and Total Hardness of 300 mg/L all as $CaCO_3$. Calculate the amount of various forms of alkalinity exerted & amount of non carbonate.

Soln:

since the pH value is 9 & hence neutralization of CO_3^{--} is only half completed. (greater than 8.2)

$\therefore CO_3^{--}$ alkanity = 2 * caustic Alkanity.

$= 2 * 70$

$= 140$ mg/L (Ans.)

Now, Total Alkanity = CO_3^{--} alkanity + HCO_3^{-} alkanity.

$\Rightarrow 230 = 140 + HCO_3^{--}$ alkanity.

$\therefore HCO_3^{--}$ Alkanity = 90 mg/L (Ans)

Again, Total Hardness = Alkanity + Non-Carbonate hardness

$\Rightarrow$ N.C.H = 300 - 230

$= 70$ mg/L. (Ans.

$pH = 7.58$. Total Alkalinity $= 332$ mg/L as $CaCO_3$. Find the carbonate & Bi-carbonate Alkalinity. Also find the concentration of carbonate & bicarbonate.

Soln:

Since pH value below 8.2, so, HCO_3^- alone will exist [As CO_3^{--} & HCO_3^- exist together, the pH value will be between 8.2 to 10].

$\therefore$ According to $pH = 7.8$, CO_3^{--} alkalinity $= 0$.

$\therefore$ Total alkalinity = CO_3^{--} alkalinity + HCO_3^- Alkalinity.

$\therefore$ HCO_3^- Alkalinity $= 332$ mg/L (Ans).

Here, $Ca(HCO_3)_2 \rightleftharpoons Ca^{2+} + 2HCO_3^-$

$162 \qquad\qquad 122$

$\therefore$ 162 mg/L $Ca(HCO_3)_2$ contains 2 mole of HCO_3^-

$\therefore$ 1 " " " $= \frac{2}{162}$ " " "

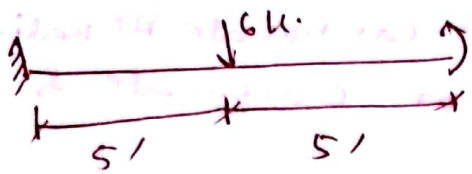
$\therefore [HCO_3^-] = \frac{2}{162}\left(\frac{\text{mole}}{\text{Litre}}\right) * 61\left(\frac{\text{mg}}{\text{mole}}\right)$

$= 6.75 \frac{\text{mg}}{\text{Litre}}$

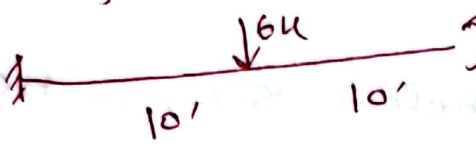
$\therefore [CO_3^{2-}] = 0.$ gm/litre (Ans

Q.62 Draw the BMD & location of main bar —

i)

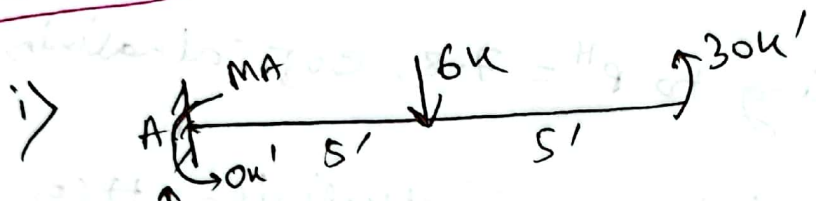


ii)



Soln.

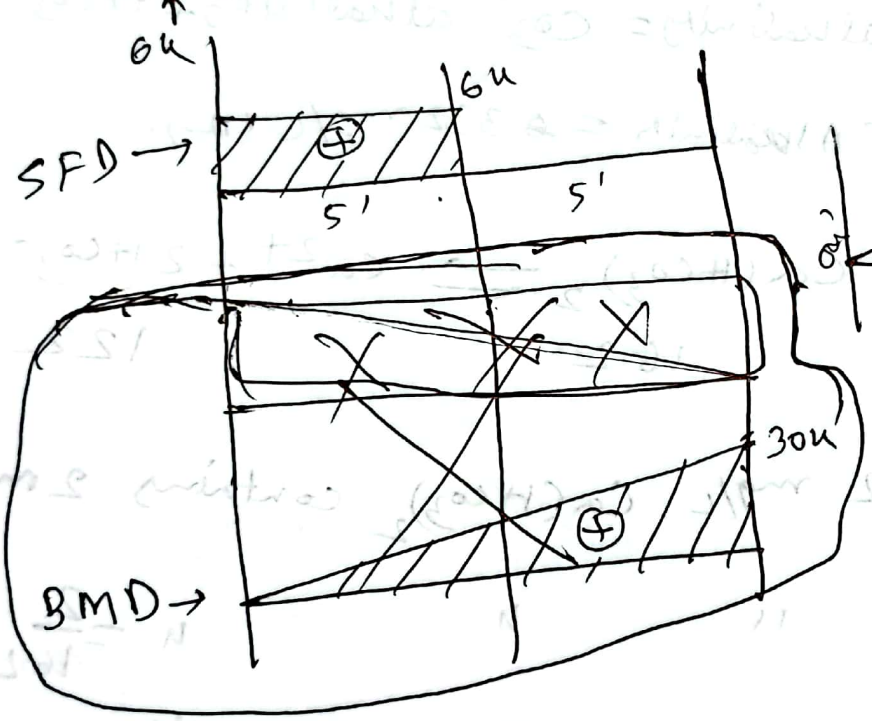
i)

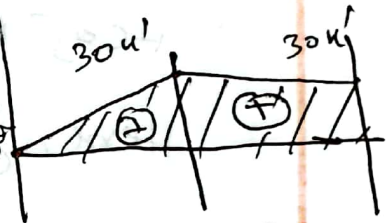


$\Sigma M_A = 0$,

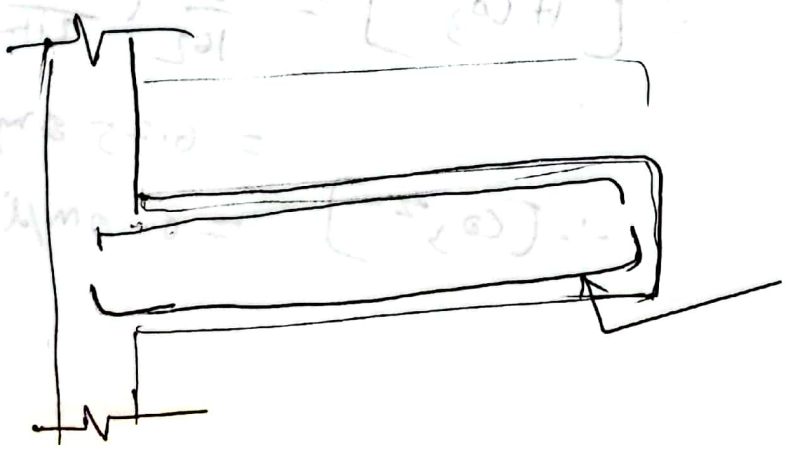
$\Rightarrow 6 \times 5 - 30 = M_A$

$\Rightarrow M_A = 0K'$

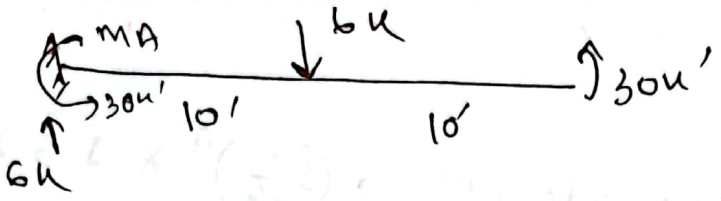




BMD



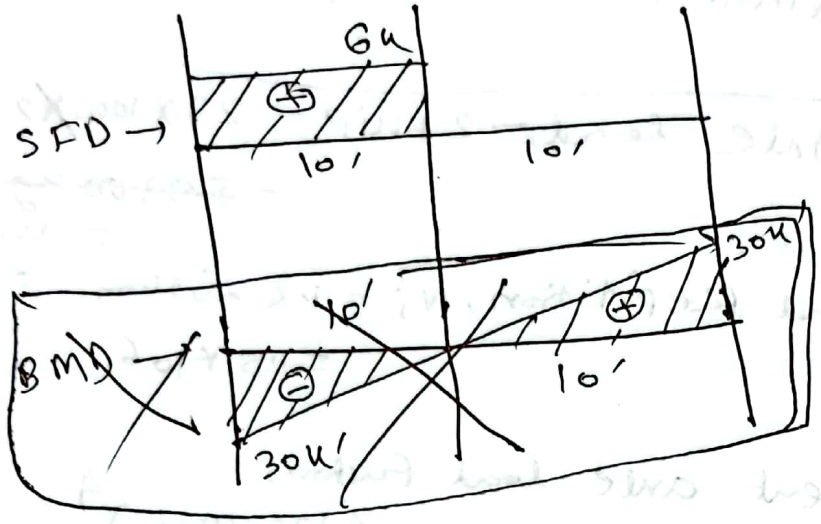
ii)

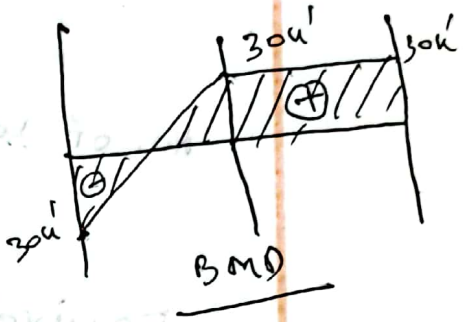


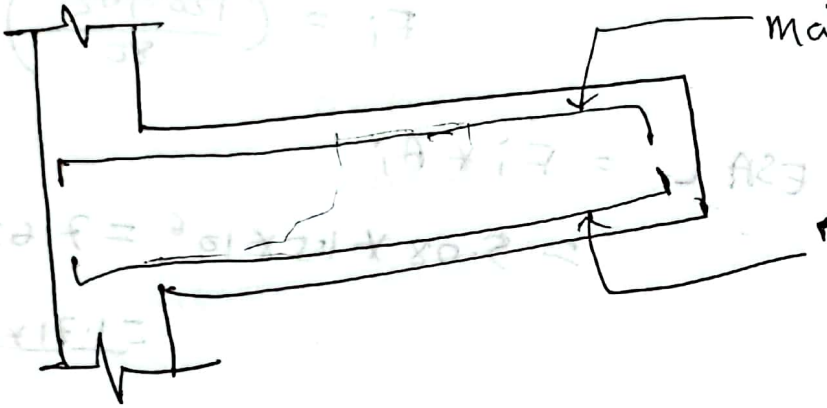
$\Sigma M_A = 0$,

$\Rightarrow 6*10 - 30 = M_A$

$\Rightarrow M_A = 30k'$







If coefficient of dynamic ~~velocity~~ viscosity is $\mu = 1\ N\text{-sec/m}^2$ and velocity distribution $v = 0.2y$ Determine the shear stress of $y = 0.45$.

Soln:

We know shear stress, $\tau = \mu \frac{dv}{dy}$ → strain(S)

Given,
$v = 0.2y$
$\mu = 1\ N\text{-sec/m}^2$
$dy = 0.45$

$\therefore \tau = 1 * \frac{0.2}{0.45}$

Slope $= \frac{dv}{dy}$ (Straining) $= 2\ N/m^2 = 2\ Pa$. (Ans

Q.64 Determine ESAL if load repetition is 1.5 million & axle load is 27 kip.

Sol^n:

Alternate soln → $\left(\frac{27}{18}\right)^4 * 1.5 * 10^6 = 7.5 * 10^6$ kN

Given Axle load, = 27 kip = $27 * 1000 * 2.2$ kg

= ~~59400 kg~~ 12272 kg

= $12272 * 9.81$ N

= 120.39 kN.

No. of load Repitition, N_i = 1.5 million.

= $1.5 * 10^6$.

Equivalent axle load factor,

$$F_i = \left(\frac{120.102}{80}\right)^4 = 5.08$$

$\therefore$ ESAL = $F_i * A_i$

= $5.08 * 1.5 * 10^6 = 7.62 * 10^6$ kN

~~= 1.71 * 10 21.~~

~~= 1.71 * 10^6 kip~~

kip.

On. ESAL = $\left(\frac{27}{18}\right)^4 * 1.5 * 10^6 = 7.59 * 10^6$ ~~kip~~ (m)

Q.65 The discharge of a pipe is 40 lps & pipe dia 150 mm, head loss due to friction is 13 m, if efficiency 75%. what will be the input power?

Sol^n:

$$V = Q/A = \frac{Q}{\frac{\pi}{4} d^2} = \frac{40 * 10^{-3}}{\pi/4 * 0.15^2} = 2.26 \text{ m/s}$$

Frictional head loss = $13 \times \frac{2.26^2}{2 \times 9.81} = 3.38$ m.

$\therefore$ velocity head = $\frac{v^2}{2g} = \frac{2.26^2}{2 \times 9.81} = 0.26$ m.

$\therefore$ Total head loss = $3.38 + 0.26 = 3.64 = 11.94$ ft.

$\therefore P = \frac{HQ}{3960} \rightarrow \frac{\text{ft}}{\text{ft}^3/\text{sec}} = \frac{11.94 \times 40 \times 10^3 \times 3.28^3}{3960}$

$= 4.26 \times 10^3$ WHP.
↳ Water House Power

$\therefore$ Efficiency = $\frac{\text{output}}{\text{Input}} \Rightarrow 0.75 = \frac{4.26 \times 10^3}{\text{Input}}$

$\therefore$ Input = 5.64×10^3 WHP (Ans).

A waste water treatment plant discharges 17360 m^3/day of treated effluent into a small stream having a flow rate of 0.43 m^3/sec and an ultimate BOD of 5 mg/L. The treated effluent has a BOD_5 of 12 mg/L and BOD decay constant 0.12 day^{-1} at 20°C.

Stream water temp = 18°C

Calculate ultimate BOD immediately after mixi

What is relative index? Is is possible to have relative index = 0? Explain

Ans:

The relative index of a cohesive soil in the natural state can be defined by a ratio called liquidity Index (LI).

$$\therefore LI = \frac{W_n - W_P}{W_L - W_P}$$

W_P = Plastic limit.
W_L = Liquid "
W_n = Natural moisture content

LI = 0; that means the soil is in plastic limit

(ii) Another index is consistency Index (CI)

$$\therefore I_c (CI) = \frac{w_L - w_n}{w_L - w_p}$$

If $I_c = 0$,

It indicates Liquid limit.

Q.68 Water content = 48%, L.L = 50%, PL = 30%, SL = 10%. Explain whether it is soft or less compressible.

Soln:

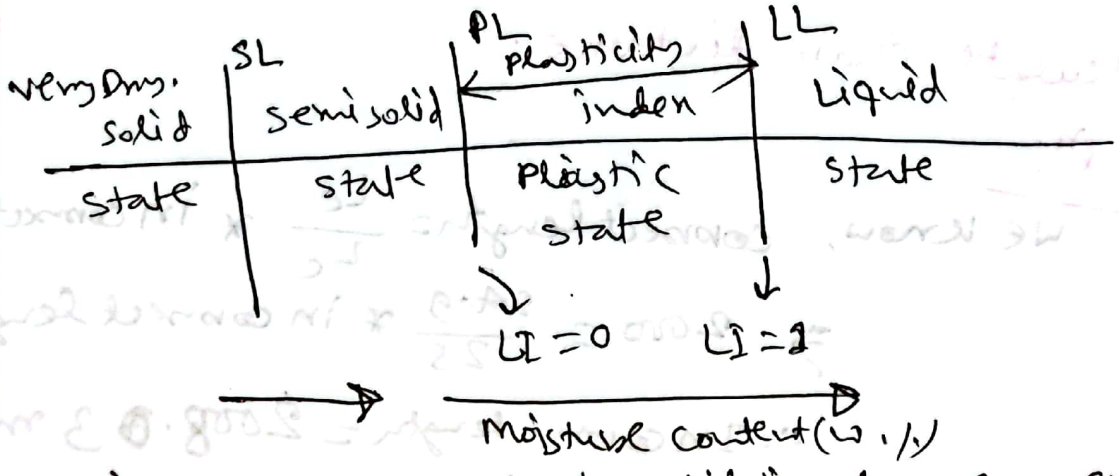
To justify the softness of soil liquidity index (I_L) formula is used —

$$I_L = \frac{w_n - w_p}{w_L - w_p}$$

$$= \frac{48 - 30}{50 - 30}$$

$$= 0.9$$

given,
$w_n = 48\%$
$LL = 50\%$
$w_p = 30\%$
$SL = 10\%$



Since, $I_L = 0.9$, so, the clay is less compressible (Ans).

Q.69 What is expansive clay? LL=70, PL=40, will it be an expansive clay?

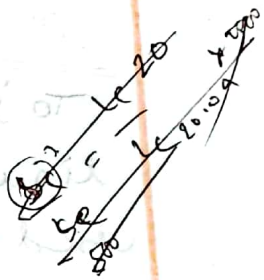
Soln:

We know,

Plasticity index, I_p(%) = $w_L - w_p$ = 70 − 40 = 30%.

∴

I_p(%)		classification
0	—	Non plastic
1 to 5	—	slight plastic.
5 to 10	→	Low "
10 to 20	→	medium "
20 to 40	→	Highly "
>40	→	very " "



BGFCL-2017

Q.1 Correct length was 2um that was measured with a 25 m chain was actually 24.9 m long. Calculate chain distance.

Soln:

We know, correct length = $\frac{L_e}{L_c}$ * incorrect length.

$\Rightarrow 2000 = \frac{24.9}{25}$ * incorrect length.

∴ Incorr. length = 2008.03 m (Ans).

BAFCL-2017

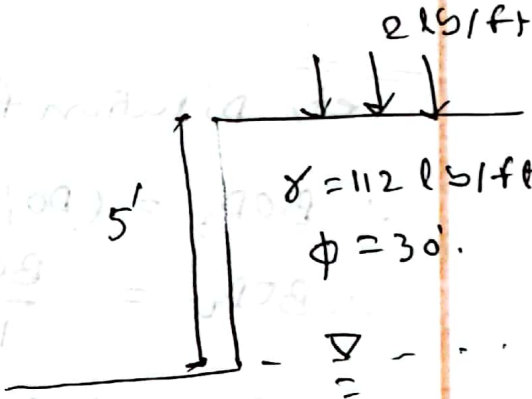
Q.2 Determine active earth pressure distribution, Over burden pressure 2 lb/ft², height 5', $\gamma = 112$ lb/ft³, $\phi = 30°$, G.W.T. below the base.

Soln:

$$K_a = \frac{1-\sin\phi}{1+\sin\phi}$$

$$= \frac{1-\sin 30°}{1+\sin 30°}$$

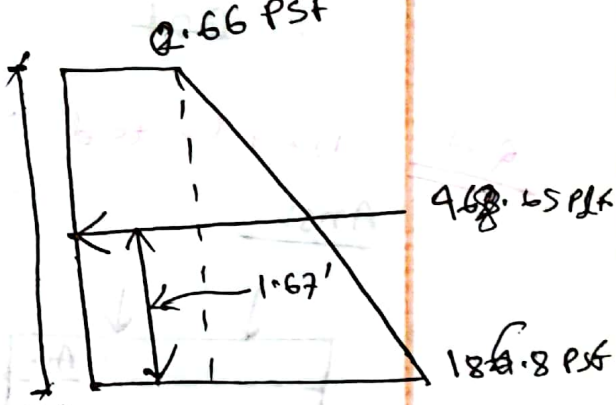
$$= 0.33$$



At $z = 0$, $\sigma_o' = 2$ lb/ft²; $\sigma_a' = K_a \sigma_o' = 0.33 * 2 = 0.66$ lb/ft²

$\therefore z = 5'$, $\sigma_o' = \gamma z = 112 * 5 = 560$ lb/ft².

$\therefore \sigma_a' = 560 * 0.33 = 184.8$ lb/ft².



∴ Lateral Active force —

$$P_a = 0.66 * 5 + (184.8 - 0.66) * 5 * \frac{1}{2}$$

$$= 468.65 \text{ lb/ft}.$$

$$\therefore \bar{Y} = \frac{0.66 * 5 * \frac{5}{2} + (184.8 - 0.66) * \frac{5}{2} * 5/3}{468.65}$$

$$= 1.69 \text{ ft}.$$

BAFCL-2017

Q.3 Initial & Final D.O in a BOD bottle after 3 days is 7 mg/L & 3 mg/L, $K = 0.2$/day. determine BOD_5 & $BOD_{ultimate}$.

Soln:

Let, Dilution factor = 50.

$\therefore BOD_3 = (DO_i - DO_f) * DF = (7-3) * 50 = 200$ mg/L

$\therefore BOD_U = \frac{BOD_3}{1 - e^{-kt}} = \frac{200}{1 - e^{-(0.2 * 3)}} = 443.27$ mg/L (Ans.

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

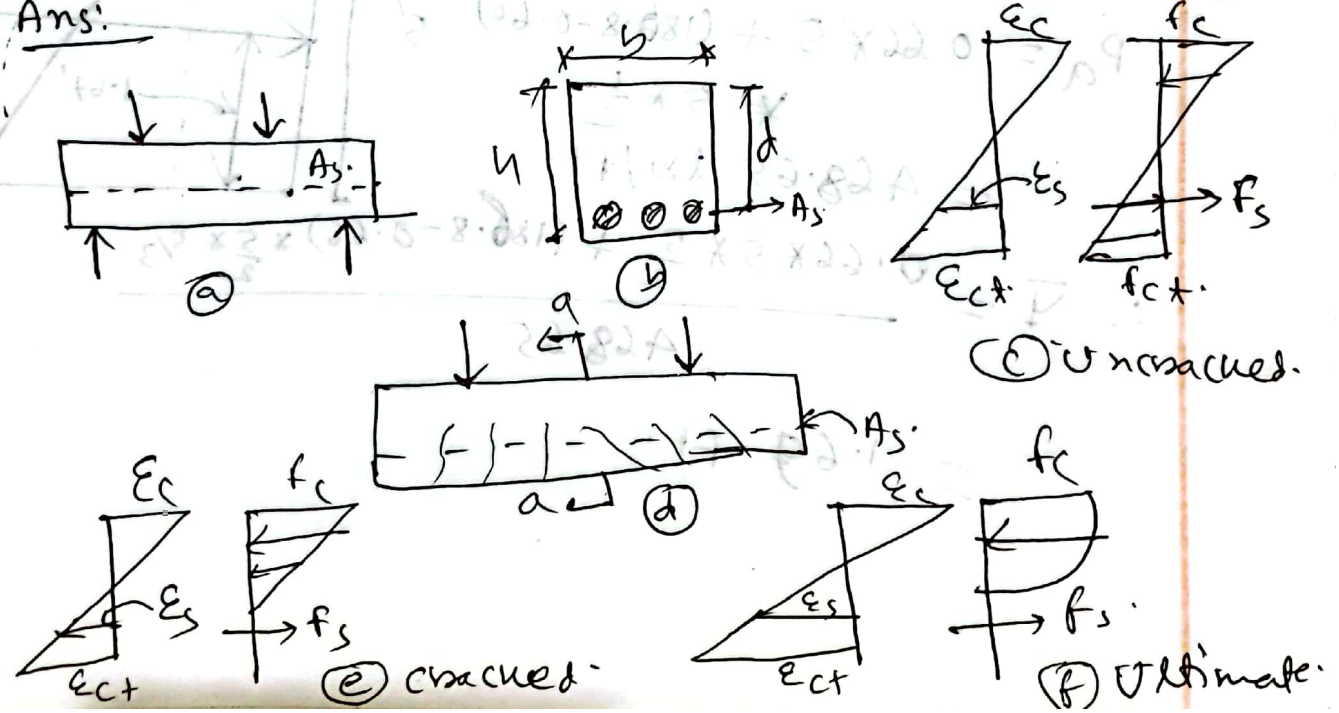
$= 443.27 (1 - e^{-0.2 * 5})$

$= 280.2$ mg/L. (Ans)

~~BOL~~

Q.4 Deflected shape of a R.C.C beam under increasing loading.

Ans:



BAFCL-2017

What is ESAL? for 1 million repitition determine ESAL.

Soln:

Let, Axle Load = 27 kip.

$\therefore ESAL = \left(\frac{27}{18}\right)^9 * 1 * 10^6 = 5062500$ kip (Ans).

Common lab test for Rebab, Asphalt & Aggregate No.s of Bag of cement of beam 30" * 12" * 18". & Ratio = 1 : 1.5 : 3.

Soln:

Volume of Beam = $\frac{30*12*18}{12^3} = 3.75$ cft.

$\therefore$ wet. volume = $1.5 * 3.75 = 5.625$ cft.

$\therefore (1+1.5+3)x = 5.625$

$\therefore x = 1.023$ cft.

$\therefore$ cement = 1.023 cft = $\frac{1.023}{1.25} = 0.82$ bag $\simeq$ 1 bag.

$\therefore$ Fine aggregate = $1.5 * 1.023 = 1.53$ cft. (Ans).

$\therefore$ Coarse " = $3 * 1.023 = 3.07$ cft.

Q.7 For a wide channel determine h. Given values are - Q = 3 m³/s, n = 5, S = 2. Also find flow in m/sec.

Soln:

For wide channel, A = h, R = h.

$R = \frac{A}{P} = \frac{bh}{b+2h} \approx \frac{bh}{b} = h$

Q =

Given:
Q = 3 m³/s.
S = 2.
h = ?.
R = 5
V = ?.
n = 5

We know,

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

$\Rightarrow \frac{Q}{A} = \frac{1}{5} * h^{2/3} * 2^{1/2}$

$\Rightarrow \frac{3}{bh} = \frac{1}{5} * h^{2/3} * \sqrt{2}$

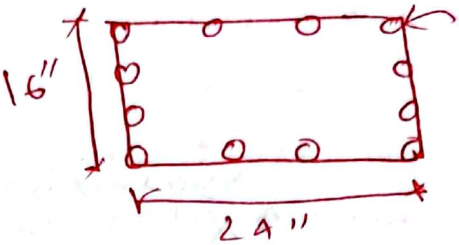
$\Rightarrow h^{5/3} = 10.61$

$\therefore h = 4.12$ m.

$\therefore V = \frac{Q}{A} = \frac{3}{h} = \frac{3}{4.12} = 0.73$ m/s. (Ans).

BAFCL-2017

Q.8 Design tie (size, spacing) and draw tie arrangement.



Soln:

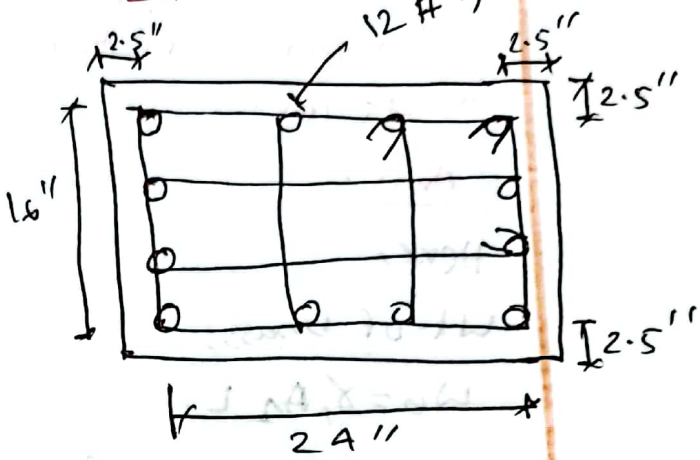
As per ACI code

#3 tie bar is used upto main rein. size #10 ϕ.

and,

#4 tie bar is used upto main rein. size greater than 10 ϕ.

So, here, #3 tie bar is used.



$$\therefore \text{spacing} = 16 * \frac{9}{8} = 18''.$$ (9 → #9 bar.)

$$\therefore S_{max} = 48 * \frac{3}{8} = 18''.$$

$$\therefore S_{amax} = 16'' \text{ (least dimension)}$$

$\therefore$ #3 ϕ @ 16" C/C used as a tie.

A base plate is constructed brass & steel materials which cross sectional area of brass is 60 cm² & steel is 40 cm² respectively. Length & unit wt. of the brass base is 10 m & steel base is 4 m & 900 kN/m³ & 900 kN/m³ also respectively. Determine total elongation of this composite bar if applied wt. is 45 kN.

Ans:

Here,

Wt. of brass,

$W_b = \gamma_1 A_1 L_1$

$= 900 * 60 * 10^{-4} * 10$

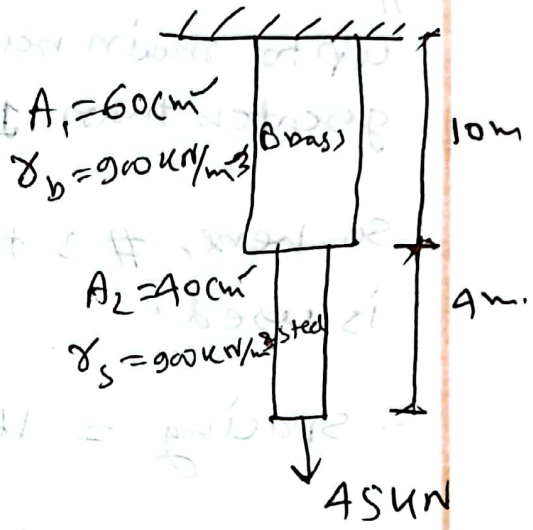
$= 54$ kN.

& Wt. of steel →

$W_s = \gamma_2 A_2 L_2$

$= 900 * 40 * 10^{-4} * 4$

$= 14.4$ kN.



∴ The force for brass, $P = 54 + 45 = 99$ kN.

∴ Elongation, $\delta_b = \frac{PL}{AE}$

$= \frac{99 * 10^3 * 10}{60 * 10^{-4} * 12 * 10^6 * 6894.75}$

$= 2 * 10^{-3}$ m.

Modulus of Elasticity for Brass = 102-125 * 10³ N/mm²

Assume, $E_b = 105 * 10^3$ N/mm².

Again, The force for steel – $P = 14.4 + 45 = 59.4$ kN

$\therefore \delta_s = \frac{PL}{AE} = \frac{59.4 * 4 * 10^3}{40 * 10^{-4} * 2 * 10^6 * 6894.75} = 2.97 * 10^{-3}$ m

1 N/m² = 1 25.5 psi

∴ Elongation = $\delta_1 + \delta_2$
= 2.1 mm (Ans)

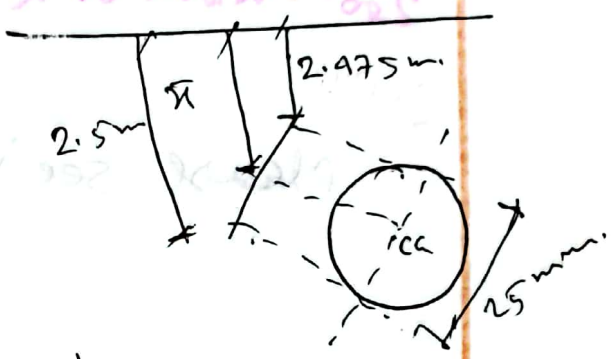
Note: E = 12 × 10⁶ psi (brass)
E = 29 × 10⁶ psi (steel)

17

25 mm diameter circular disk is on the base of a swimming pool of depth 2.5 m, width 3 m, find the force on the circular disk, g = 9.8 m/s².

Soln:

$\bar{x} = \frac{2.5 + 2.475}{2}$
= 2.49 m.



we know,

P = WA$\bar{x}$
= 9810 * 4.9 × 10⁻⁴ * 2.49
= 11.990 N
= 12 N. Ans

A = π/4 * (0.025)²
= 4.9 × 10⁻⁴ m²
W = 9810 N/m²

17

25% retained on each no. sieve, 0.60 mm, 0.425 mm, 0.30 mm, 0.15 mm. Find FM of this sand sample.

Soln:

Sieve size		% Retained		Cumulative % retained
0.60	—	25	—	25
0.425	—	25	—	50
0.30	—	25	—	75
0.15	—	25	—	100

∴ FM = $\frac{25 + 75 + 100}{100}$ = 2 (Ans).

1 million Repetition of 100kN axle load. Find ESAL.

Soln:

$$ESAL = \left(\frac{100}{80}\right)^4 * 1 * 10^6 = 2.99 \times 10^6 kN.$$ (Ans).

Estimate earth excavation. Design RL 18.0 ft. Embankment RL = 21', 18', 16' at distance, 0', 80', 200'. width of embankment 3m, H:V = 2:1.

Soln:

Please see in Q. No. 78.

~~DGCB Preparation.~~

Q.75 In a dynamic compaction test a weight of 18 kip is drop from a height of 5 ft. what will be the compaction depth.

Soln:

Formula,

$$D = 0.5\sqrt{Wh}$$

$$= 0.5\sqrt{8.17 * 1.52}$$

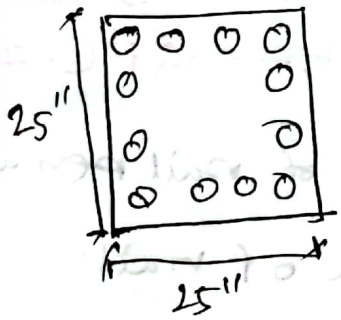
$$= 1.762 \text{ m.}$$

Here,
$W = 18 \text{ kip} = 0.454 * 18$
$= 8.17 \text{ M.ton.}$
$h = 5' = 1.52 \text{ m.}$

(Here, D = Depth of densification.
Wt = Dropping wt. M.ton
h = Height of drop.)

Q.76 A column consist of 12 # 9 bars. calculate size, spacing & draw them.

Soln:



$$\rho_g = \frac{A_{st}}{A_g} = 0.02.$$

$$\Rightarrow \frac{12}{A_g} = 0.02 \Rightarrow A_g = 600 \text{ in}^2.$$

$\therefore$ size $= 24.49" * 24.49"$
$\approx 25' * 25'.$

Assume, $f_c' = 4 \text{ ksi}$, $f_y = 60 \text{ ksi}$.

Design capacity, $P_u = \phi\phi [0.85 f_c' (A_g - A_{st}) + A_{st} f_y]$

$= 0.65 * 0.80 * [0.85 * 4 * (625 - 12) + 12 * 60]$

$= 1958.189 \text{ kips.}$ (Ans.)

Tie spacing:

1) $S = 16 * d_{min} = 16 * 9/8 = 18''$

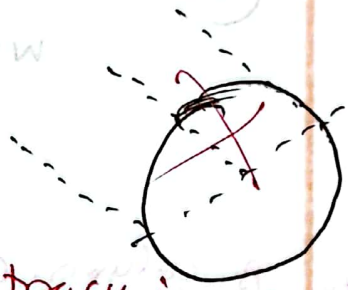
2) $S = 48 * d_{tie} = 48 * 3/8 = 18''$.

3) S = least lateral dimension of col^n = 25"

∴ spacing 18" c/c use # 3 bar.

25 mm diameter circular disk is on the base of a swimming pool of depth = 2.5m, width 3m, find the force on the circular disc.

Soln:



Standard rail length of BG track is 12.80m

If 45 kg/m rail is used in a particular BG track in Rajshahi, what is the total wt. of each individual rail girder). what maximum axle load can be safely imposed on that track). → (SAFL-17)

Soln:

wt. of rail = No. of rail * wt. of rail per unit length * length of rail.

= 1 * 12.80 * 45 kg.

= 576 kg (Ans).

According to IS:

maximum axle load —

= 560 * standard wt. of rail in kg/m (lb/yard)

= 560 * 45 kg/m

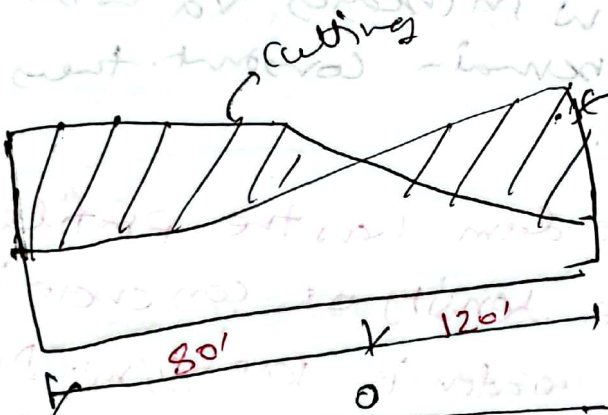
= 25200 kg/m

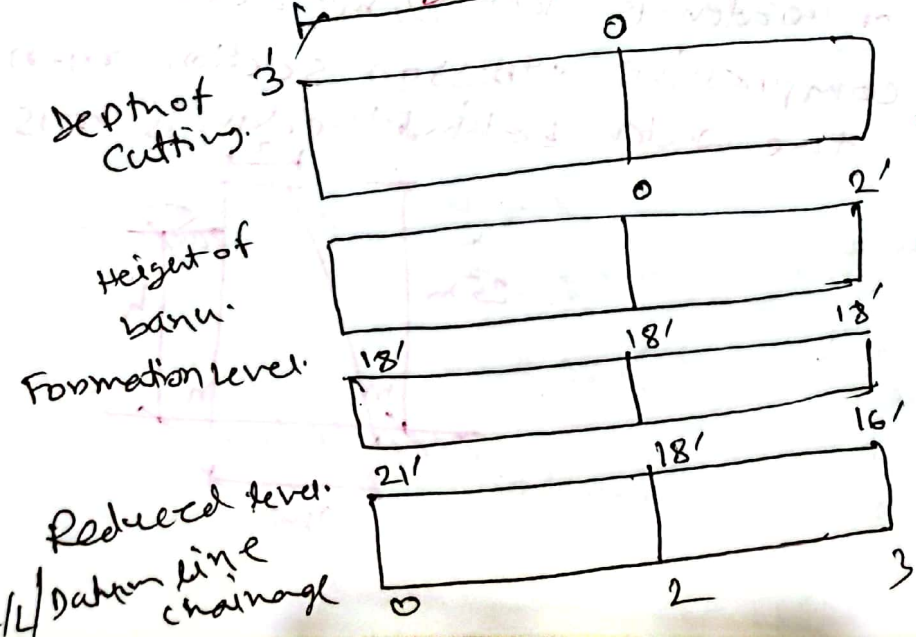
= 25.2 tones.

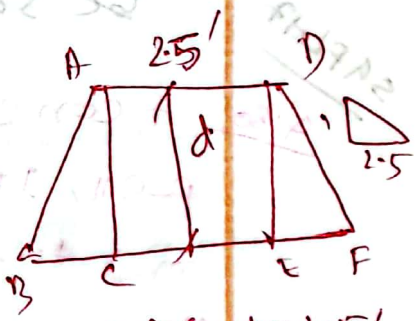
(Ans)

If ground is level across an embankment width, determine the volume of earth work. Given, RL of FL 18', width of FL = 25', side slope = 2.5 H : 1 V. RL of centreline of GL at chainage 0', 80' & 200' are 21', 18', 16' respectively.

Soln:







From $\triangle ABC$, $d = 1.5'$

$H = 1.5 * 2.5 = 3.75'$.

Area, $A = \frac{1}{2} * 1.5 * 3.75$

$= 2.81 ft^2$.

From $\triangle DEF$ — $d = 1'$

$H = 2.5 * 1 = 2.5'$.

$A = \frac{1}{2} * 2.5 * 1$

$= 1.25 ft^2$.

$\therefore \triangle ABC + \triangle DEF = 2.81 + 1.25$

$= 4.06 ft^2$.

Station (ft)	RL (ft)	Formation level (ft)	Depth (ft)	mean depth $d=\frac{d_1+d_2}{2}$	Area Bd (ft²)	Area of side (ft²)	BD+SJ	Distance (ft)	cutting (ft³)	Filling (ft³)
0	21′	18′	−3′ (d_1)							
80	18′	18′	0′ (d_2)	−1.5	−375	2.81	4.31	80′	344.8	
200	16′	18′	2′ (d_3)	1	25	1.25	2.25	120′		270

∴ Total Earth work = Filling + Cutting
= 344.8 + 270 = 614.8 ft³ (Ans.)

If a partially saturated soil becomes fully saturated soil due to change in water table, then how it affects void ratio of soil).

Ans:

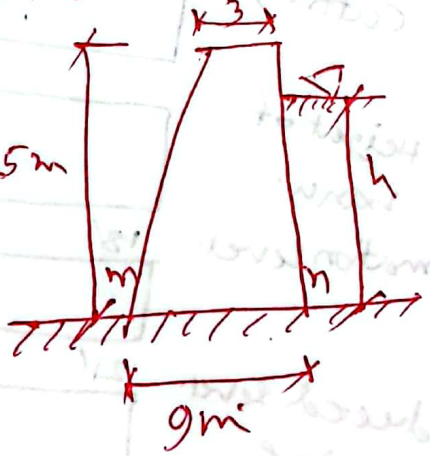
$Se = w G_s \Rightarrow e = \frac{w G_s}{S}$ Now, ~~increase~~ decrease

Value of S, void ratio will must decrease.

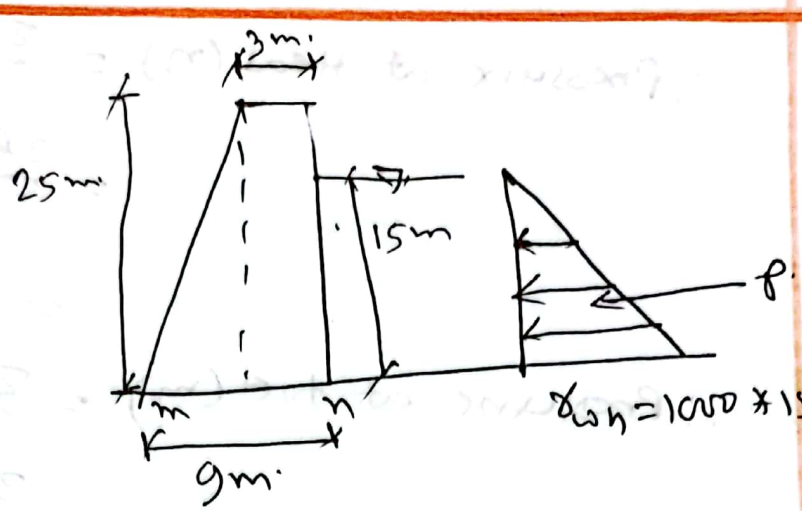
Void ratio, $e = \frac{V_v}{V_s}$, $V_v = V_a + V_w$.

if V_w increases V_a will decreases. and V_s will remain constant. then void ratio will be same.

A concrete dam has the profile shown in fig. p-911, If the density of concrete is 2400 kg/m³ and that of water is 1000 kg/m³. Determine the maximum compressive stress on section m-n if the depth of the water behind the dam is h = 15 m.



Soln:



$\gamma_w h = 1000 * 15 = 15000$ kg/m²

Total Pressure, $P = \frac{1}{2} * 15000 * 15 = 112500$ kg/m.

Portion	Wt.	c.g.	Moment.
①	$3 * 25 * 2400 * 1 = 180000$ kg	$\frac{25}{2} = 12.5$	$180000 \text{ kg} * 12.5 = 2250000$ kg-m
②	$\frac{1}{2} * 25 * 6 * 2400 * 1 = 180000$ kg.	$\frac{25}{3} = 8.33$	$180000 * 8.33 = 1500000$ kg-m
	Total wt. = 360000.		$\Sigma M_R = 3750000$ kg-m

$\therefore M_o = 112500 * 15/3 = 562500$ kg-m.

$\therefore \bar{x} = \frac{M_R - M_o}{\Sigma W} = \frac{3750000 - 562500}{360000} = 8.85$

Eccentricity, $e = \frac{b}{2} - \bar{x}$

$= \frac{2}{2} - 8.85$

$= -4.35 < \frac{b}{6}$ → But negative, Here, tension will developed

[if, $e < b/6$; no tension will develope]

$\therefore$ Pressure at Heal (m) $= \frac{\Sigma W}{B}\left(1 - \frac{6e}{b}\right)$

$= \frac{360000}{9}\left(1 - \frac{6 * 4.35}{9}\right)$

$= -76000 \text{ kg/m}^2$

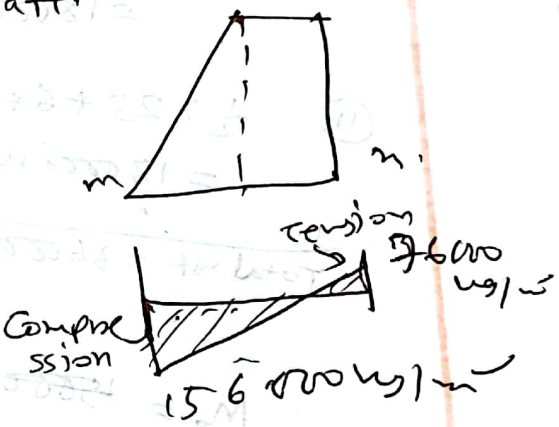
$\therefore$ Pressure at toe (m) $= \frac{\Sigma W}{b}\left(1 + \frac{6e}{b}\right)$

$= \frac{360000}{9}\left(1 + \frac{6 * 4.35}{9}\right)$

$= 156000 \text{ kg/m}^2$

$\therefore$ Maximum compressive stress $= 156000 \text{ kg/m}^2$ (m)

But the structure is not safe.



Fineness Modulus (F.M).

According to "AASHTO T27 ASTMC136"
"IS/BS" IS:383.

The passing for fine aggregate on 9.5 mm sieve must be "100% on retain must be 0%".

On 4.75 mm sieve, " passing 90-100% on retain 0 to 10%.

⇓

Grading Zone - 2, 3 & 4.

Again for Grading Zone-5, " on 4.75 mm passing must be 95-100%".

$$\text{F.M. for (F.A)} = \frac{\text{cumulative \% retain on 4.75 mm to \# 100 sieve}}{100}$$

According to ASTM 33 —

For coarse aggregate → The minimum passing through 4.75 mm sieve is "0" & maximum passing through 4.75 mm is 5% & 3/8" (9.5mm Min → 0 & maximum 15%.

F.M.

Q.1 Determine the FM of the aggregate portion only from a sieve analysis result. Also determine the percentage of coarse aggregate silt & clay.

Soln:

sieve size (mm)		Retain (gm)	% Retain	cumulative % Retain.
$\frac{3}{4}$"	19	— 175 —		
	12.5	— 125 —		
Missing sieve 9.5 mm				— 50
(#4)	4.75	— 100 —	50	— 75
(#8)	2.36	— 50 —	25	— 85
(#16)	1.18	— 20 —	10	— 90
(#30)	0.6	— 10 —	5	— 95
(#50)	0.3	— 10 —	5	— 97
(#100)	0.15	— 4 —	2	— 99
(#200)	0.075	— 4 —	2	— 100
Pan		— 2 —	1	
		Total = 200 gm (F.A)		~~Total = 492~~

$$\therefore FM = \frac{50+75+85+90+95+97}{100} = 4.92$$

[The value is so large due to absence of sieve size 9.5 mm]

F.M

∴ % of Coarse Aggregate.

$$= \frac{175}{500} + \frac{125}{500} + \frac{100}{500}$$

$$= 80\%$$

∴ % of silt & clay $= \frac{2}{500} = 0.9\%$

Determination of FM of coarse aggregate portion only from a sieve analysis result.

Solution:

Sieve size	Retain gm	% Retain	Cumulative % Retain
19 mm	175	35	35
12.5 mm	125	25	60
4.75 mm	100	20	80
2.36 mm	50	10	100
1.18 mm	20	4	100
0.6 mm	10	2	100
0.3 mm	10	2	100
0.15 mm (#100)	4	0.8	100
0.075 mm	4	0.8	100
Pan	2	0.4	
Total	500 gm.		

∴ F.M (Coarse aggregate) $= \frac{35+60+80+100+100+100+100+100}{100}$

$= 6.75$ (Ans)

F.M.

Determination of F.M of Aggregate using standard sieve.

Q.e

Sol^n:

Sieve size (mm)	Retain (gm)	% Retain	Cumulative Retain (%)
75 mm	0	0	0
37.5 mm	0	0	0
19 mm	175	35	35
12.5 mm	125	25	60
9.5 mm	0	0	60
4.75 mm	100	20	80
2.36 mm	500	10	90
1.18 mm	20	4	94
0.6 mm	10	2	96
0.3 mm	10	2	98
0.15 mm	4	0.8	98.8
0.075 mm	4	0.8	99.6 (No)
Pan	2	0.4	100 (No)
Total = 500gm			Total = ~~651.8~~ 591.8

$$\therefore FM = \frac{591.8}{100}$$

$$= 5.92 \text{ (Ans)}$$

Q.81 Water content of a standard soil sample is 50%, Sp.gr. of soil solid (G_s) = 2.65. Find the values of bulk unit wt. and void ratio. (-

Soln:

Let, $V_s + V_v = 1$

$$\Rightarrow \frac{W_s}{G_s \gamma_w} + \frac{W_w}{\gamma_w} = 1$$

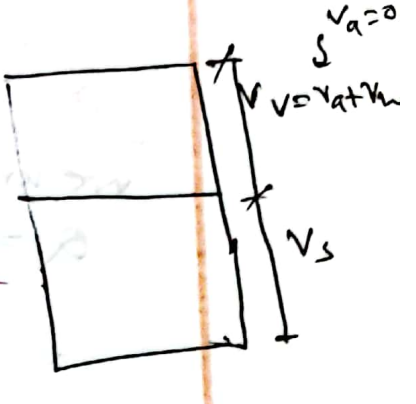
$$\Rightarrow \frac{W_s}{2.65 * 62.4} + \frac{0.5 W_s}{62.4} = 1$$

$$\Rightarrow W_s = 71.12 \text{ lb}$$

$\therefore W_w = 35.56$ lb.

$w = \frac{W_w}{W_s}$

$\Rightarrow 0.5 W_s = W_w$



~~Alternatively:~~

$$\therefore \gamma_d = \frac{W_s}{V} = \frac{71.12}{1} = 71.12 \text{ lb/ft}^3$$

$$\gamma_d = \frac{G_s \gamma_w}{1+e} \Rightarrow 71.12 = \frac{2.65 * 62.4}{1+e}$$

$$\Rightarrow e = 1.33.$$

$$\therefore \gamma_{bulk} = \frac{W_s(1+w)}{V} = \frac{71.12(1+0.5)}{1} = 106.68 \text{ lb/ft}^3$$

Q.82 For a rectangular channel section, $n = 0.013$, $b = 2$ & discharge, $Q = 50$ cfs, $y = ?$, $S_0 = 0.0028$.

Soln:

We know,

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$\Rightarrow 50 = \frac{1.49}{0.013} \times 2y * \left(\frac{y}{1+y}\right)^{2/3} * (0.0028)^{1/2}$$

$\therefore y = 4.69$ ft. (Ans.)

$R = \frac{A}{P} = \frac{2y}{2+2y} = \frac{y}{1+y}$.

A 2.5 ft high

Q.8

On a rectangular channel section ~~as shown~~ a sharp crested weir 3' high extends across a rectangular channel, which is 8' wide. When the head is 1.12'. Determine the flow rate by neglecting the velocity of approach.

6' wide

Soln:

we know,

$Q = 3.32 L H^{2/3}$.

$= 3.32 * 8 * (1.2)^{2/3}$

$= 29.99$ ft³/sec (Ans).

Length of weir crest, $L = 8'$.

Height of weir crest, $P = 3'$.

Head measured, $H = 1.20$ ft.

Fig: Flow over a sharp crested weir.

we know,

$Q = \frac{2}{3} C_d b (2g)^{1/2} H^{3/2}$

$\therefore C_d = 0.602 + 0.083 * \frac{1.12}{12.5}$

$= 0.639$.

$\therefore Q = \frac{2}{3} * 0.639 * 6 * (2 * 32.2)^{1/2} * (1.12)^{3/2}$.

$= 24.31$ ft³/sec (Ans).

where,

$C_d = 0.602 + 0.083 \frac{H}{P}$

(C_d values varies between 0.60 ~ 0.62)

Now, length of weir crest, or $L = 6'$.

Height of weir crest, $P = 2.5'$

Head measured, $H = 1.12'$

Q.84 A rectangular channel of 4m width carries water at the rate of 8 cumec under critical condition. Determine the i) specific energy ii) critical depth.

Soln:

i) Sp. Energy:

$$E = y + \frac{V}{2g} \qquad \left| \begin{array}{l} Q = VA \\ \Rightarrow V = \frac{Q}{By} \end{array} \right.$$

$$= y + \frac{Q}{2gBy}$$

$$= 0.74 + \frac{8}{2*9.81*4*0.74} \quad [\because y = 0.74 \text{ from (ii)}]$$

$$= 1.11 \text{ m. (Ans)}$$

ii) For Critical condition, $F_r = 1$

and depth, $y = \sqrt[3]{\frac{q}{g}}$ where, $q = Q/B = 8/4 = 2 \text{ m}^2/\text{s}$

$$= \sqrt[3]{\frac{2}{9.81}} = 0.74 \text{ m (Ans).}$$

SGFL 2017 Q.85 Find the resultant force on one side of a 25cm diameter vertical circular plate standing at the bottom of 3m wide and 2.5m depth swimming pool. Density of water = 1000 kg/m³. g = 9.81 m/s².

Soln: Force on the side of plate / horizontal force

$$= \gamma h_{cg} * A_{vertical}$$

$$= 9.81 * (2.5 - 0.25) * (3 * 2.5) = 165.54 \text{ kN.}$$

[Here, γ = unit wt. of water = 9.81 kN/m3].

vertical force = γ * Area of plate * width of pool.

$= 9.81 * \frac{\pi}{4} * (0.25)^2 * 3$

$= 1.445$ kN.

$\therefore$ Resultant force $= \sqrt{H^2 + V^2}$

$= \sqrt{165.59^2 + 1.445^2}$

$= 165.55$ kN. (Ans).

SGFL-

Q.8

Q.86 If ground is level across an embankment width. Determine the volume of earth work. Given, RL of F.L (Formation Level) 18', width of FL = 25'. Side slope = 2.5':

SGFL-17

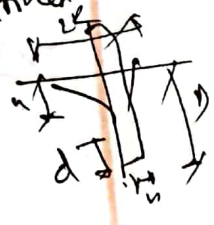
Q.86 An Artesian aquifer of 10m thickness with pizometric surface 40m above the bottom confining layer is being pumped by a fully penetrated well. The aquifer is a medium sand (hydraulic Conductivity = $1.5 * 10^{-4}$ m/s), steady state drawdown of 5.0m & 1.0m are observed at two non-pumping wells located 20m & 200m respectively from the pumped well. Determine the discharge of the pumped well in m^3/s.

Soln:

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

Artesian → Confined.

$$= \frac{2\pi k m (D-d)}{\ln\left(\frac{R}{r}\right)}$$



$$\therefore Q = \frac{2\pi * 1.5*10^{-9} * 10 * (5-1)}{\ln\left(\frac{200}{20}\right)}$$

$$= 0.0163\ m^3/s.$$

(Ans.

Given,

$S_1 = 5.0\ m$

$S_2 = 1.0\ m.$

$K = 1.5*10^{-9}\ m/s$

$r_2 = 200\ m.$

$r_1 = 20\ m.$

$m = 10\ m.$

$b = 40\ m$

Now, Transmissibility, $T = Kb.$

$= 1.5*10^{-9} * 40$

$= 6*10^{-3}\ m^2/s.$

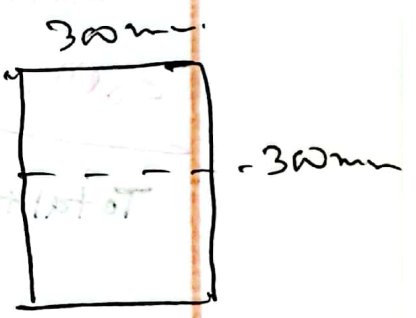
SAFL-II

Q.87 Cross section of a beam is 300 mm × 300 mm. Moment about both principal axis are 1 kN-m and 2 kN-m respectively. Find maximum bending stress.

Solution:

Here, $I_{x-x} = \frac{bh^3}{12}$

$= \frac{0.3*0.3^3}{12} = 6.75*10^{-4}\ m^4.$



$I_{yy} = \frac{hb^3}{12}$

$= 6.75*10^{-4}\ m^4.$

$\sigma_x = \frac{M_x c_x}{I_{yy}} = \frac{2*10^3 * 0.15}{6.75*10^{-4}} = 444.45\ kN/m^2$

$\therefore \sigma_y = \frac{M_y c_y}{I_{xx}} = \frac{1*0.15*10^3}{6.75*10^{-4}} = 222.22\ kN/m^2.$

$\therefore$ Max^m bending stress / Normal stress:

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

$$\therefore \sigma_1 = \left(\frac{444.95 + 222.22}{2}\right) + \left(\frac{444.95 - 222.22}{2}\right)$$

$$= 333.334 + 111.11$$

$$= 444.45 \text{ kN/m}^2 \text{ (Ans)}.$$

SGFL-17

Q.88 Laboratory analysis of water sample, All concentrations are "as substance" $Ca^{2+} = 74 mg/L$, $Mg^{2+} = 18.3 mg/L$, $Na^{+} = 27.6 mg/L$, $K^{+} = 39.1 mg/L$, $pH = 7.8$, $HCO_3 = 274.5 mg/L$, $SO_4 = 72 mg/L$, $Cl^{-} = 49.7 mg/L$. Determine (i) Hardness of water in mg/L as $CaCO_3$ (ii) Amount of lime needed to remove hardness of $CaCO_3$.

Q.89

Soln:

$$\text{Total Hardness} = \frac{Ca^{2+} * 50}{20} + \frac{Mg^{2+} * 50}{12.2} + \frac{Sr^{2+} * 50}{43.8}$$

$$= \frac{74 * 50}{20} + \frac{18.3 * 50}{12.2} + 0$$

$$= 260 mg/L \text{ as } CaCO_3 \text{ (Ans)}.$$

Again, $pH = 7.8$ [$\because pH < 8.2$], so, $CO_3^{2-} = 0 mg/L$.

$\therefore$ Alkalinity $= 274.5 mg/L$.

Here, lime requirement to remove $CaCO_3$, hardness at $CaCO_3$.

$$CO_2 = 0 mg/L.$$

$\therefore$ Alkalinity $= \frac{279.5 * 56}{100} = 153.72$ mg/L.

$Mg^{2+} = \frac{18.3 * 56}{24.3 (Mg^{2+})} = 42.17$ mg/L.

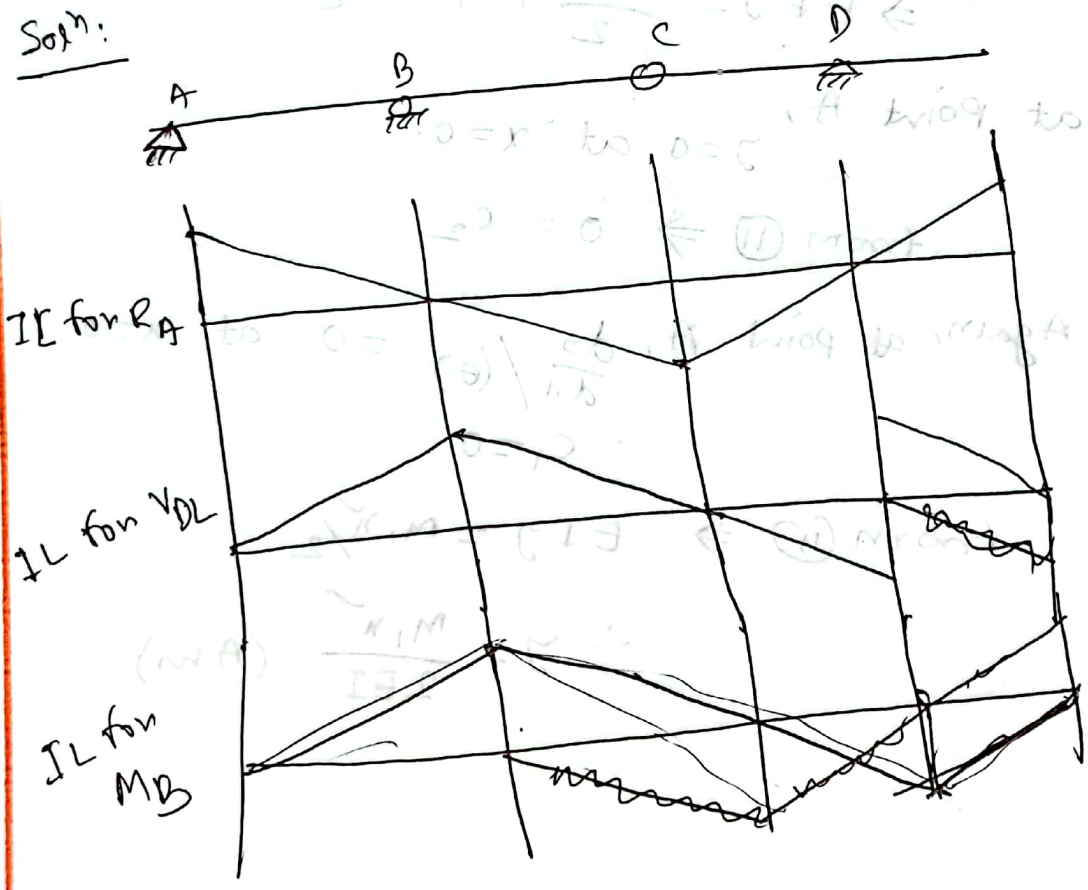
Excess lime = 0 mg/L.

$\therefore$ Total CaO (56gr) required = 195.9 mg/L (Ans)

Q.89 Draw in fluence line.

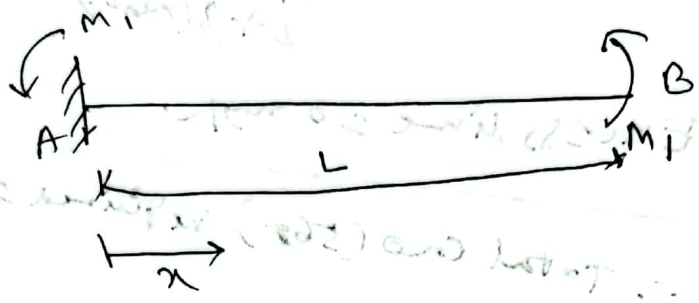
R_A, V_{DL}, M_B = ??

Soln:



Q.90 Moments of a cantilever beam in free end M_1, of Length L, Develop the equation of elastic curve Modulus of Elasticity E, moment of inertia I of that beam.

Soln.



We know,

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

$$\Rightarrow EI\frac{dy}{dx} = M_1x + C_1 \quad \text{——(I)}$$

$$\Rightarrow EIy = \frac{M_1x^2}{2} + C_1x + C_2 \quad \text{——(II)}$$

at point A, $y = 0$ at $x = 0$.

$\therefore$ from (II) $\Rightarrow 0 = C_2$

Again, at point A, $\frac{dy}{dx}/(\theta) = 0$ at $x = 0$

$\therefore C_1 = 0$.

from (II) $\Rightarrow EIy = M_1x^2/2$

$$\therefore y = \frac{M_1x^2}{2EI} \quad \text{(Ans).}$$

A circular curve with 4% gradient, length of curve L = 250', Perception time = 2.5 sec. Determine the maxm safe speed.

Soln:

Let, stopping sight distance = S
Length of circular curve = L

For, S > L, we know,

$$L = 2S - \frac{4.4}{A}$$

$$\Rightarrow 76.2 = 2S - \frac{4.4}{0.04}$$

$$\therefore S = 93.1 \text{ m}.$$

A = 4% = 0.04
L = 250' = 76.2 m.

Now, $S = vt + \frac{v^2}{2gf}$ [f = 0.4 (Assume)]

$$\Rightarrow 93.1 = V * 2.5 + \frac{v^2}{2 * 9.81 * 0.4}$$

$$\therefore V = 18.97 \text{ ms}^{-1} \text{ (Ans)}.$$

[N.B.: for S < L, $L = AS^2/4.4$]

An ascending gradient of 1 in 100 meets a descending gradient of 1 in 120. A summit curve is to be designed for a speed of 80km/h so as to have an overtaking sight distance of 470m.

Soln:

$$N = \frac{1}{n_1} - \left(\frac{1}{n_2}\right)$$

$$= \frac{1}{100} + \frac{1}{120} = \frac{11}{600}.$$

Here,

$$n_1 = \frac{1}{100}$$

$$n_2 = \frac{-1}{120}$$

if $L > OSD$ then—

$$L = \frac{NS}{9.6} = \frac{11 * 470}{600 * 9.6}$$

$$= 422m. < 470m.$$

$\therefore$ Assume, $L < OSD$.

if $L < OSD$

$$L = 2S - \frac{9.6}{N} = 2 * 470 - \frac{9.6 * 600}{11}$$

$$= 416.9 \text{ say } 417m. < 440m.$$

Therefore the length of summit curve = 417m

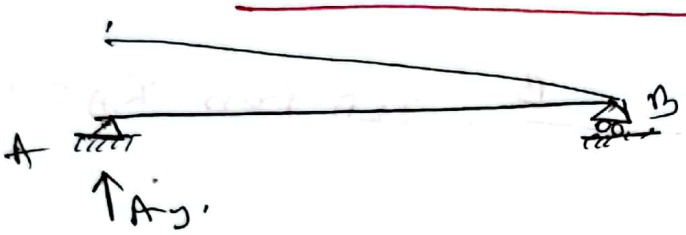
Influence Line Diagram.

The Muller-Breslau Principle states:

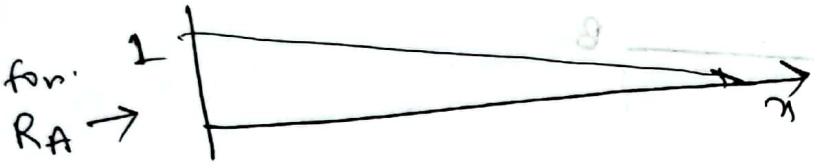
The influence line for a function (reaction, shear, moment) is to the same scale as the deflected shape of the beam when the beam is acted on by the function.

Qualitative Influence Lines

Q. 1)

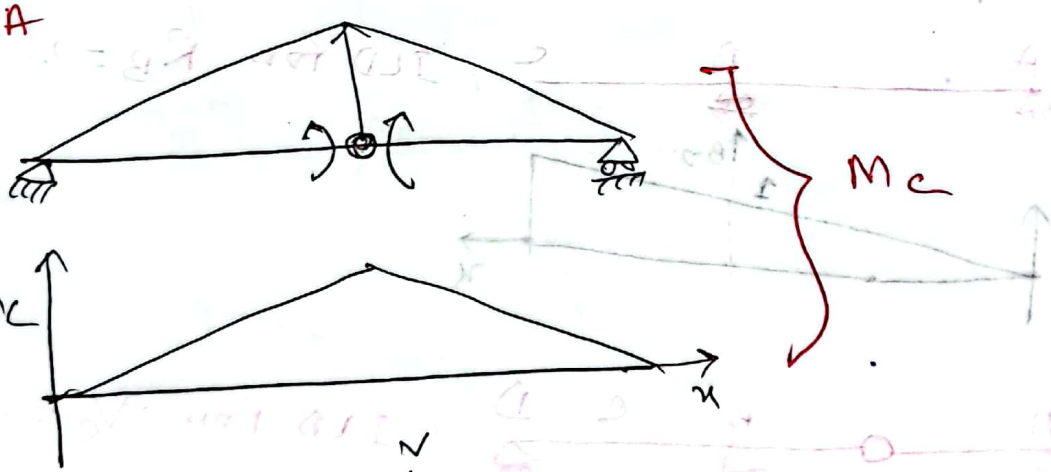


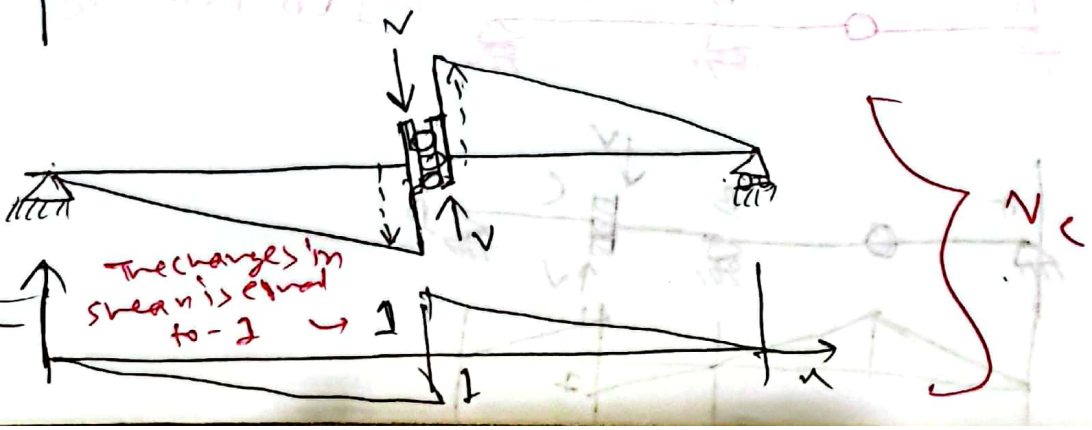
, ILD for R_A = ?.



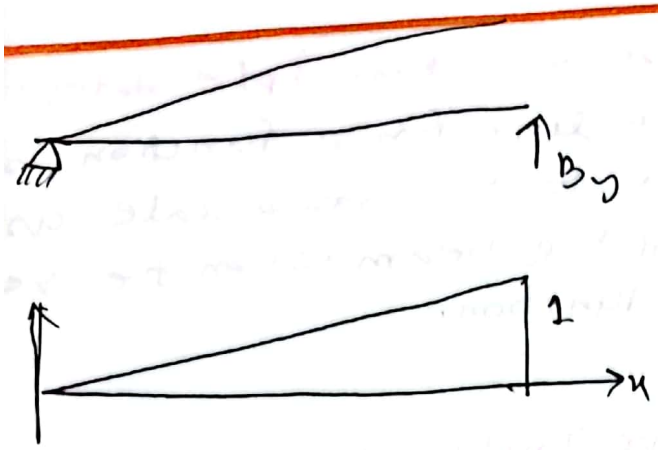
Q. 2)

, ILD for M_C, V_C, R_B = ?.

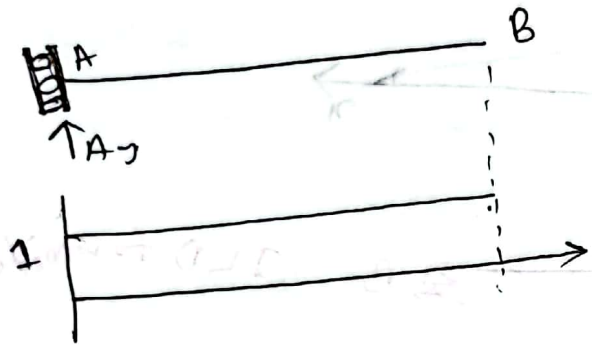




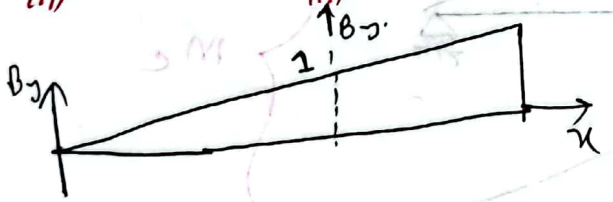
ILD

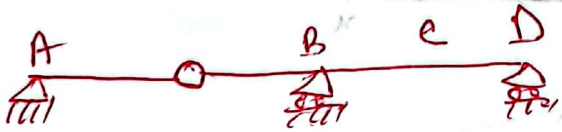


, ILD for $R_A = ?$.

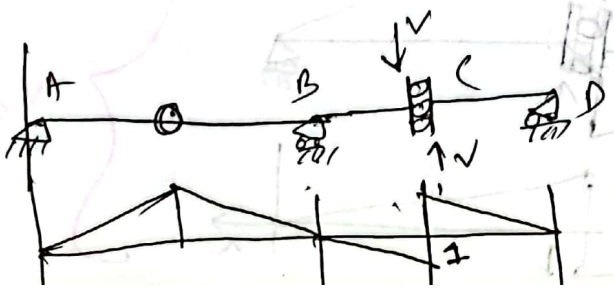


, ILD for $R_B = ?$.



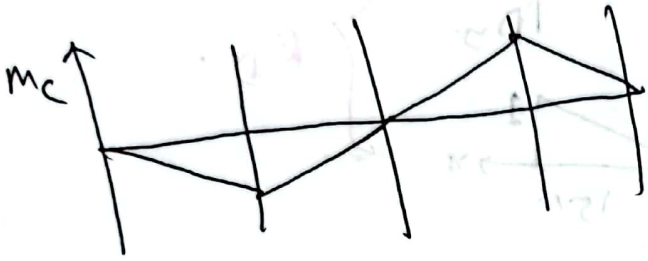


; ILD for $V_C = ?$.

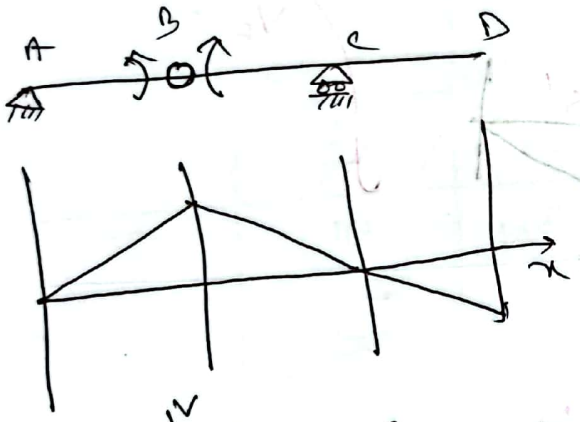


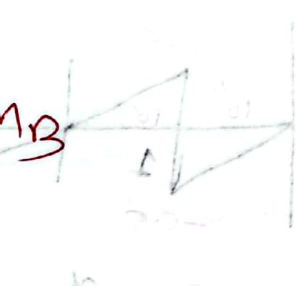
Influence Line Diagram.

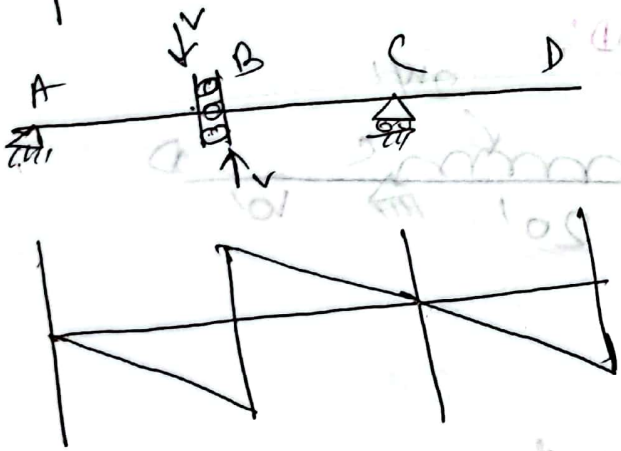
; ILD for moment at C.

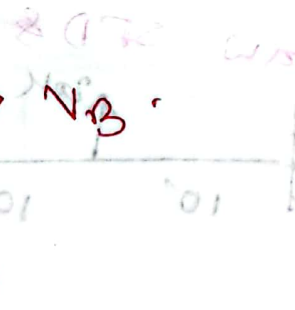


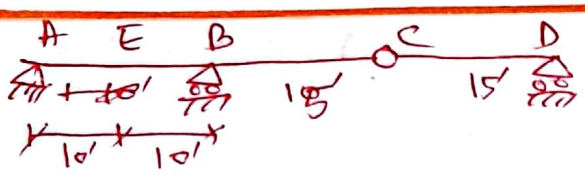
; ILD for moment at B & Shear at B :)





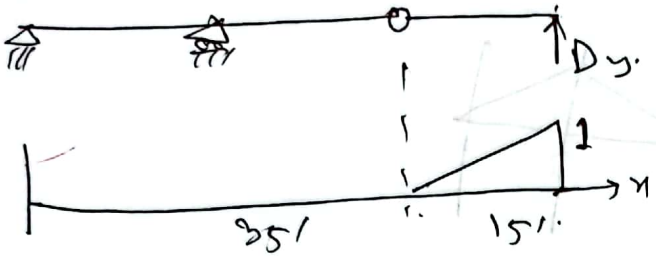




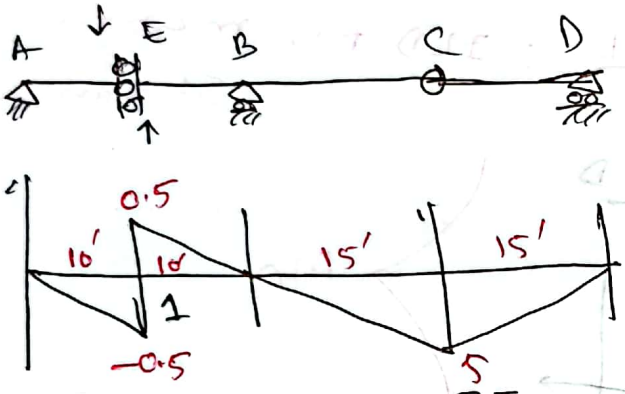
Q.8 

R_D & V_E = ?

Soln:



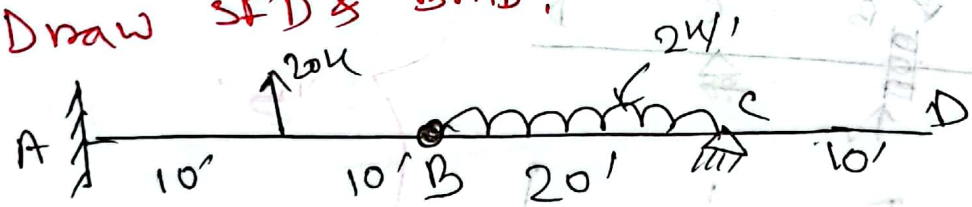
R_D.



V_E.

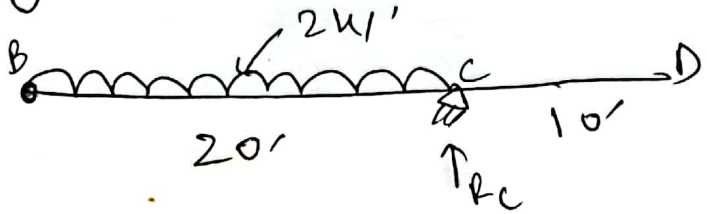
$$\frac{0.5}{10} = \frac{x}{15} \Rightarrow x = 0.75$$

Q.9 Draw SFD & BMD:



Ans:

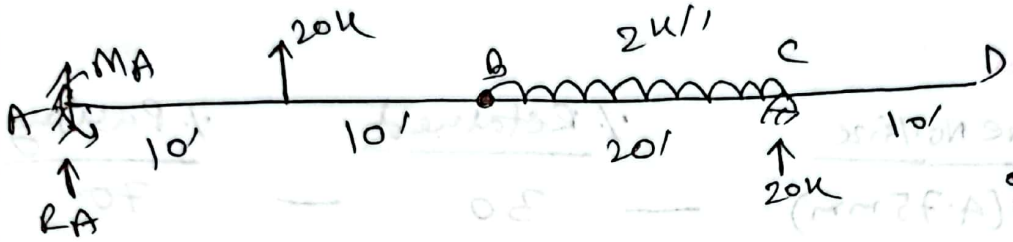
Taking B C D part –



$\Sigma M_B = 0$;

$\Rightarrow 2*20*\frac{20}{2} + -R_C * 20 = 0$

$\Rightarrow R_C = 20k$.



$\Sigma F_y = 0$;

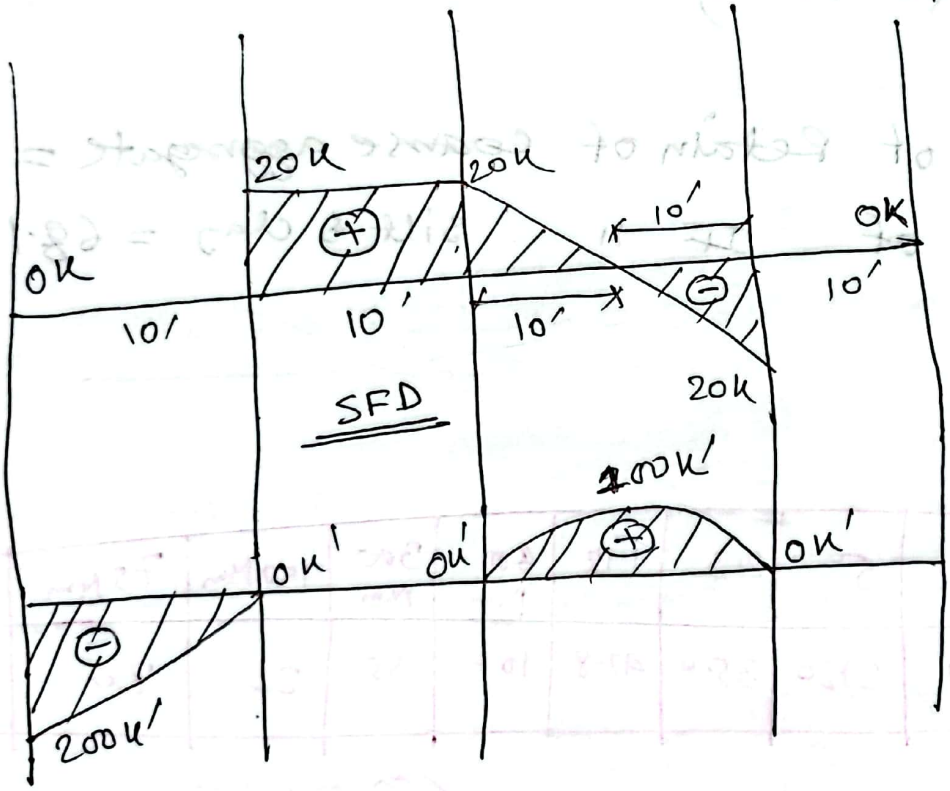
$\Rightarrow R_A + 20 + 20 - 40 = 0$

$\Rightarrow R_A = 0$;

$\Sigma M_A = 0$;

$\Rightarrow -20*10 + 40*30 - 20*40 = M_A$

$\Rightarrow M_A = 200k'$



BMD

Q.94 If a sample having percentage of retain by 4.75 mm (#4) and 0.075 mm (200 #) is 30% & 2%. Determine percentage of retain of coarse aggregate, silt & clay.

Soln.

Sieve No./size	% Retained	% Passing
#4 (4.75mm)	30	70
#200 (0.075mm)	2	68

∴ % of Retain of coarse aggregate = 30%.

∴ % of " " silt & clay = 68%.

~~N.B.~~

Q.95

S. Size (mm)	10	5	2.3	1.18	600 Mm	300 Mm	150 Mm	75 Mm	Pan
Retain	0	31.20	35.0	42.8	107	55	22	20	15.

Find (a) FM=?

(b) % of CA = ?

(c) % of FA = ?

(d) % of silt & clay = ?

(e) FM of CA = ?

(f) FM of FA = ?