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Subjects : 1

Section : ..... Year : 201.....

③ Flow modulus of a city is given. for 25% area is 2.84. for 50% area is 3.12, for 15% area is 1.32 & for 10% area is 1.82. Find the combined flow modulus of the city. [BWDB & BB AD]

Sol Flow modulus = 0.25 × 2.84 + 0.5 × 3.12 + 0.15 × 1.32 + 0.1 × 1.82

= 2.65 Ans.

④ Sieve Analysis were performed for a course sand & it has been found that 100% of sample retained on no. 30 sieve. What is the value of FM. [DG CB]

Soln

Sieve no	passing	Σ Retained
#30	100%	100%
#50	0%	100%
#100	0%	100%

FM = Σ Cu. Retained / 100
30 এ retain করেছে সব
কিছুই গুরুত্ব।

$$F.M = \frac{100+100+100}{100} = 3$$ Ans

(5) Of the BOD for 3 days at 10° of sewage sample is 250 mg/l. Calculate it's 10 days BOD at 25 degree.

Soln

$$R_t = R_{20} \times 1.047^{t-20}$$

$\therefore R_{10} = 0.063$

$R_{25} = 0.126$

Now, $L_t = L(1 - 10^{-Rt})$

$\therefore 250 = L(1 - 10^{-0.063 \times 3})$

$\therefore L = 708.5$

$\therefore E_{25} = 708.5(1 - 10^{-.126 \times 10})$

$= 669.56$ mg/l.

(6) Calculate the angularity no of aggregate sample.

R.D = 2.8. Mass of water = 2500

Mass of cylinder + Aggregate = 5150 gm.

Mass of cylinder = 1120 gm.

Soln Angularity no $= 67 \frac{150W}{CG_s}$

$= 67 - \frac{100 \times (2500 - 2400)}{}$

W = Wt. of agg
C = Wt of water filling the cyl.
G_s = Density or Sp. gravity.

$$= 67 - \frac{100 \times (5150 - 100)}{2.8 \times 2500}$$

$$= 9.14 \text{ (Betn 0 to 11)}$$

(Ans)

(x) How many kg of bleaching powder with 30% of available cl will be required to treat 4 million litres of water with a (Cl) dosage of 0.5 mg/litre. [30th BCS].

Solⁿ

$$\text{chlorine} = (4 \times 10^6 \times 0.5 \times 10^{-6}) \text{ kg}$$

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

30 kg cl is in 100 kg bleach

1 " " " $= \frac{100}{30}$ " "

2 " " " $= \frac{100 \times 2}{30}$

$= 6.67$ kg

(8) A sample of dry sand was tested in direct shear test under a normal load of 36 kg. The sample failed under shearing load of 58 lb. The sample size is 2" x 2". Calculate the φ. [PGCB] & [GTCL].

Soln

We know

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

$$\therefore 14.5 = 0 + 20 \tan\varphi$$

$$\therefore \varphi = \tan^{-1}\left(\frac{14.5}{20}\right)$$

$$= 36^\circ \quad \text{Ans}$$

In direct shear test —— $c = 0$.

Shear Strength $\tau = \frac{58}{2 \times 2}$

$= 14.5$ psi

Vertical stress $\sigma = \frac{36 \times 2.2}{2 \times 2}$

$= 19.98$

$= 20$ psi

(9) Calculate the dimension of a settling tank if discharge is 45 m^3/hr, over flow rate 0.5 m/hr. Detention period is 3 hours. [B.B.A.D]

Surface Overflow Rate, $\boxed{SOR = \frac{Q}{B.L}}$ [$B.L = A$]

$$\therefore B.L = \frac{45}{0.5} = 90\ m^2.$$

Again, $\boxed{T = \frac{LB.H}{Q}} = \frac{90 \times H}{45}$ $\therefore H = \frac{45 \times 3}{90} = 1.5m.$

For, settling tank, $L = 4B$.

$B \times 4B = 90$

$\therefore B = 4.75.$

$\therefore L = 4 \times 4.75 = 19 m.$

Dimension $= L \times B \times H$

$= 19 \times 4.75 \times 1.5$

Ans.

(10) A road embankment 10m wide at foundation level, side slope 2:1 & with average height of 5m is constructed with an average gradient 1 in 40 fm contour 220m to 280 m. Find the Vol^m of earthwork?

Sol^n: Difference in level of both ends of the road $= 280 - 220 = 60m.$

Average gradient is 1 in 40.

1m ht @ 2) 40m length

$\therefore 60m$ " " " $(40 \times 60) = 2400$ m length.

Area of cross-section $= (b + sh) \times h$

$= (10 + 2 \times 5) \times 5$

$= 100$ m^2.

Vol^m of embankment $= (100 \times 2400)$

$= 240,000 m^3$

(Ans)

(11) Calculate the sectional area of an embankment 10m wide, side slope 2:1; ground level is transverse direction to the centre line. Central height of embankment is 2.5m.

Solⁿ $s=2$. $b=10m$. $h=2.5$

$$A=(b+sh)\times h$$
$$=(10+2\times 2.5)\times 2.5$$
$$=37.5\ m^2 \quad \underline{Ans}$$

(12) If the radius of curve is 300' & width 20; $f=0.14$ $V=90$ mph. Calculate superelevation.

$$e=\frac{V^2}{127R}=0.14 \Rightarrow$$

$$=\frac{149.09^2}{127\times 91.46}-0.14=1.67m$$

~~$=5.348\times10^{-4}$~~

~~= Cent deficiency. ∴ e.~~

$\underline{Ans}$

~~$V=0.082$ ft/s~~

$V=90$ mph

$=90\times1.61$ kmph

$=144.9$

~~240.25~~

~~$=0.037$ km~~

$R=300'$

$=91.46m$

+ Raising of water edge $=\frac{Be}{2}$

$=\frac{6.09\times1.67}{2}$

$=5.08$ (Ans)

$B=20'$

$=6.09m$

$E=e\times B$

$=1.67\times6.09$

$=10m$

$V=132$ ft/s

$e=\frac{132^2}{32.2\times300}-0.14$

$=1.66$ ft/ft

But $e_{max}=0.067$ ft/ft

So, $E=0.067\times20$

$=1.34$ ft (Ans)

(যদি 300)

10. -এর কয় প্রকার।

11. What are the type of scour that can be near a bridge? Given. bridge discharge = 5800 m³/s. Hydraulic mean depth if the river is 58 m and mean regime velocity is 10.5 m/s. Calculate the scour depth using Lacey's silt factor.

Soln flowing water causes three types of scour.

1. Degradation scour.
2. Contraction scour.
3. Local scour.

We know,

$$R = \frac{5}{2} \cdot \frac{V^2}{f_s}$$

$$\therefore f_s = \frac{5}{2} \cdot \frac{V^2}{R}$$

$$= \frac{5}{2} \times \frac{10.5^2}{58} \Rightarrow 4.75^2$$

$$\text{Scour depth} = 0.47 \times \left(\frac{Q}{f_s}\right)^{1/3}$$

$$= 0.47 \times \left(\frac{5800}{4.75}\right)^{1/3}$$

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

(12) A pile of 20" dia & 50' length is embeded in sand. The top of pile is 10' below the ground surface. Unit wt. of soil in saturated condition is 120 pcf. Angle of internal frictim is 30°. GWT is at ground surface. Calculate, skin friction Capacity of pile Qs.

Soln Given that

$D = 20"$, $L = 50'$, $\gamma_{sat} = 120 lb/ft^3$, $\phi = 30°$, $\gamma = 120 lb/ft^3$

$z = 50' + 10' = 60'$

Friction capacity, $Q = PLf$.

f = Unit friction resistance

$= K \bar{\sigma}_{av} \tan\delta$

$= (1 - \sin\phi)\left(\frac{\gamma z}{2}\right) \tan(0.8\phi)$

$= (1 - \sin 30°) * \left(\frac{120 \times 60}{2}\right) \tan(0.8 \times 30°)$

$= 801.41.$

δ = Soil - pile friction angle

$= 0.8\phi$

$\therefore Q_s = \pi D * L * f$

$= \pi \times \frac{20}{12} \times 50 \times 801.41$

$= 209,808.26 \approx 209$ kip.

(13) The unconfind compression of a soil is 50 kPa. Find the max. unsupported ht.

Soln

Let $\phi = 22°$ (Assume). $q_u = 50$ kPa.

$$\alpha = 45° + \frac{\phi}{2} = 56°$$

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

$\gamma = 19 kN/m^3$.

Unsupported ht $H_1 = \frac{4 c_u}{\gamma} \tan\alpha$

$$= \frac{4 \times 25}{19} \times \tan 56°$$

$$= 7.8 m \text{ (Ans)}$$

Tension Crack $= \frac{2c}{\gamma} \tan\alpha$

(14) The hourly ordinate of 6-h UH for a particular basin is 36 cumec. The flood peak due to 6 hr storm was 130 cumec. The constant base flow ~~was 130 cum~~ 6 cumec & ave. loss 6 mm/hr. Determine the depth of storm rainfall & streamflow at 3 hr interval

Soln: D.R.O peak = flood peak − B.F

$$= 130 - 6 = 124 \text{ cumec.}$$

$$P_{net} = \frac{\text{D.R.O peak}}{\text{UG peak}} = \frac{124}{36} = 3.44 \text{ cm.}$$

Depth of storm rainfall, $P = P_{net} + \text{loss}$ (cm)

$$= 3.44 + (6 \times 0.6)$$

$$= 7.04 \text{ cm (Ans)}$$

Again, DRO = UR0 × Pnet
= 36 × 3.44
= 123.84 [আগের 124 বের করেছি আছে]

D.R.O + B.F = TRO
∴ TRO = 123.84 + 6
= 129.84 cumec Ans.

(15) Determine the spacing required for the shrinkage & temperature in a one way slab if t = 6". Use #3 bar with f_y = 60 ksi, f_c' = 3 ksi

Soln Ar(min) = 0.0018 bt
= 0.0018 × 12 × 6
= .13 in²

#3 bar. Spacing = $\frac{0.11 \times 12}{0.13}$ = 10.15 ≈ 10" c/c.

(16) The estimated batch quantities per cubic meter of concrete for SSD condition of aggregates are: cement = 306 kg, C.A = 1152 kg, F.A = 870 kg, water = 162 kg. In fine aggregate 5% surface moisture & coarse aggregate absorbs 0.1%. Workout field adjustments.

Soln In field condition, the extra water must be added to achieve the SSD of the aggregate as per absorption capacity.

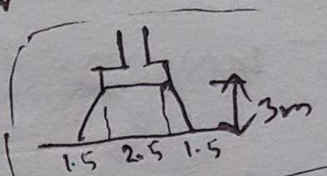
→ for fine aggregate, extra water is required to gain the S.S.D condition = 870 × 5% = 43.5 kg.

→ for course aggregate = 01% × 1152 = 1.152 kg.

on field, the total water required = (162 + 43.5 + 1.152)
= 206.652 kg. Ans

(17) A square footing (2.5 m × 2.5m) is to be placed on a homogeneous clay layer at 3m depth. The load on footing bare from the corresponding col^n 50 kN. Determine the net pressure.

+ Soln



$\frac{50}{5.5\times5.5} = 1.65$ kN/ft² ✓

pressure = $\frac{50}{2.5\times2.5}$ = 8 kN/m²

γH = 18 × 3 | let γ = 18
= 54 kN/m²

Total pressure = 8 + 54
= 62 kN/m²

[Sure na]

$q_{net} = q_u - \gamma D$
$= \frac{50}{2.5\times2.5} - 18\times3$
$= 8 - 54 = -46$ kN/m²

(18) Design a simply supported beam for a bending moment of 1440 k-in. concrete strength f'_c = 3500 psi, Steel strength. d_y = 60 ksi. n = 9. (WSD).

Soln $f_c' = 3500$ psi, $f_c = 1575$ psi. $f_y = 60,000$ psi. $\left(n = \frac{E_s}{E_c}\right)$

$f_y = 24,000$. $r = f_s/f_c = 15.24$, $k = \frac{n}{n+r} = 0.37$, $j = 1 - k/3 = 0.887$

We have, $M_c = \frac{1}{2} f_c j k b d^2$

$bd^2 = 2535.85$.

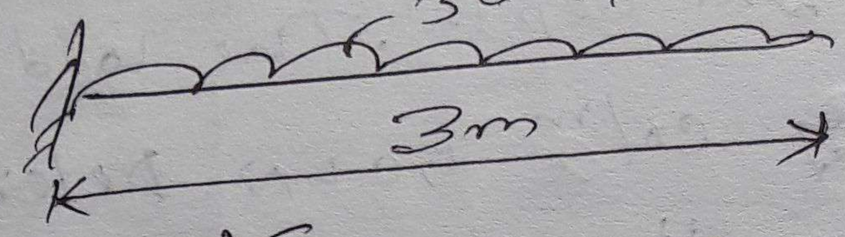
when b = 10", d = 15.92 ≈ 16". So, Section may be = (10" × 16")

$M = A_s f_s j d$. Use 6 - #8 bars.

$A_s = 4.28$ in²

(19) A cantilever beam of 3m long subjected to a uniformly distributed load of 30 kN/m. The allowable working stress in either tension or compression is 150 MPa. If the cross section to be rectangular. Determine the dimension (height is twice the width.

Soln



$$M = \frac{30 \times 3^2}{2} = 135 \text{ kN-m.} \qquad c = h/2$$

$$b = \frac{h}{2}. \quad I = \frac{bh^3}{12} = \frac{\frac{h}{2} \times h^3}{12} = \frac{h^4}{24}.$$

Now, $150 \times 10^3 = \frac{135 \times h/2}{\frac{h^4}{24}}$. $\left[\sigma = \frac{Mc}{I}\right]$

$$\text{or } 150 \times 10^3 = \frac{135 \times 24}{2h^3}$$

or $h = 0.22$ m. The beam size $= 0.11 \times 0.22$ (Ans)
$b = 0.11$ m.

(20) In an unconfined compression test, sample of clay 8 cm long & 4 cm dia fails at a load of 1 kg at 7% strain. Find undrained shear strength of clay, taking in account that the effect of cross-section. (PBB-14)

Soln Strain ratio = 7% = $\frac{7}{100}$ = 0.07

Area = $\frac{\pi \times 1.5^2}{4}$ = 1.94 in²

Actual cross-sectional area, A = $\frac{A_0}{1-\varepsilon}$ = $\frac{1.94}{1-0.07}$ = 2 in²

Load = 12 kg = 12 × 2.2 = 26.4 lb.

Unconfind compressive strength, $q_u = P/A$ = $\frac{26.4}{2}$

= 13.2 psi

[1 psi = 0.072 Tsf] = 0.95 Tsf.

Undrained shear strength, $c = \frac{q_u}{2}$ = $\frac{0.95}{2}$ = 0.475 Tsf.

(Ans)

(21) For aerial photography, determine the number of flight line from the following data.

Area = 16 × 20 miles, focal length = 12", photograph size 9" × 9". photo scale = 1 : 10,000. Over lap = 60%. Side lap = 25%. flight lines in the direction of 20 miles and outer lines coincides with boundary.

Soln W = 9" = 22.86 cm. [width of photograph]

Side lap = 25%.

Scale = 1 in 10,000

Theoritical ground distance between flight lines,

$W = w(1 - P_w)/s$

$= \frac{22.86 \times (1 - .25)}{100 \times \frac{1}{10,000}}$ = 1714.50 m.

Number of flight required, $N_2 = \frac{W_1}{W} + 1$

$W_1 = 20$ miles

$= 20 \times 1.609 \times 1000$

$= 32180$ m

$= \frac{32180}{1714.5} + 1$

$= 19.8$

≈ 20 Ans

(22) For a building construction, total beam length of 1650 m is required. 5- @ 20 mm plain bars are used in these beams. Unit wt. of plain bar is 7850 kg/m³ and cost is tk 48,000 tk per ton. Make the cost estimate for the steel bars.

Soln

Cross-sectional area $= \frac{\pi \times (\frac{20}{1000})^2}{4}$

$= 3.14 \times 10^{-4}$ m²

*5 (Same)

Length, $= 5 \times 1650 = 8250$ m.

Weight $= 8250 \times 3.14 \times 10^{-4} \times 7850$ kg.

$= 20335.4$ kg

$= 20.335$ m. tons

Total cost $= 20.335 \times 48,000$

$= 976100$ tk

(Ans)

1 metric ton = 48,000 tk

$(5 \times \frac{\pi \times (\frac{20}{100})^2}{4} \times 1650)$ m³ $\times$ 7850 kg/m³

$\times$

(25) A canal commands an irrigation area of 350 ha. the peak field irrigation requirement is 9mm/day. Determine, the design discharge of canal at the offtake, water loses 25%.

Soln

Total ~~area~~ water requirement $= \frac{9}{1000 \times 24 \times 3600} \times 350 \times 10^4$

$= .36 m^3/s.$

An 25% loss Design discharge $= \frac{.36}{1-0.25}$

$= 0.48 m^3/s.$

$Q = .36 + 0.36 \times \frac{25}{100} = 0.45 m^3/s$ (Ans)

(26) Sequent depth ~~of~~ Math (mrs).

$$\frac{h_2}{h_1} = \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right).$$

(27) Calculate the settlement of a 2.5m deep clay layer due to increase of 30 kN/m² pressure at mid-height of clay layer, Given eff. ver. Stress at mid ht = 30 kN/m², ~~e=0~~. $e_0 = 0.8, C_c = 2.28$ (PG, CB)

Soln

$$S = \frac{C_c H}{1+e_0} \log \frac{P_0 + \Delta P}{P_0}$$

$$= \frac{0.28 \times 2.5}{1+0.8} \log \frac{30+30}{30}$$

$= 0.117 m$

$= 11.7 cm$ (Ans)

(28) The unconfind compresion of the soil is 50kPa. Determine the depth of excavation without any lateral support. [BPDB]. একক আয়তন ভার, $\gamma = 18 kN/m^3$

Soln

Critical height, $h_c = \frac{4c}{\gamma} \tan\alpha$

$= \frac{4 \times 25}{18} \tan 45$

$= 5.56 m$ (Ans.)

$\phi = 20°$

$q_u = 50 kPa$,

$C_u = \frac{q_u}{2}$

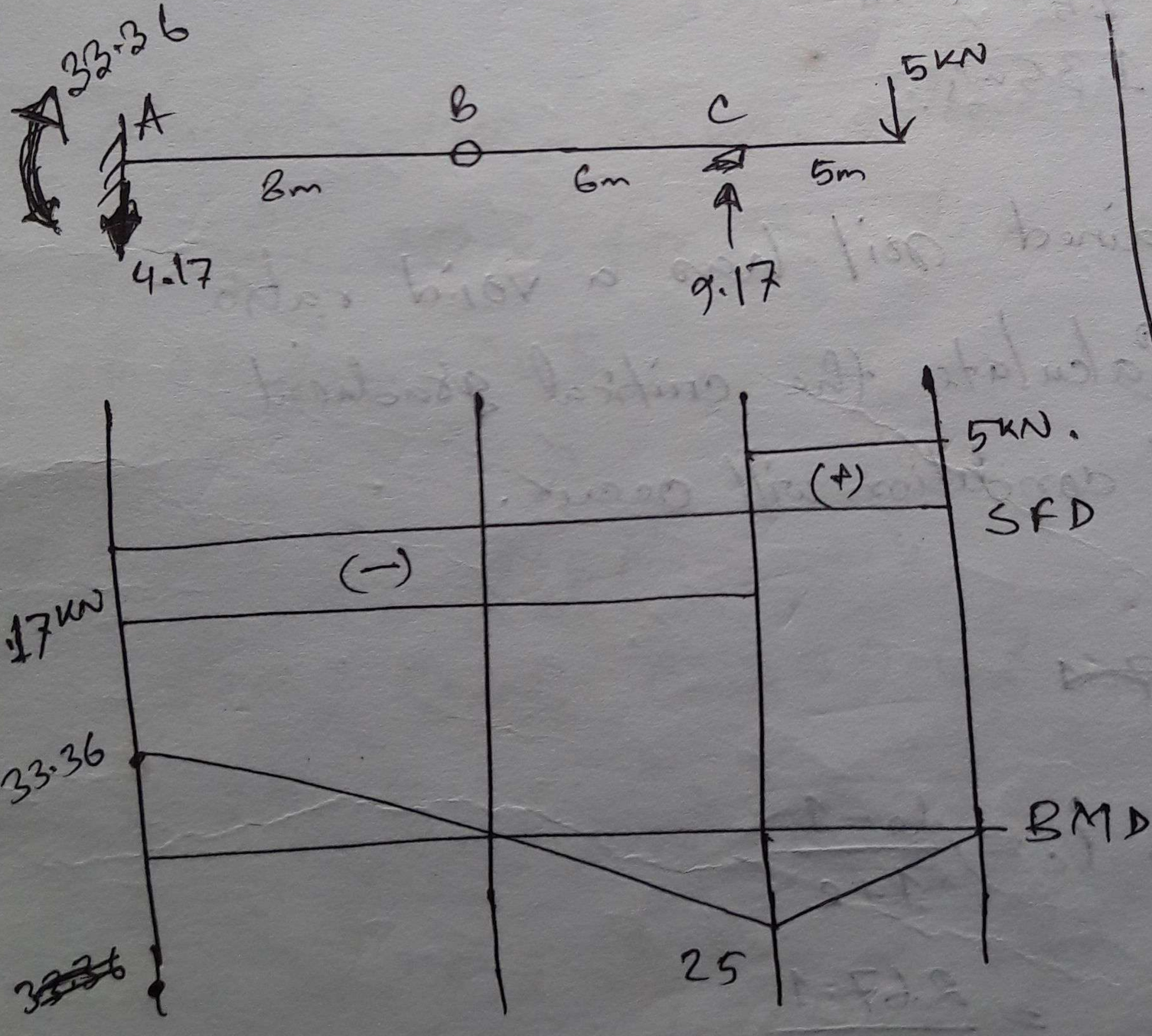
$= \frac{50}{2}$

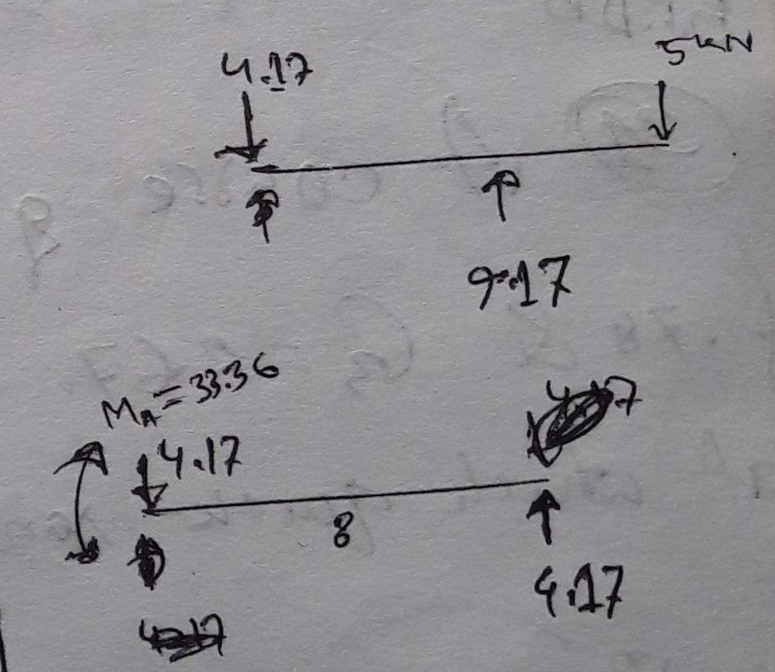
$= 25 kPa$

$\alpha = 45° + \frac{\phi}{2}$

$= 45°$

(29)





(30) A settling tank 3m deep, 60m long. Particle Size = 0.025m. Specific gravity = 2.65. $V = 0.01 m^3/s$ find flow velocity. Free board = 0.5m.

Soln. Settling velocity —

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

$$= 0.056 m/s.$$

Again, $\frac{L}{h} = \frac{V}{V_s}$

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

$$= \frac{60}{2.5} \times 0.056$$

$$= 1.35 m/s.$$

(Free board.

$3 - 0.5 = 2.5$

B.P.D.B

(31) A coarse grained soil has a void ratio of .78 & $G_s = 2.67$. Calculate the critical gradient at which quick sand condition will occur. V.V.I

Soln.

~~$i_c = \frac{2.67 - 1}{}$~~

Critical gradient, $i_c = \frac{G - 1}{1 + e}$

$$= \frac{2.67 - 1}{1 + .78}$$

$$= 0.94$$ Ans

(32)

&

wt.

(32) The saturated unit wt. of soil is 19.5 kN/m³ & the Sp. gravity is 2.65. Determine the dry unit wt. of soil.

Soln

We know,

$$\gamma_d = \frac{G_s(\gamma_{sat} - \gamma_w)}{G - 1}$$

$$= \frac{2.65(19.5 - 9.81)}{2.65 - 1}$$

$$= 15.56 \text{ kN/m}^3$$

(33) Calculate the max. allowable speed on a horizontal curve of radii 200m for the data, $v = 80$ kmph.

$l_{max} = 0.07$, $f_{max} = 0.15$.

$$e = \frac{v^2}{225R} = \frac{80^2}{225 \times 200} = 0.14 \text{ m}.$$

$e > l_{max}$, $l_{max} = 0.07$.

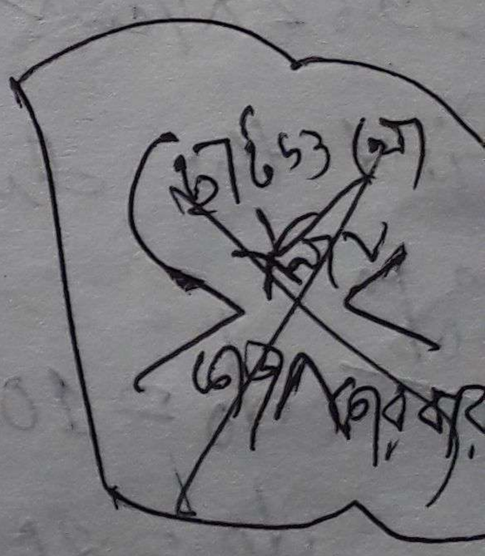
Now, $e + f = \frac{v^2}{127R}$

or, $0.07 + f = \frac{80^2}{127 \times 200} - 0.07 = 0.18$

$f > f_{max}$.

So, $l_{max} + f_{max} = \frac{v_a^2}{127R}$

$\therefore v_a = \sqrt{127R \times (.15 + 0.07)} = 74.75$ kmph.



(39) From a series of flood peaks on a stream it is found that in a period of 23 years discharge 490 m³/s or more occured 36 times and a dis. 600 m³/s or more occured 8 times. What are return period of this flood? What are the corresponding exceedence probability?

Sol^n

$$P_{a_1} = \frac{36}{23} = 1.57, \quad P_{a_2} = \frac{8}{23} = 0.35$$

$$T_1 = \frac{1}{1.57} = 0.64, \quad T_2 = \frac{1}{.35} = 2.86$$

$$P_1 = (1 - e^{-P_{a_1}}) \times 100 = (1 - e^{-1.57}) \times 100 = 79.2\%. \text{ Ans}$$

$$P_2 = (1 - e^{-P_{a_2}}) \times 100 = (1 - e^{-.35}) \times 100 = 29.53\%. \text{ Ans}$$

(40) What is the probability of 200 year flood to exceeded in next 20 yrs??

Sol^n

$$P = 1 - \left(1 - \frac{1}{T_n}\right)^n$$

$$= 1 - \left(1 - \frac{1}{200}\right)^{20}$$

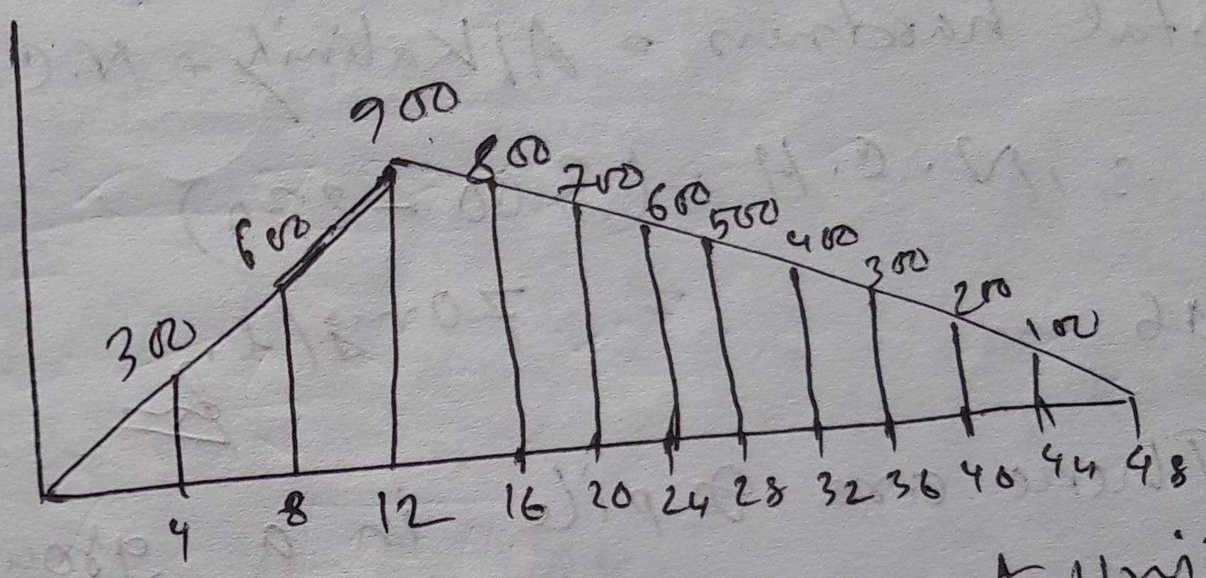
$$= 0.0954$$

$$= 9.54\% \simeq 10\%.$$

(Ans)

(41) The 4 hour unit hydrograph of a basin may be approximated as a triangle with a base period of 48h. and a peak discharge of 900 m³/s at the end of 12th hour. The design storm is having a total duration of 12 hour with rainfall intensities of 2.5 cm/hr, 4 cm/hr & 3 cm/hr in three successive 4h interval. Determine the design flood discharge & it's time of occurance.

Soln



$Q_{peak} = (900 \times 2.5 + 800 \times 4 + 700 \times 3)$ [Unit hydrograph]

$= 7550 \text{ m}^3/\text{s}$

probable occurance time (12th hour to 20th hour).

GTCL-16 (Not exactly)

(42) A water sample with pH 9, had a caustic alkalinity of 70 mg/l, total alkalinity of 230 mg/l & total hardness of 300 mg/l. All as $CaCO_3$. Calculate the amount of various forms of alkalinity present & the amount of noncarbonate hardness.

Soln The pH of sample is 9 and hence the neutralization of CO_3^{--} is only half completed.

CO_3^{--} alkalinity = 2 × Caustic al.

= 2 × 70

= 140 mg/l.

Total alkalinity = $CO_3^{--} + HCO_3^{--}$

∴ 230 = 140 + HCO_3^{--}

∴ HCO_3^{-} = (230 − 140) mg/l

= 90 mg/l. (Ans)

Total hardness = Alkalinity + N.C.H

∴ N.C.H = (380 − 230)

= 70 mg/l. (Ans)

As
T.H > Alkalinity,
C.H = Alkalinity
so,
T.H = C.H + N.C.H
= Al + N.C.H.

BTCL-16

(43) There are 9 pile in a group, each having 9" in dia, 65' long, $\alpha = 0.5$. $q_u = 1080\ lb/ft^2$ find skin friction for a single pile.

Solⁿ

Skin friction = $\alpha_2 \bar{c}$ Asurface

= 0.5 × 500 × πDL

= 0.5 × 500 × π × $\frac{9}{12}$ × 65

= 38.28 kip.

$c_2 = \frac{q_u}{2}$

= 500 psi

S/K for single pile = $\frac{38.28 \times 9}{3}$

= 114.84 k. (Ans)

ultimate bearing capacity কে 9 দিয়ে ভাগ করা হয়েছে।

$\frac{38.28}{\frac{\pi \times 9^2}{4}}$

= □ (Ans)

(Q4) DBSC-16 If $V_s = 65\left(1 - \frac{K}{110}\right)$.

Determine the following condition.

1. flow density & flow speed.
2. Free flow, jam density & capacity.

Soln we know,

$$V_s = V_f\left(1 - \frac{K}{K_j}\right) \qquad \left(v = v_{max}\left(1 - \frac{k}{k_j}\right)\right)$$

So, V_f = 65 km = free flow.

K_j = Jam density = 110 vpm.

Also, we have, $q = V_s K$ $\qquad (q = vk)$

$$= 65\left(1 - \frac{K}{110}\right) \times K$$

$$= 65K - .59K^2$$

$$\& \frac{dq}{dK} = 65 - .59 \times 2K$$

$$0 = 65 - 1.18K$$

flow density, $K = 55$ vpm.

flow speed, $V_s = \frac{V_f}{2} = \frac{65}{2} = 32.5$ kmph

Capacity, $= 32.5 \times 55 = KV_s$

$= 1790.1$ veh/hr.

সুবিধাবা

$V_s = V_f\left(1 - \frac{55}{110}\right)$

$= V_f \times \frac{1}{2}$

$= \frac{V_f}{2}$

(45) find the weight of a steel sheet having his size 18'×8' & thickness = 10mm.

Soln

$$\text{Weight} = \text{Volume} \times \text{Unit. wt}$$

$$= \frac{18\times 8}{3.28\times 3.28} \times \frac{10}{1000} \times 7850$$

$$= 1050.6\text{ kg}$$

$$= 1.056 \text{ ton}$$ Ans

BADC-12

(46) for 100 cft concrete the ratio is 1:2:4. find the bag of cement.

Soln

$$(1+2+4)x = 1.5 \times 100$$

or $$x = \frac{1.5\times 100}{7}$$

$$= 21.4 \text{ cft or } \frac{21.4}{1.25} = 17 \simeq 18 \text{ bag.}$$

Ans.

* দেয়াল 100 ft² Brick wall এর জন্য ---(1:3)

ইট লাগবে = 5×100 = 500 ft³

~~Concrete~~ Mortar $= 100 \times \frac{5}{12} = 500 \times \frac{9.5\times 4.5\times 2.75}{12\times 12\times 12}$

$$= 7.65 \text{ cft}.$$

$x + 3x = 7.65 \times 1.5$

find cement. Ans

(47) Taking 920gm sample, determine FM. The FM of one type of soil is 2.28, other having 2.74 & combined FM is 2.48. Determine, the amount of soil of two types.

Soln

$$\text{Ratio} = \frac{F_1 - F_{com}}{F_{com} - F_2}$$

$$= \frac{2.28 - 2.48}{2.48 - 2.74}$$

$$= \frac{2.74 - 2.48}{2.48 - 2.28}$$

$$= 1.3$$

$\therefore R:1 = 1.3:1$.

Sum of ratio $= 1.3 + 1 = 2.3$

$$m_1 = \frac{1.3}{2.3} \times 920 = 520 \text{ gm}$$

$$m_2 = \frac{1}{2.3} \times 920 = 400 \text{ gm}$$ } (Ans)

(48) What are the methods of calculating RL. In a levelling operation, the RL of 1st & last benchmarks were 108.78 & 114.95 respectively. The sum of back & fore reading were 24.88 & 18.64. Find closing error.

Soln "See 247 নং প্রশ্নোত্তর দেখ"

1. Rise-fall method.
2. Height of instrument method.

Height of instrument = 108.78 + 24.88 = 133.66

" " 2nd benchmark = 133.66 - 18.64 = 115.02

closing error = (115.02 - 114.95)

= 0.07 (Ans)

(49) What is the nautical mile. From the fundamental definition of N.M prove that 1 nautical mile = 6082'. The radius of earth is equal to 3960 mile.

Soln A nautical mile is a unit of distance and is defined by as a distance spanned by one minute of arc length along a meridian of the earth & developed from the sea mile & the related geographical mile.

Or

1 minute of arc length on earth = 1 nautical mile.

Now. $360^\circ \sim 2\pi r$

$\therefore 1^\circ \sim \frac{2\pi r}{360}$

$\therefore 1 \text{ minor } \frac{1}{60}^\circ \sim = \frac{2\pi r}{60 \times 360} = \frac{2\pi \times 6400}{60 \times 360}$

$= \frac{1.86}{1.6}$ km $\sim$ 1.16 mi

$= 1.16 \times 1760$

$= 2047 \text{ yrd} \times 3$

$= 6082'$ Ans.

(50) If the most optimistic time of an activity equal to 6 days, most probable (likely) time 8 days & most pessimistic time 16 days. Find Expected time of completion of activity.

Sol^n We know,

$$t_E = \frac{t_o + 4t_L + t_p}{6}$$

$$= \frac{6 + 4\times 8 + 16}{6} = 9 \text{ Ans}$$

(51) Calculate the area by Simpson's rule.

Chainage(m)	0	3	6	9	12	15	18	21	24
Offset	1.2	2.3	4.5	4.2	3.1	3.5	7.1	7.3	4.1

Sol^n

$$\text{Area} = \frac{h}{3}\left[1.2 + 4.1 + 4\times(2.3 + 4.5 + 4.2 + 3.1 + 3.5 + 7.1 + 7.3) + 2(4.5 + 3.1 + 7.1)\right]$$

$= 103.9 \text{ m}^2$. (Ans)

$\frac{h}{3}\left[1.2 + 4.1 + 4(2.3 + 4.2 + 3.5 + 7.3) + 2(4.5 + 3.1 + 7.1)\right]$

$=$ (Ans).

(54) A pump lift 95,000 l of water per hour against total head of 23m. If the pump has an eff. of 75%. Compute the horse power & shaft horse power. (GTCL)

Soln $Q = \frac{95,000}{3600} = 23.39$ l/s.

Water horse power $= \frac{QH}{76} = \frac{23.39 \times 23}{76}$

$= 7.98$ WHP.

Brake/Shaft " " $= \frac{WHP}{\eta} = \frac{7.98}{0.75} = 10.64$ (BHP).

(55) Water is flowing through a pipe of 70mm dia under a gauge pressure of 3.5 kg/cm^2 & with mean velocity of 1.5 m/s. The pipe is 7m above the datum line. Neglecting friction, find the head of water. (GTCL)

Soln

Total head $= \frac{P_1}{w} + \frac{v_1^2}{2g} + z_1$

1 kg = 9.8 N

$= 7 + \frac{150^2}{2 \times 9.81} +$

$= 7 + \frac{1.5^2}{2 \times 9.81} + \frac{3.5 \times 100 \times 100}{1000}$

$= 42.11$ m. A

(56) A trapizoidal channel has a bottom width of 6m & side slope 1:1. The depth of flow is 1.5m at a discharge of ~~1.5~~ 15 m^3/s. Determine the specific energy in terms of head of water.

Soln

Area = $(b + sh) * h$

$= (6 + 1 \times 1.5) \times 1.5$

$= 11.25\ m^2$

$V_1 = \frac{Q}{A} = \frac{15}{11.25}$

$= 1.33$

Sp. energy = $y_1 + \frac{V_1^2}{2g}$

$= 1.5 + \frac{1.33^2}{2 \times 9.8}$

$= 1.59m$

BCS-35.

(57) A static cone penetration test was performed in a cohesive soil at a depth of 7m with a tip resistance q_c of 1 MPa & friction ratio 3%. PI = 15%. find Undrained shear strength

Soln

$P_c = .243\ q_c^{.96}$

$= .243 \times 1^{.96}$

$= .243\ MN/m^2$

Now $\frac{C_u}{P_c} = 0.11 + 0.0037 PI$

$= 0.243 (0.11 + 0.0037 \times .15)$

$= 0.0269\ MN/m^2$

(66) Find the shortest length L for a steel column with ends having a cross-sectional area of (60×100) mm for which the elastic Euler formula applies. E = 200 GPa. Assume proportional limit to be 250 MPa.

Soln

$$I_{min} = \frac{bh^3}{12} = \frac{100 \times 60^3}{12} = 1.8 \times 10^6 \text{ mm}^4$$

$$r_{min} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{1.8 \times 10^6}{60 \times 100}} = 17.32 \text{ mm}$$

For no case, let both end fixings $L_e = L$

$$\sigma_{cr} = \frac{\pi^2 E}{(L/r)^2} = \frac{\pi^2 \times 200 \times 10^3}{(L/r)^2}$$

$$\Rightarrow \left(\frac{L}{r}\right)^2 = \frac{\pi^2 \times 200 \times 10^3}{250}$$

$$\sigma_{cr} = \frac{P_{cr}}{A}$$

$$\therefore P_{cr} = \sigma_{cr} \times A$$

or $\frac{L}{r} = 88.9$ mm.

or, $L = 88.9 \times 17.32 = 1540$ mm (Ans)

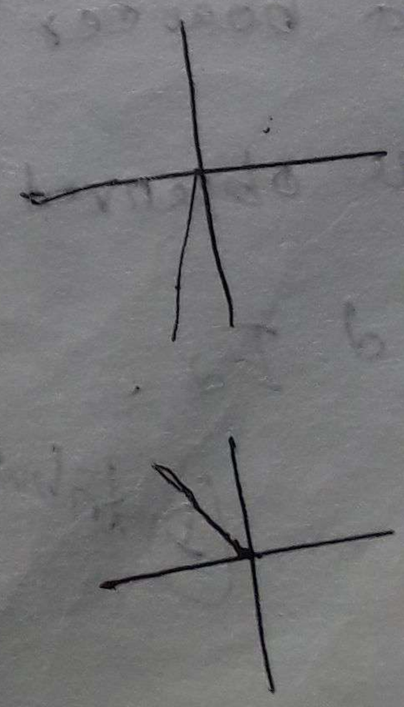
(67) The magnitic bearing declination at a plane if the magn bearing of the Sun at noon is (a) 184° (b) 350° 20'

Soln

(a) True Bearing = M.B + Declination

or $180° = 184° + \text{Declination}$

$\therefore$ Declination = $180 - 184° = -4°$ (Ans)



(b) $T.B = MB + D$

or $360° = 350°20' + D$

$\therefore D = 9°40'$ (Ans)

(68) The magnatic bearing of a line is 48°24'. Calculate, true bearing if declinatim is 5°38'.

True bearing = 48°24' + 5'38'
= 54°02' (Ans)

* Quadrantal system ও back bearing কাকে for bearing বা opposite হবে।

That is, F.B = N 40°25' E
B.B = S 40°25' W Okey.

(69) 15 m³/s of water was delivered to a 34 ha field for 4 hours. Soil proving, 0.3 m has been stored in the root zone. Compute, the water application eff.

Sol^n We know,

$$E_a = \frac{W_s}{W_f}$$

$$\therefore E_a = \frac{102,000}{216,000} * 100$$

$$= 47.22\%$$ Ans

W_s = Stored in the root zone = 34 × 104 × 3
= 102,000 m³

W_f = Total delivered to the field = 15 × 4 × 3600
= 216,000 m³.

(70) The depth of penetration along the length of a boarder strips at points 30m apart were probed. The observed values are 2.0, 1.9, 1.8, 1.6 & 1.5. Find E_d. (Distribution eff.)

Soln

$$\Delta = \frac{2+1.9+1.8+1.6+1.5}{5} = 1.76\text{m}.$$

Deviation from the mean = $(2-1.76)$; $|1.9-1.76|$; $|1.6-1.76|$
$|1.5-1.76|$ $|1.8-1.76|$

$= 0.24, 0.14, 0.04, 0.16, 0.26.$

$$d = \frac{0.24+0.14+0.04+0.16+0.26}{5}$$

$= 0.168.$

We know, $E_d = \left(1 - \frac{d}{D}\right) * 100$

$= \left(1 - \frac{0.168}{1.76}\right) * 100$

$= 90.45\%$

(7) Determine the discharge of water over a 60° triangular weir, if the measured head is 0.632 ft.

Soln For triangular notch →

$$Q_{th} = \frac{8}{15}\sqrt{2g}\tan\theta/2 \cdot H^{5/2} \longrightarrow$$

$$= \frac{8}{15}\sqrt{2*9.8} \times \tan 30° \times \left(\frac{.632}{3.28}\right)^{5/2}$$

$= 0.022 \text{ m}^3/\text{s}.$

Now, $Q_a = C_d \times Q_{th}$

$= 0.6 \times 0.022$

$= 0.0132 \text{ m}^3/\text{s}$ Ans

(72) What is the classification of irrigation water having the following characteristics? Concentration of Ca, Mg & Na are 3, 1.5 & 22 & EC = 200 micromhos

Soln $SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}} = \frac{22}{\sqrt{\frac{3+1.5}{2}}} = 14.67$

Here EC = 200

We know,

EC = 100-250 → C_1	SAR = 1-10 → S_1	
250-750 → C_2	10-18 → S_2	
750-2250 → C_3	18-26 → S_3	
>2250 → C_4	Above 26 → S_4	

This sample is C_1-S_2

i.e. low salinity & medium sodium.

(73) The population of a city was 124,000 in 1960 & 156,000 in 1970. (a) What is the annual rate of increase? (b) What will be the probable population in 1980?

Soln

(a) $r = \sqrt[n]{P_2/P_1} - 1$

$= \sqrt[10]{\frac{156000}{124000}} - 1$

$= 0.023$ (Ans)

(b) $P_{1980} = P_{1970}(1+r)^n$

$= 156,000 (1+0.023)^{10}$

$= 195830.77$ Ans.

(74) An 18" sewer with $n = 0.013$ is laid on a grade of 0.015. Find

(a) Capacity when flowing full.

(b) ~~Velocity~~ when depth of flow = ~~6~~ 9".

Soln

$$D = \left(\frac{2.16\,Qn}{\sqrt{S}}\right)^{3/8}$$

$$\Rightarrow 1.5 = \left(\frac{2.16 \times Q \times 0.013}{\sqrt{0.015}}\right)^{3/8}$$

$\therefore Q = 12.9$ cfs.

$R = \frac{A}{P} = D/4$

$Q = AV$

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

$= 8.66$ ~~cfs~~ ~~for~~

when 9" full means half-full, then discharge will also be half i.e = 6.5 cfs. (A)

GTCL

(75) In a BOD test, on a diluted waste water sample (1:20 dilution but not seeded), the initial DO is 8.4 mg/l & final DO after 5-day is 4.2 mg/l. If reaction rate = 0.22/day.

Find (i) 5-day BOD of waste water.

(ii) Ultimate Carbonaceous BOD (CBOD).

(iii) Remaining oxygen demand after 5 days.

Soln

(a) $BOD_5 = (DO_i - DO_f) \times D.F = (8.4 - 4.2) * 20$

$= 84$ mg/l. A

(b) $L_5 = L_0(1 - e^{-K_1 t})$ ~~$= 84(1 - e^{-0.22 \times 5}) = 12$~~

$\Rightarrow 84 = L_0(1 - e^{-K_1 t})$ $\therefore L_0 = 126$ mg/l.

(c) $L_t = L_0 e^{-K_1 t} = 126 e^{-.22 \times 5} = 41.94$ mg/l.

$= 42$ mg/l.

(76) A rectangular sedimentation tank is to treat 400,000 gpd of raw water. The detention period is 4hrs. velocity of flow 3 in/min & the depth of water & Sediment is 14'. If an allowance of 4' for sedimentation is made, what should be the length & width of tank?

Soln. $V = 3$ in/min $= \frac{3}{12} = 0.25$ fpm.

3 × 4 × 60 = 720 in
= 60 ft.

Total length $S = Vt = 0.25 \times 4 \times 60 = 60'$.

Volume of water treated in 4 hr = D.T × Flow rate.

$$= 4 \times \frac{400000}{24}$$

$$= 66700 \text{ gallons}$$

$$= 8920 \text{ cft}$$

$$T = \frac{V}{Q}$$

(1 cft = 7.48 g)

Cross-sectional area $= \frac{8920}{60} = 148.7$ ft²

Depth = 14 − 4 = 10'

& Width $= \frac{148.7}{10} = 14.87 \approx 15'$

(77) Determine the size of the tile drain if the tile gradient is .25%. n = 0.01 &, Area = 10 ha.

Soln Let Drainage co-eff = 1% in 24 hrs &

Annual rainfall = 100 cm.

$$Q = \frac{\frac{100}{100} \times \frac{1}{100} \times 10 \times 10^4}{24 \times 60 \times 60} = 0.0116 \text{ m}^3/\text{s}$$

Now,

$$Q = AV$$

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

$$0.0116 = \frac{\pi d^2}{4} \times \frac{1}{n} \times \left(\frac{d}{4}\right)^{2/3} \times \left(\frac{.25}{100}\right)^{1/2}$$

$\therefore d = 23$ cm (Ans).

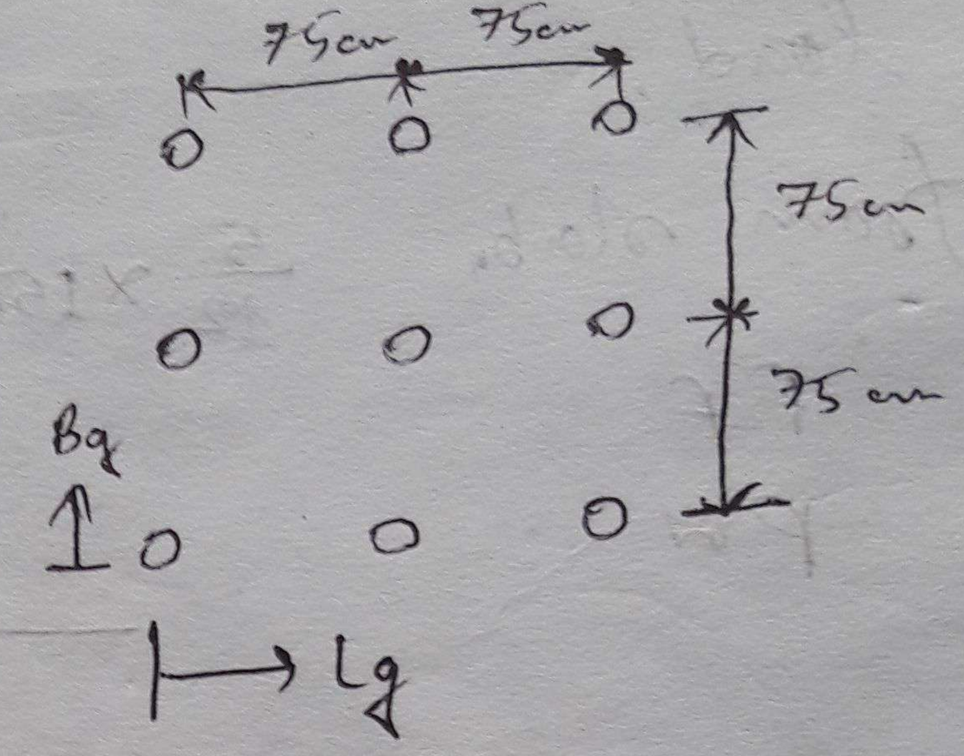
$= 0.02$

$= 7.28 \text{ in}^2$

(2M)

$M_{nw} = A_{sw} f_y (d - a/2)$.

(79) A pile group consisting of 9 friction piles of 30 cm dia & 12m long driven in clay ($c_u = 100$ kPa, $\gamma = 19$ kN/m^3). Determine safe load. F.S = 3, $\alpha = 0.65$.



Sol^n

$L_g = 2 \times 75 + 30 = B_g$

$= 180 \text{ cm} = 1.8 \text{ m}$.

$L = 12$ m.

$n = 9$, $C_u = 100$ kPa

$\alpha = 0.65$

For piles acting individually →

$$\Sigma Q_u = n [\alpha C A_s]$$

$$= 9 [0.65 \times 100 \times \pi \times (\tfrac{30}{100}) \times 12]$$

$$= 6616.19 \text{ kN}.$$

for piles acting in group...

$$\Sigma Q_u = C_u \times L \times P \quad [\alpha C A_s]^{\alpha=1}_{A_s = P \times L}$$

$$= 100 \times 12 \times 2 (L_g + B_g)$$

$$= 100 \times 12 \times 2 (1.8 + 1.8)$$

$= 8640$ kN.

$Q_u = 8640$ kN

$Q_u = Q_{u\,min}$

$= 6616.19$ kN

$Q_{au} = \dfrac{6616.19}{3}$

$= 2205$ kN

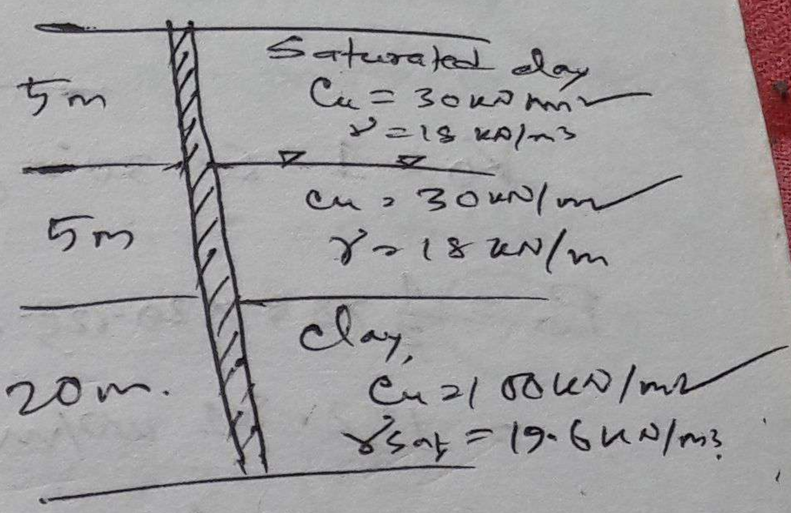
A

(80) pile shown has a outside dia. 400 mm. Using Meyerhof's method, Calc -

(i) Net point bearing Capacity

(ii) Skin resistance

(iii) Allowable net pile capacity for F.S = 4



Soln. $C_{u(1)} = 30\ kN/m^2$, $C_{u(2)} = 100\ kN/m^2$

(i) Net point bearing capacity

$$Q_p = C_{u(2)}\, N_c\, A_p$$

$$= 100 \times 9 \times \frac{\pi}{4} \times \left(\frac{400}{1000}\right)^2$$

$$= 113.10\ kN.$$

(ii) For, $C_u = 100\ kN$, $\alpha = 0.5$
" $C_u = 30\ kN$, $\alpha = 1$
} Graph or chart.

Skin resistance, $Q_s = \Sigma \alpha C A_s$

$$= \left(30 \times \pi \times \frac{400}{1000} \times 10 \times 1\right) + \left(100 \times 0.5 \times \pi \times \frac{400}{1000} \times 20\right)$$

$$= 1634\ kN.$$

(iii) Ultimate capacity, $Q_u = Q_p + Q_s = (113.1 + 1634)$

$$= 1747.1\ kN.$$

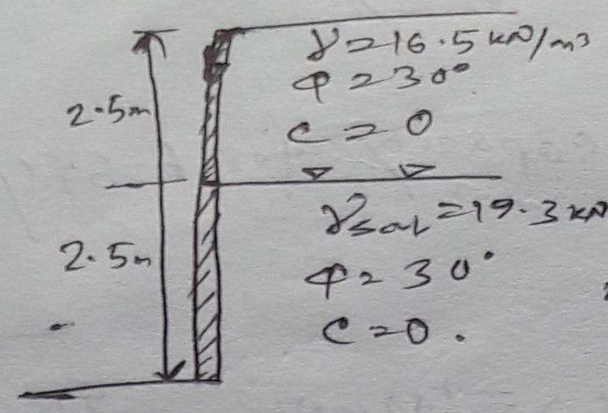
$$Q_{all} = \frac{Q_u}{F.S} = \frac{1747.1}{4}$$

$$= 437\ kN.$$

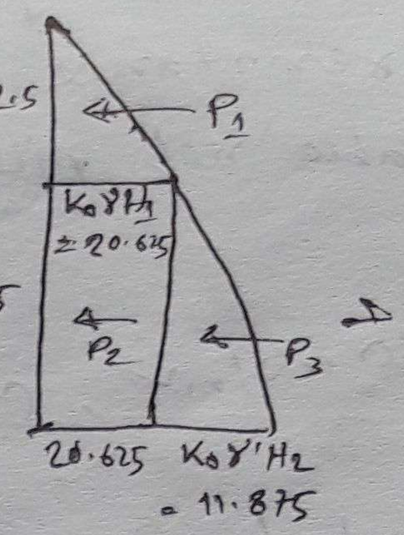
(Ans).

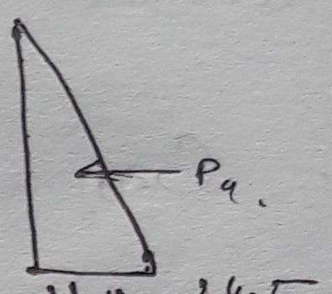
(81) For the retaining wall as shown find the lateral earth ~~pressure~~ force per unit length of the wall. Also find the location of resultant force.

Soln



Diagram





$K_0 = 1 - \sin 30° = 0.5$

$P_0 = \frac{1}{2} \times 2.5 \times 20.625 + 20.625 \times 2.5 + \frac{1}{2} \times 11.875 \times 2.5 + \frac{1}{2} \times 24.5 \times 2.5$

$= 122.81$ kN/m. Ans

$\bar{z} = \dfrac{25.78 \times (2.5 + \frac{2.5}{3}) + 51.56 \times 1.25 + 14.64 \times \frac{2.5}{3} + 30.625 \times \frac{2.5}{3}}{122.81}$

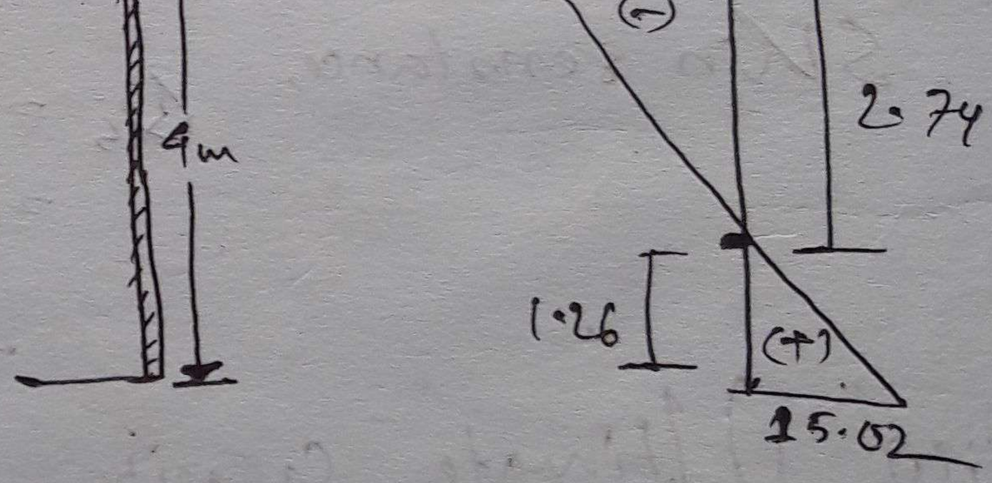
$= 1.53$m. Ans

(82) For the given figure --

(i) Draw EPD.

(ii) Max. depth of potential crack

(iii) Max. depth of unsupported excav.



Soln

(i) $P' = K_a \gamma z - 2c\sqrt{K_a}$.

$= 0.66 \times 18 \times z - 2 \times 20\sqrt{.66}$

$= 11.88z - 32.5$.

when $z = 0$; $P' = -32.5$

when $z = 4$, $P' = 15.02$

(ii) Max. depth of potential crack

when, $P = 0$.

$0.66 \times 18 \times z = 2 \times 20\sqrt{.66}$

$\therefore z = 2.74$.

$\frac{2c}{\gamma} \tan(45° + \frac{\varphi}{2})$

(iii) Max. depth of unsupported excavation,

$H_c = 2z_c$

$= 2 \times 2.74$

$= 5.5 > 4$.

Ans

or,

$H_c = \frac{4c}{\gamma} \tan(45° + \frac{\varphi}{2})$

$= 5.48 \simeq 5.5$

Ans

(83) A consolidated drained triaxial test was performed for NCC. $\sigma_3 = 276\ kN/m^2$ & $(\sigma_d)_f = 276\ kN/m^2$. Determine (i) ϕ. (b) (c) δ & τ.

σ_1 or σ_3, major & minor stress respectively
σ_d = Deviator stress

Soln

(i) $\sigma_1 = \sigma_3 + (\sigma_d)_f$
$= 276 + 276$
$= 552\ kN/m^2$

$\sin\phi = \frac{\sigma_1 - \sigma_3}{\sigma_1 + \sigma_3} = \frac{552 - 276}{552 + 276} = .33$; $\phi = 19.45°$ (Ans)

(ii) $\theta = 45° + \frac{\phi}{2} \Rightarrow 45° + \frac{19.45}{2} = 54.73°$ (Ans)

(iii) Normal Stress,

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

$= 368.03\ kN/m^2$. (Ans)

Shear stress,

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

$= 130.22\ kN/m^2$ (Ans)

(84) A footing $\underset{(Square)}{4' \times 4'}$, FS = 3. find out the gross allowable load. $\gamma = 110\ lb/ft^3$, $\phi = 20°$, $c = 200\ lb/ft^2$, $N_c = 17.7$, $N_q = 7.4$, $N_\gamma =$ [redacted] $D_f = 3'$.

Soln

$q_u = 1.3cN_c + qN_q + 0.4\gamma B N_\gamma$.
$= 7924\ lb/ft^2$

$q_{all} = \frac{q_u}{F.S} = \frac{7924}{3} = 2641.33\ lb/ft^2$

Again $q_{all} = \frac{Q}{A}$ ∴ $Q = q_{all} \times A$
$= 2641.33 \times 16$
$= 42261.3\ lb$. (Ans)

* If local shear failure occur,
$c \leftarrow \frac{2}{3}c$, $\tan\phi' = \frac{2}{3}\tan\phi$.
proceed the same.

(85) $w = 15\%$, Unit wt. $= 120$ pcf, $e_{min} = 0.5$
$e_{max} = .85$, $S = 2$ R.D $= ?$ $G = 2.65$

Soln $R.D = \frac{e_{max} - e}{e_{max} - e_{min}} = 0.74.$

Shortcut
$\gamma_d = \frac{\gamma}{1+w} = \frac{120}{1+.15} = 104.34$
$\gamma_d = \frac{G_s \gamma_w}{1+e} \Rightarrow e = 0.59$
$Se = wG_s$
$S = \frac{wG_s}{e} = 67.37\%$
:-) (-_-)

(বাহ!! 2টি ফলাফল?)

Now, $w = \frac{W_w}{W_s}$

$\therefore W_w = 0.15 W_s$.

$W_w + W_s = W \Rightarrow 0.15 W_s + W_s = 120 \Rightarrow W_s = 104.3$ lb

$W_w = 15.7$ lb.

Now, $V_s = \frac{W_s}{G_s \gamma_w} = \frac{104.3}{2.65 \times 62.4} = 0.63$ ft^3

Let $V = 1$

$V_w = \frac{W_w}{\gamma_w} = \frac{15.7}{62.4} = 0.25$ ft^3

$V_a = V - (V_w + V_s) \Rightarrow 1 - (0.25 + 0.63) = 0.12$ ft^3

$S = \frac{V_w}{V_v} = \frac{0.25}{0.25 + 0.12} = 67.57\%$ $\left[V_v = V_a + V_w \right]$

Ans $e = \frac{V_v}{V_s} = 0.59.$
(Ans.)

(86) During the vane shear test, 20 N-m torque is applied by vane apparatus. If the Ht. of vane is 400 mm & dia. 200 mm. Determine the undrained shear strength of soil.

Sol^n $T = 20$ N-m, $H = 0.4$ m, $D = 200$ mm $= 20$ cm.

$$C_u = \frac{T}{K} = \frac{20}{3.66\times10^{-8} D^3 (cm)} = \frac{20}{3.66\times10^{-8}\times 20^3}$$

$$= 683 \text{ N/m}^2 \quad (Ans)$$

(87) Return period — Peak flood

50 — 40809

100 — 46300

Estimate flood peak for 500 yrs.

Sol^n We have,

$$x_T = \bar{x} + \sigma(.78 \ln T - 0.45)$$

$$= \bar{x} + \sigma(.78 \ln 50 - .45)$$

$$\therefore 40809 = \bar{x} + 2.6\sigma \quad \text{---(I)}$$

$$\& \quad 46300 = \bar{x} + 3.14\sigma \quad \text{---(II)}$$

$\bar{x} = 14,370$ & $\sigma = 10168.5 \approx 10169$

$$\therefore x_{500} = 14,370 + 10169(.78 \ln 500 - .45)$$

$$= 59087 \text{ m}^3/\text{s} \quad (Ans)$$

(88) A canal exerts waste water in a river at 55000 m³/day. BOD of the waste water is given in [redacted] 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? (G+CL-16)

Soln

BOD of the waste water = 0.25 mg/l.

BOD exerted in a river = $(55{,}000 \times 0.25 \times \frac{1000}{10^6})$

= 13.75 kg/day. (Ans)

BOD after treatment = $13.75 \times (1 - 0.7)$

= 4.125 kg/day. (Ans)

(89) Calculate the balancing depth of a channel section having a bed width equal to 18m & side slope @1:1 & 2:1 in filling. The bank embankment are kept 3m high above the birm level & crest width is 2m.

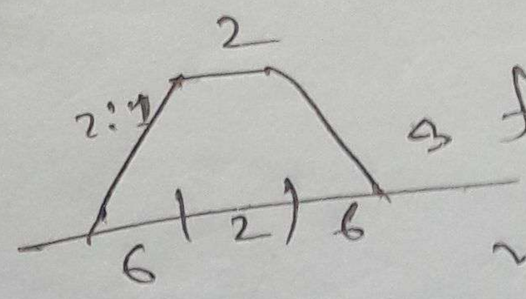
Soln

Area of cutting = $(b + sh) \times h = 18d + (1 \times d) \times d$

$= 18d + d^2$

Area of filling = $+2\left[\frac{2+14}{2} \times 3\right] = +48\ m^2$.

Equating both, $d = 2.35$ m. (Ans)

filling 

a filling 2 ft

(90) A concrete pile is 50' long & 16" × 16" in Cross-section. $\gamma = 110\ lb/ft^3$ & $\phi = 30°$; Compute the Ultimate pile load, Q_p. $C = 0$. $N_q = 55$.

Soln

for Sand,

$Q = q_u \times A$

$Q_p = A_p q_p$.

$q_u = cN_c + qN_q$

Sand, $q_u = qN_q$

Load = pressure × Area

$= q_u \times A$

$= \square A$

$Q_p = A_p q_p N_q$

$= A_p \times \gamma L \times N_q$

$= \frac{16}{12} \times \frac{16}{12} \times 110 \times 50 \times 55$

$= 537777.78\ lb$

$= 537.77\ kip.$

$q_p = cN_c + qN_q$

Sand হয় তখন c=0 তখন,

$q_p = qN_q$

Clay হয় তখন $\phi = 0$ তখন

$q_p = cN_c$

(91) A circular sedimentation tank 3.5×10^6 lit/day of raw water of detention period is 5 hr and depth of tank is 3m. What should be the dia?

Soln

$$\text{Capacity} = \frac{3.5 \times 10^6 \times 5}{24} = 7.29 \times 10^5 = 729\ m^3$$

Now $V = \frac{\pi}{4} d^2 (0.011d + .785 \times H)$

or $729 = d^2 (0.011d + .785 \times 3)$

$\therefore d = 17m$ (Ans)

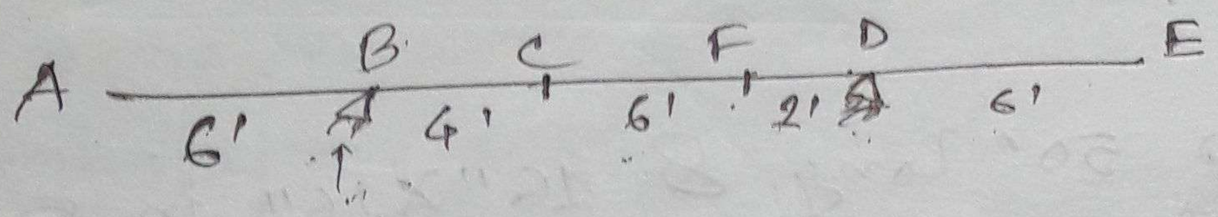
Alternative

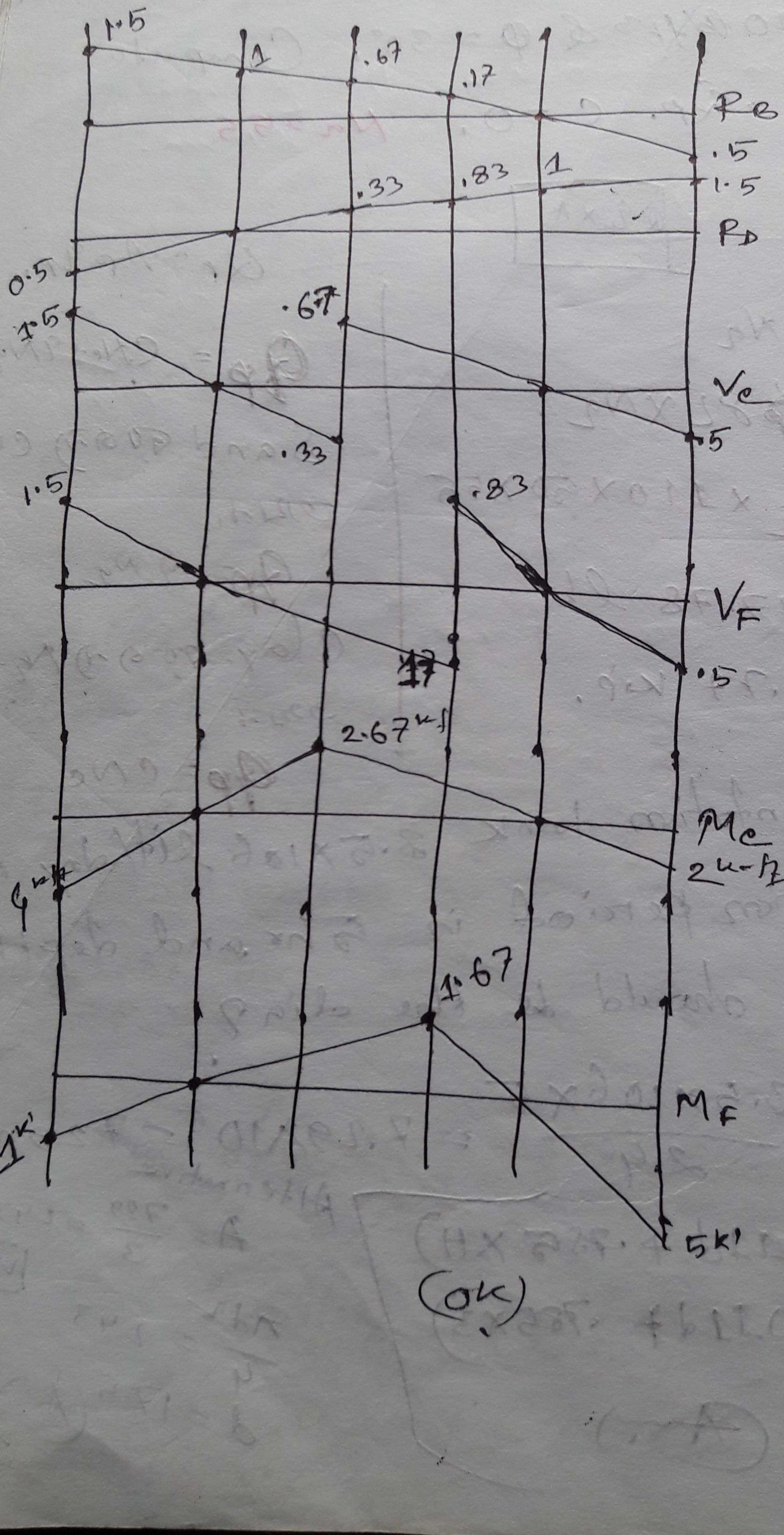
$A = \frac{729}{3} = 243$

$\frac{\pi d^2}{4} = 243$

$d = 17.5$ (Ans)

92 Draw IL


A
B
C
F
D
E
6'
4'
6'
2'
6'


1.5
1
.67
.17
RB
.5
.33
.83
1
1.5
RD
0.5
1.5
.67
VC
.33
.5
1.5
.83
VF
.17
.5
2.67 k-ft
MC
2 k-ft
4 k-ft
1.67
MF
1 k-ft
5k'

(ok)

(93) Estimate F for a slope having H = 20m, D = 4.0m
$\beta = 25°$, $\gamma = 19 kN/m^3$, $C_u = 50 kPa$. [BCS].

Soln

$$D_f = \frac{H+D}{H} = \frac{20+4}{20} = 1.2$$

[D_f, i = B then ok]

for, $\beta = 25°$, $D_f = 1.2m$, $S_N = 0.164$ (punmia book).

$$S_N = \frac{c}{F.\gamma H}$$

$$\therefore F = \frac{c}{S_N \gamma H}$$

$$= \frac{50}{.164 \times 19 \times 20}$$

$$= 0.8 \quad (Ans).$$

Alternate.

$$f_s = \frac{c}{\gamma H \cos^2\beta \tan\beta} + \frac{\tan\phi}{\tan\beta} \quad [\phi = 0 \text{ condition}]$$

$$= \frac{50}{19 \times 20 \times (\cos 25)^2 \times \tan 25} + 0$$

$$= 0.343 \quad (Ans)$$

বিষয়টির লেখে করা আছে।

BWDB-16

(94). A directional sign needed. Highway turnoff 85th percentile speed of 50 mph, vehicle turn at design speed of 25mph can travel at 50 mph during perception reaction time, using a perception reaction time of 2.5 sec to read & understand the sign and decelerate rate 0.3g. What is the minimum distance, the direction sign should be placed in advanced turn off?

Soln:

$$S = 1.47 vt + \frac{v^2 - u^2}{30f}$$

$$= 1.47 \times 50 \times 2.5 + \frac{50^2 - 25^2}{30 \times .3}$$

$$= 392.1 ft$$

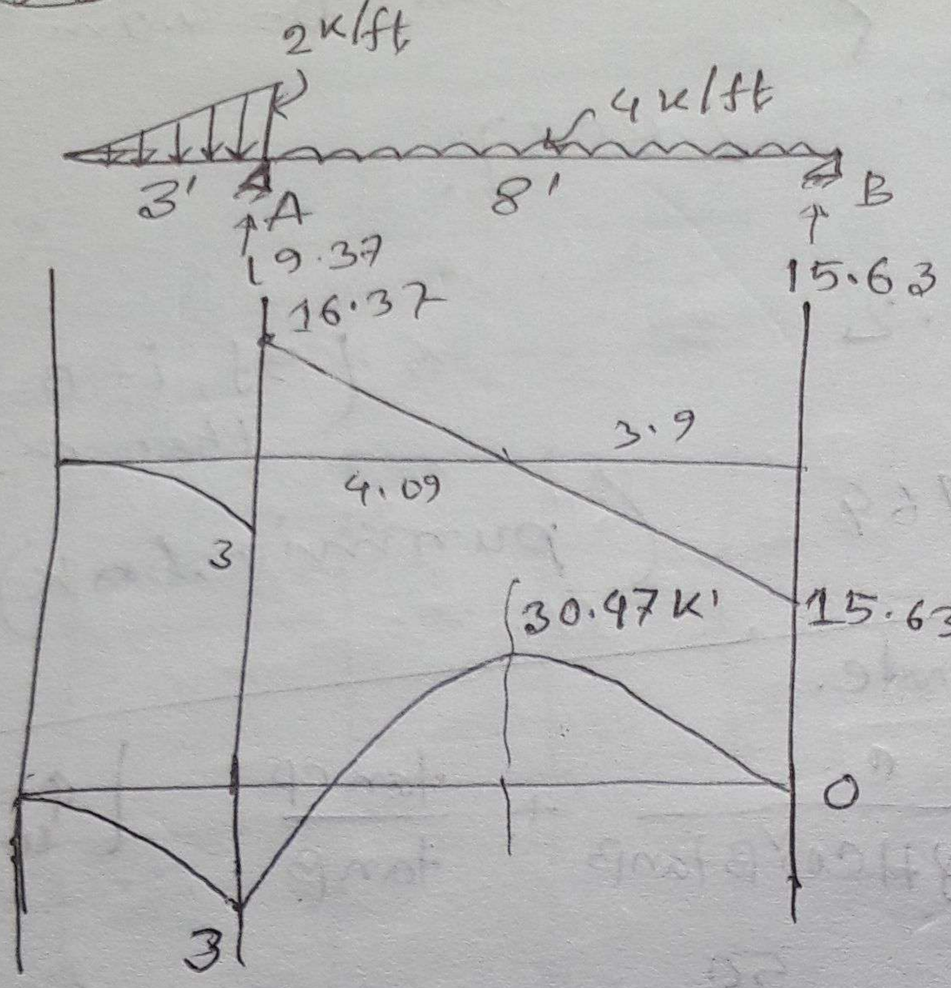
in fps

$$S = 73.33 \times 2.5 + \frac{73.33^2 - 36.67^2}{2 \times 32.2 \times 0.3}$$

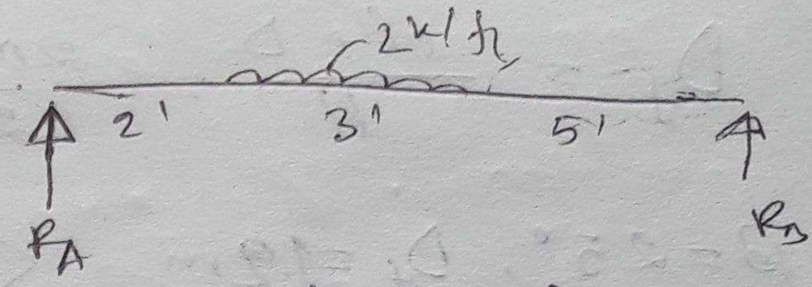
$$= 392.1 ft$$

$$\frac{50 \times 5760 \times 3}{3600} = 73.33 ft/s.$$

(5.5) DRAW SFD & BMD.



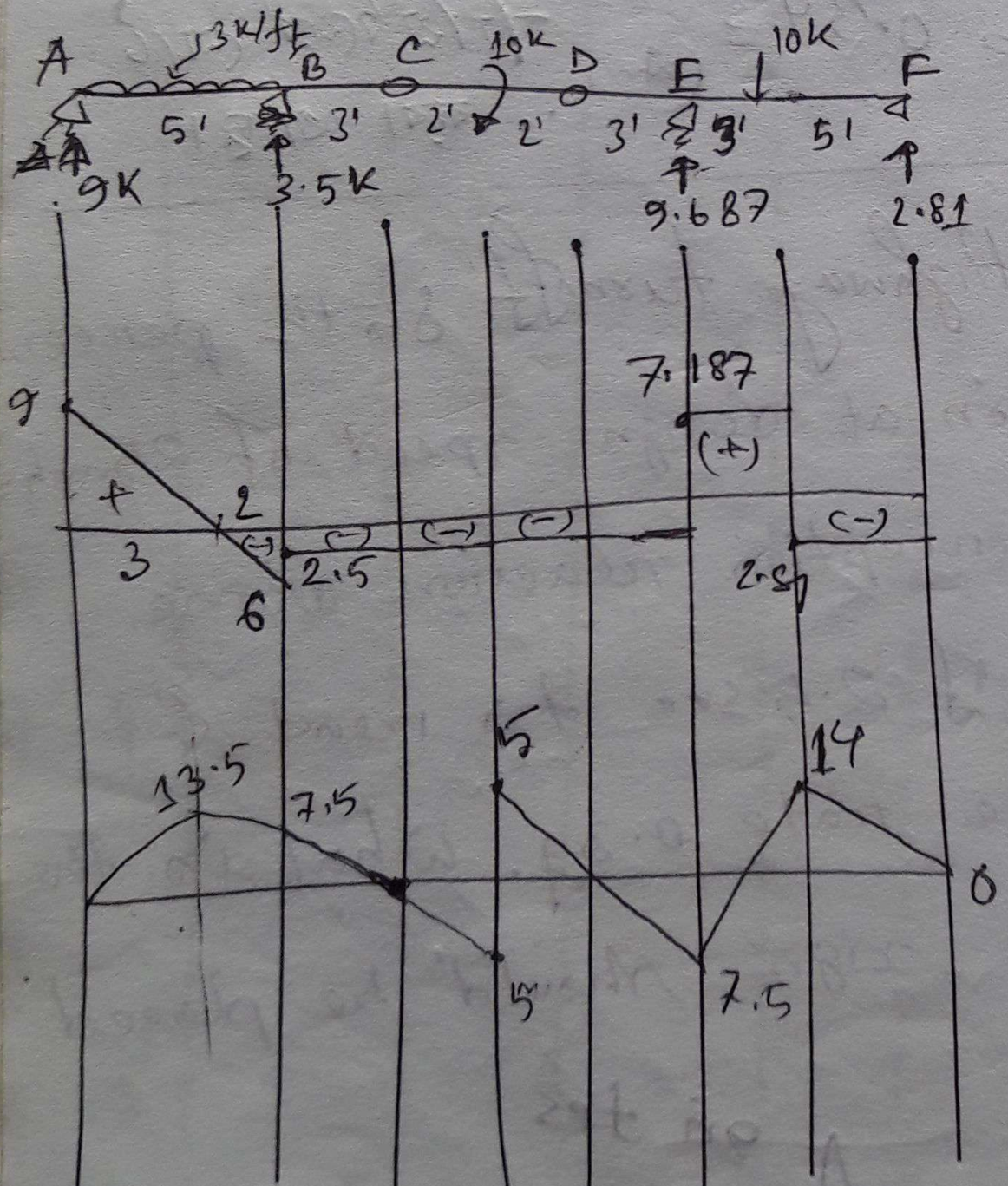
**

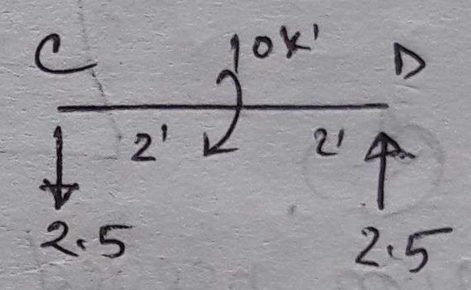


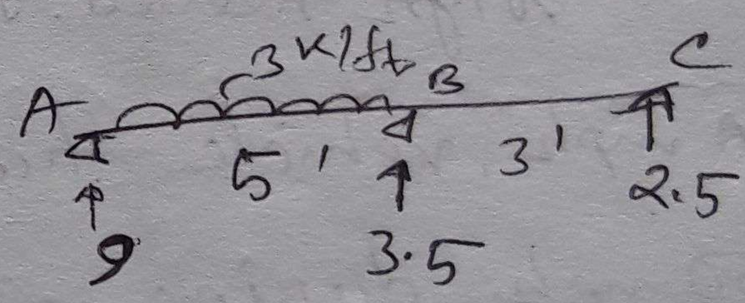
← Equation for deflection

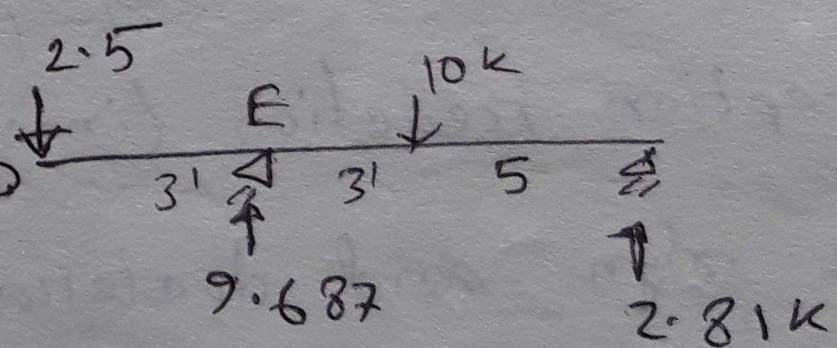
$$EI\frac{d^2y}{dx^2} = R_A \times x - 2\frac{\langle x-2\rangle^2}{2} + 2\frac{\langle x-5\rangle^2}{2} =$$

(5.6) DRAW SFD & BMD

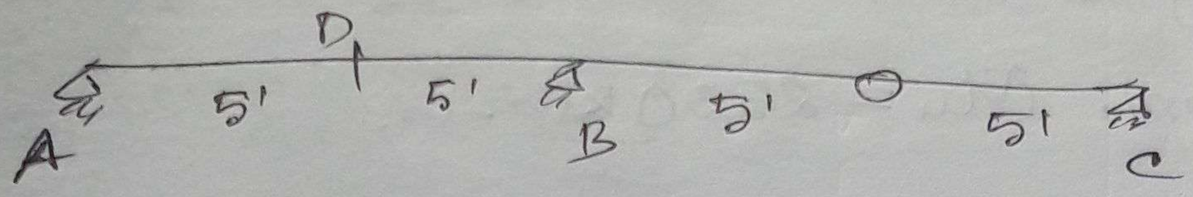


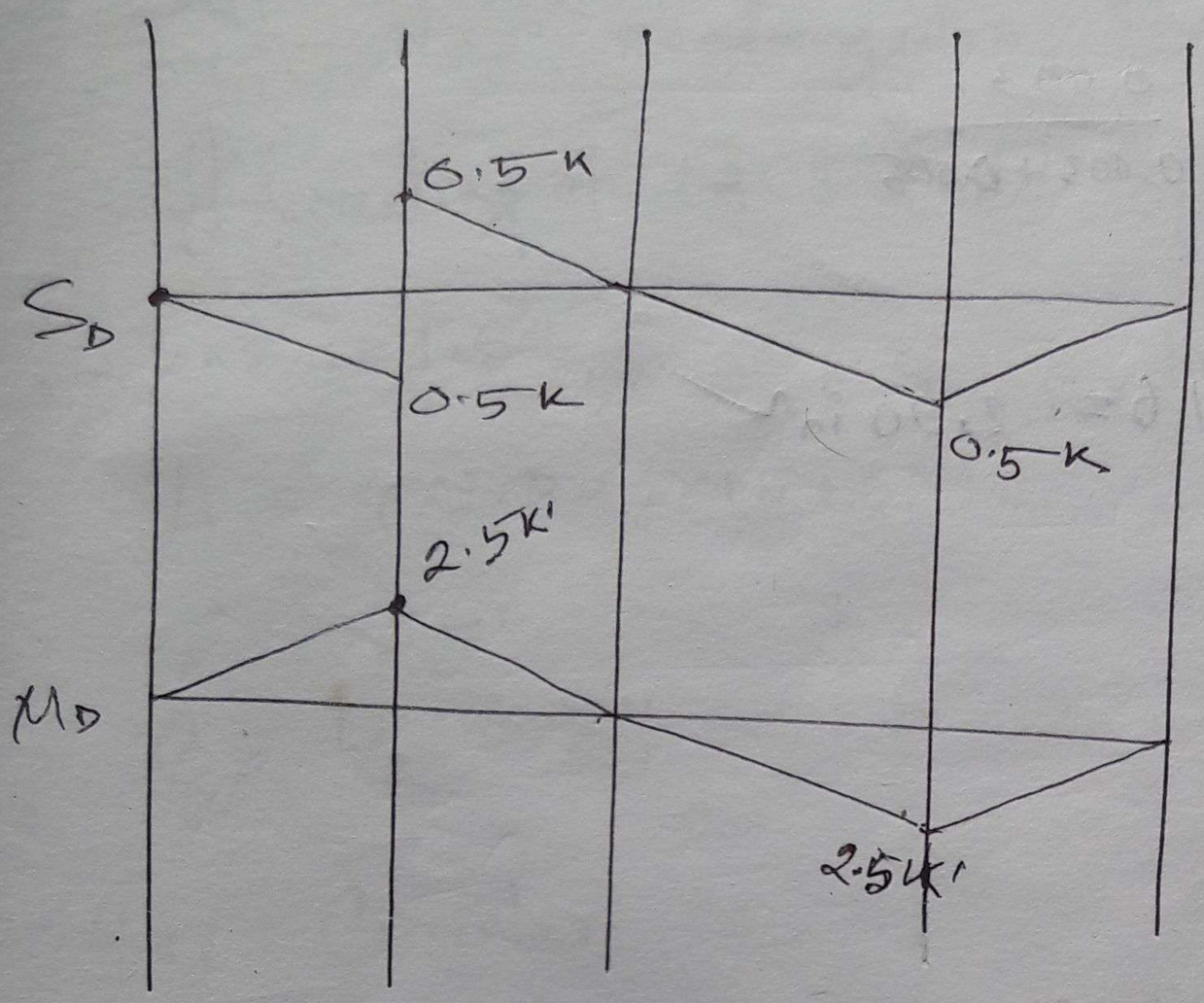




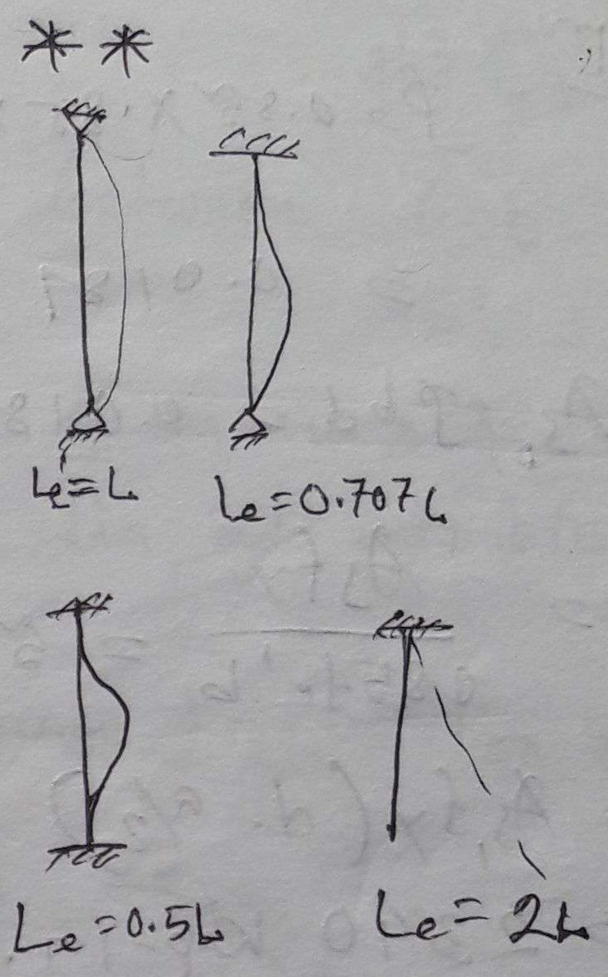


(102) DRAW IL FOR Shear At D & Moment at D.

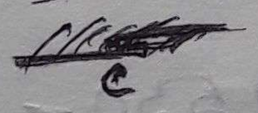


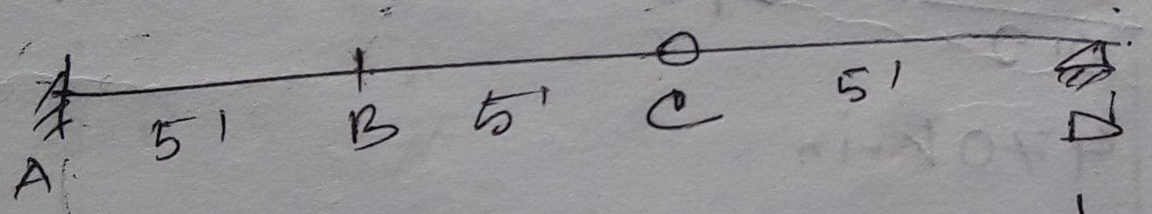


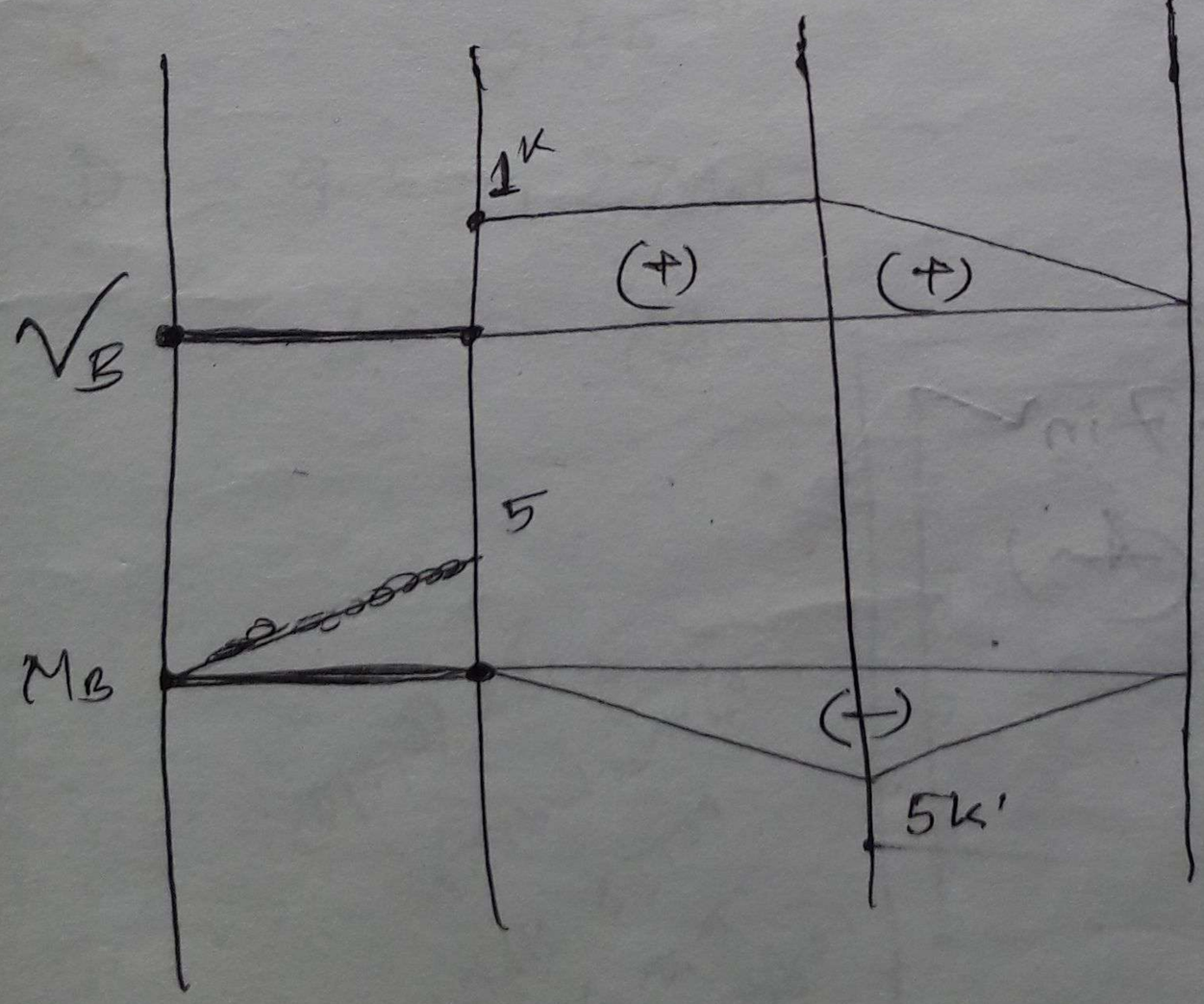
(PDB) (BEAD)

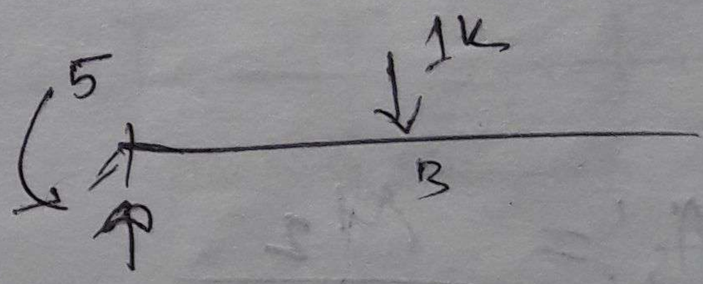


(103) DRAW IL FOR V_B & M_B.

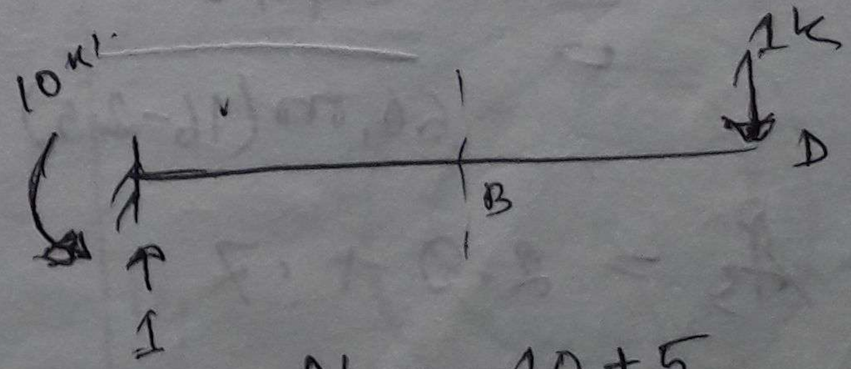








$M_B = 5 - 5 = 0$. OK??



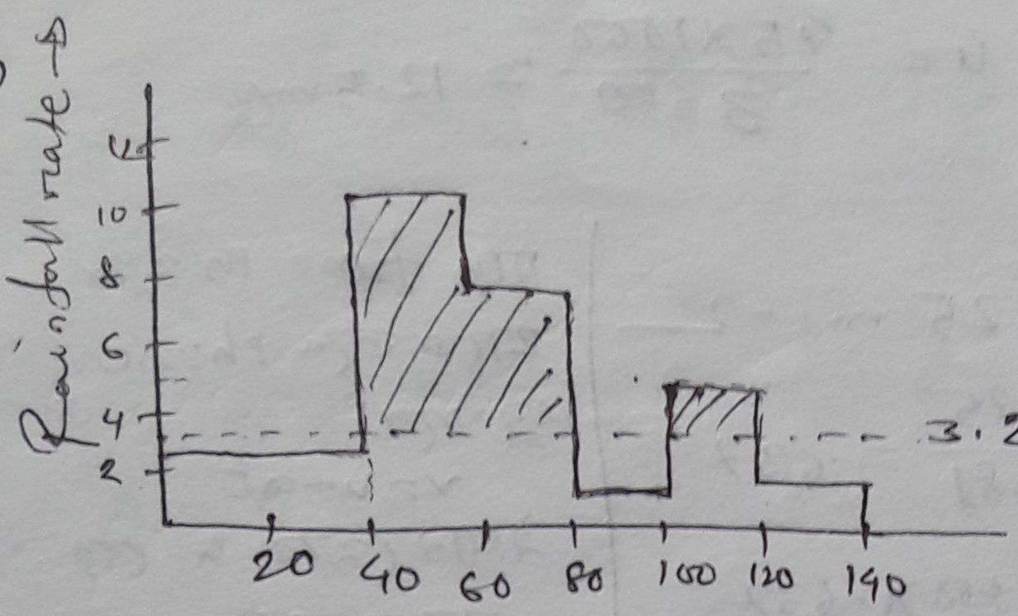
$M_B = -10 + 5$
$= -5\,K'$

OK

C তে লোড দিলেও A point এর লোড নিয়ে নিবে। OK??

(107) The following are the rates of rainfall for successive 20 min period of a 140 min storm: 2.5, 2.5, 10, 7.5, 1.25, 5 cm/hr. Taking the value of Φ index as 3.2 cm/hr. find out the net runoff in cm, the total rainfall & the value of W index.

Soln



hyetograph

Total runoff,

(Hatched area) $\rightarrow Q = (10-3.2)\times\frac{20}{60} + (7.5-3.2)\times\frac{20}{60} + (5-3.2)\times\frac{20}{60}$

$= 4.3$ cm.

Total precipitation (P) $= (2.5\times2 + 10 + 7.5 + 1.25\times2 + 5)\times\frac{20}{60}$

$= 10$ cm.

$W_{index} = \frac{10-4.3}{(\frac{140}{60})} = 2.44$ cm/hr.

(108) A vehicle travelling at a speed of 36 kmph is stopped by applying break. Skid length 5.8 m. find average skid resistance

Soln $\quad v = \frac{36\times1000}{3600} = 10$ m/s.

Breaking distance, $L = \frac{v^2}{2gf}$

$\therefore f = \frac{v^2}{2gL} = \frac{10^2}{2\times9.8\times5.8}$

$= .878$ (Ans)

(11) Design an open well in coarse sand for a yield of 0.004 m³/s when operated under a depression head of 3m.

Fine sand = 0.5
Clay = 0.25

Soln

$Q = 0.004\ m^3/s$
$= 0.004 \times 3600 = 14.4\ m^3/hr.$

for coarse sand, (Specific capacity or yield) = 1 $m^3/hr/m^2$

$Q = (\text{Sp}).A.S$

or $14.4 = 1 \times A \times 3$
$\therefore A = 4.8\ m^2$

Now, $A = \frac{\pi d_w^2}{4}$

$\therefore d_w = 2.48\ m$
$\simeq 2.5\ m$ (Ans)

(12) During a recuperation test, water level in an open well is depressed by pumping of 2.5m and it recuperated by (পুনরুদ্ধার) an amount of 1.6m in 70 min.

(a) Determine the yield from a well of 3m dia under a head of 3.5m.

(b) Also, determine the dia of well to yield 10 l/s under a depression head of 2.5m.

Soln (a) $\text{Sp} = \frac{2.3}{T} \log \frac{S_1}{S_2} = \frac{2.3}{70 \times 60} \log \frac{2.5}{0.9}$
$= 2.43 \times 10^{-4}$ f/s

$S_1 = 2.5m$
$S_2 = 2.5 - 1.6$
$= 0.9m$
$T = (70 \times 60)$ s

$Q = (\text{Sp}).A.S = 2.43 \times 10^{-4} \times \frac{\pi \times 3^2}{4} \times 3.5 = 6.03\ m^3/s$ (Ans)

(b) $Q = 10$ l/s $= 10 \times 10^{-3}\ m^3/s$, $S = 2.5$

$Q = (\text{Sp}).A.S$
or $10 \times 10^{-3} = 2.43 \times 10^{-4} \times \frac{\pi \times d^2}{4} \times 2.5$
$\therefore d = 4.6m$ (Ans).

(113) Estimate the constant rate of withdrawal from a 1375 ha reservoir in a 30 day month during which the reservoir level dropped by 0.75m in spite of an average inflow into the reservoir of 0.5 Mm³/day. During the month, the average seepage loss from the reservoir was 2.5 cm. Total precipitation on the reservoir was 18.5 cm and the total evaporation was 9.5 cm.

Soln precipitation = $1375 \times 10^4 \times \frac{18.5}{100}$

$= 2.54 \times 10^6 m^3$.

Seepage loss = $1375 \times 10^4 \times \frac{2.5}{100}$

$= 0.34 \times 10^6 m^3$.

Evaporation = $\frac{1375 \times 10^4 \times 9.5}{100}$

$= 1.3 \times 10^6$

Inflow = $0.5 \times 10^6 \times 30$

$= 15 \times 10^6 m^3$.

$\Delta S = (2.5 - 0.34 - 1.3 + 15) \times 10^6$

$= 15.9 \times 10^6 m^3$.

Rate of withdrawal = $\frac{15.9 \times 10^6}{30 \times 24 \times 3600} = 6.13 m^3/s$ (Ans)

IWM (114) A rainfall of 10cm occurs in an urban area ($25 km^2$) that produces a direct runoff vol'm of $2 \times 10^6 m^3$. Determine & hr duration. Compute,

(i) Runoff coefficient

(ii) ϕ - index.

Soln

(i) Total rainfall, $P = 25 \times 10^6 \times \frac{10}{100}$

$= 2.5 \times 10^6 m^3$

Runoff coefficient $= \frac{2 \times 10^6}{2.5 \times 10^6} = 0.8$ Ans $= \frac{\text{Run Vol}^m}{\text{Total Rainfall}}$

(ii) Φ index.

$$\Phi = \frac{P - R_d}{t_d}$$

P = Total rainfall = 10 cm

R_d = Direct sur. runoff

$= \frac{2 \times 10^6}{25 \times 10^6} = \frac{\text{Vol}^m}{\text{Area}}$

$= 0.08 m = 8 cm.$

$= \frac{10 - 8}{8}$

$= .25$ cm/hr. (Ans.)

(115) A 2m wide rectangular channel is laid on a slope of 0.0004, the shear stress in N/m² on the boundary for a depth of 0.5m. Ao be found.

Soln for wide channel.

$\tau = \omega y s$

$= 9.81 \times 0.5 \times 0.0004$ kN/m²

$= 1.962$ N/m² (Ans)

**A problem of tractive force. Main formula $\tau = \omega RS$, where $R = A/P$. for wide channel $\tau = \omega y s$.

OK??

IWM

(125) The peak of 5-h unit hydrograph 225 m^3/s. Compute the peak of flood hydrograph for a 5-h effective storm if depth of rainfall is 4.5 cm. $\phi = 0.1$ cm/h, constant base flow = 25 m^3/s.

Soln

$$\phi = \frac{\text{Rainfall} - \text{Rainfall excess}}{\text{Duration}}$$

$$\phi = \frac{P - P_{net}}{t}$$

$$\therefore 0.1 = \frac{4.5 - R.E}{5}$$

$$\therefore R.E = 4 \text{ cm}.$$

$$\text{peak of 5-hr unit hydrograph} = \frac{\text{peak of D.R.H}}{R.E}$$

$$\therefore 225 = \frac{D.R.H}{4 \text{ cm}}$$

$$\therefore D.R.H = 900 \text{ } m^3/s.$$

$$P_{net} = \frac{DRO}{UGO}$$

Peak of flood hydrograph = 900 + base flow

= 900 + 25

= 925 m^3/s (Ans)

IWM

(126) A stream of 100 l/s was delivered to a field of 1.6 ha for 8 hr. The run off was estimated at 420 m^3 and there was no deep percolation loss from the field. Calculate water application efficiency.

Soln

$$Eff = \frac{W.S. \text{ in the root zone}}{\text{Delivar}}$$

$m^3 \times \% = m^3$

$$= \frac{1.6 \times 10^4 \times 8 \times 60 \times 60 \times 100 \times 10^{-3} - 420}{8 \times 60 \times 60 \times 100 \times 10^{-3}} \times 100$$

$$= 85.4\% \text{ (Ans)}$$

(127) A pipeline 0.6m dia. is 1.5 km long. Find discharge per second if $f = 0.04$ & head at inlet = 30m.

Soln

$$H = h_f = 30 = \frac{f l v^2}{2gD}$$

$$\text{or, } 30 = \frac{0.04 \times 1500 \times v^2}{2 \times 9.81 \times 0.6} \quad \therefore v = 2.426 \text{ m/s}$$

$$Q = Av$$
$$= \frac{\pi \times .6^2}{4} \times 2.426$$
$$= 0.69 \text{ m}^3/\text{s} \quad \text{(Ans)}$$

(128) Calculate the fresh water flow in coastal aquifer extending to a length of 40km along the coast assuming an average hydraulic conductivity of 40 m/day. average thickness of 20m and piezometric gradient of 5 m/km.

Soln

piezometric gradient = hydraulic gradient

$$= \frac{dh}{L}$$

Darcy's law, $v = ki$ $\quad m/day \times \frac{m}{km}$

$$= 40 \times 5$$
$$= 200 \text{ m}^2/\text{km/day}.$$

Water flow, $Q = AV$

$$= 40 \times 20 \times 200$$
$$= 160,000 \text{ m}^3/\text{day}$$
$$= 1.85 \text{ m}^3/\text{s}. \quad \text{(Ans)}$$

IWM
(129) Calculate the surface area required for an oxidation pond for treating sewage a residential colony with population of 8000 person. Assume that, the sewage be treated at the rate of 125 lpcd. the $BOD_5 = 325$ p.p.m. Sp. gravity of organic load is 1 & organic loading in pond 300 kg/ha/day.

Solⁿ Quantity of sewage to be treated per day $= 125 \times 8000$
$= 1000 m^3$

B.O.D content per day $= 1000 \times \frac{325}{106} \times 10^3$
$= 325 kg.$

Surface area $= \frac{325}{300} = 1.08 ha.$

IWM
(130) A wooden pile is driven by a drop hammer weight 1000kg and having a free fall 3m. The final set is 1.2cm. Determine the allowable load using Engineering New's formula.

Solⁿ
$$Q_a = \frac{Wh}{F(S+C)}$$
$$= \frac{1000 \times 3 \times 100}{6(1.2+2.5)}$$
$$= \frac{1000 \times 3 \times 100}{6(1.2+2.5)}$$
$$= 135135 kg.$$
$$= 13.51 ton.$$

(Ans)

W = wt. of hammer
h = fall height (cm)
S = Final Settlement
C = Constant (2.5cm for drop hammer & .25 for Single acting hammer)
F = factor of Safety = 6.

IWM (131) Find the gross safe bearing ~~capacity~~ pressure for a wide strip footing on sand having $\phi = 36°$ and $\gamma = 1.8$ ton/m³.

Soln

$$q_u = cN_c + qN_q + \frac{1}{2}\gamma B N_\gamma$$

$$= \frac{1}{2}\gamma B N_\gamma$$

$$= \frac{1}{2} \times 1.8 \times 1 \times .36$$

$$= 0.324 \text{ ton/m}^2 \text{ (Ans)}$$

Here,
$C = 0$ (sand)
$d = 0$, $q = 0$
$N_\gamma = \frac{1}{2}\tan\phi$ (সূত্রমালা-৭)
$= \frac{1}{2} \times \tan 36°$
$= 0.36$

for cohesive soil, $q_u = cN_c + qN_q$ [$N_\gamma = 0$].

IWM (132) Discharge through an alluvial channel is 2500 m³/s. The depth of flow is 5m and the median size of the river bed sediment is 0.10 mm. Calculate the volume per meter length of launching apron of protection elements when launched on a slope 2.5H : 1V. Take, thickness of cover layer at the toe is 300 mm.

Soln $f = 1.76\sqrt{d_{mm}} = 1.76\sqrt{0.1} = 0.556$

$$R = 0.47\left(\frac{Q}{f}\right)^{1/3} = 0.47 \times \left(\frac{2500}{.556}\right)^{1/3}$$

$$= 7.76 \text{ m}.$$

$y = 5$m.

$t = 0.06 Q^{1/3}$ if not given. here $t = 300$ mm

Scouring depth, $D = 1.25R - y$

$= 1.25 * 7.76 - 5$

$= 4.7$m.

unlaunched volume $= 1.5 D \times t$

Length of apron $= 1.5D = 1.5 \times 4.7 = 7.03$m.

volume per meter length $= (\sqrt{2.5^2 + 1^2}) \times D \times t \Rightarrow \sqrt{2.5^2+1^2} \times 4.7 \times .3 = 3.78$ m (Ans)

(147) Design a sedimentation tank for 3h concentration of 3h discharge 125 l/h. Ratio H:B:L = 1:1:3. (BWDB)

Soln $Q = 125\ l/h = 0.125\ m^3/h$. $T = 3h$

We know, $T = \frac{L \times B \times H}{Q}$

$$3 = \frac{H \times H \times 3H}{.125}$$

$$\therefore H^3 = \frac{3 \times .125}{3}$$

$$\therefore H = .5, \quad B = .5, \quad L = 1.5 \quad (Ans)$$

(148) Show beam shear check for a column. Given. $L \times B = 10' \times 10'$; $a = 12''$, $d = 16.5''$, $t = 20''$ $q_u = 3.5 ksf$.

Soln

$$V_{dev} = \left(\frac{L}{2} - \frac{a}{2} - d\right) \times q_u \times 4 = 109.37k$$

$$\& \quad V_{all} = \frac{2\phi \sqrt{f_c'}\, b \cdot d}{1000} \quad (b = 10') = 187.83k \qquad V_{all} > V_{dev} \ (OK)$$

(149) An irrigation channel is to be constructed in coarse alu gravel with D-75 size of 5cm. The channel has to carry of discharge and slope is 0.01. The bank of is in gra scouring. Find minm width.

Soln

$$n = \frac{d^{1/6}(m)}{24} = 0.0258m$$

$$R = \frac{d(m)}{11.5} = 0.455m$$

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

$$= 2.29\ m/s$$

$$Q = AV$$

$$= b \cdot y \cdot V$$

$$\text{or. } 3 = b \cdot R \cdot V$$

$$\therefore b = 2.88m \quad (Ans)$$

(164) The CBR values are calculated of every km on a selected Stretch of 10km having the same type of soil 3.8, 2.8, 4.5, 3.9, 4.2, 4.7, 4.6, 3.2 & 4.5. Find design CBR value for 50% & 85%. As the distribution of CBR value are normal. (BUET)

Soln

$$\bar{x} = \frac{3.8 + \cdots + 4.5}{9} = 4.02$$

Standard deviation $\delta = \sqrt{\frac{(3.8-4.02)^2 + (2.8-4.02)^2 + \cdots}{9}}$ — Should be 8.

$= 0.62$

for 50% relability, $CBR = \bar{x} - K_\alpha \cdot \delta$

$= 4.02 - 0 \times 0.62$

$= 4.02$ Ans

For 85% " , $CBR = 4.02 - 1.062 \times 0.62$

$= 3.36$ Ans

[K_α from chart]

(165) $\mu = 1.6\ N\text{-}s/m^2$, velocity distribution $u = 0.9y - y^2$. find shear Stress at .45m.

Soln

$u = 0.9y - y^2$

$\frac{du}{dy} = 0.9 - 2y$.

At 0.45m, $\frac{du}{dy} = 0.9 - 2 \times .45 = 0$.

$\tau = \mu \cdot \frac{du}{dy}$

$= 1.6 \times 0$

$= 0$ Ans

(166) Determine (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 weight = 166.8 gm oven dry wt = 140 gm. Sp. gr. = 2.70 (BUET)

Soln

(i) $\omega = \frac{166.8 - 140}{140} \times 100 = 19.14\%$

(ii) $\gamma = \frac{166.8}{\frac{\pi \times 3.81^2}{4} \times 7.62} = 1.92 \text{ gm/cm}^3$

$\gamma = \frac{W}{V}$, $V = \frac{W}{\gamma}$

(ii) $\gamma_d = \frac{140}{\frac{\pi \times 3.81^2}{4} \times 7.62} = 1.61 \text{ gm/cm}^3$

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

or $1.61 = \frac{2.70 \times 1}{1+e}$

$\therefore e = 0.68$

(v) $Se = \omega G_s$

or $S = \frac{\omega G_s}{e}$

$= \frac{.1914 \times 2.70}{0.68} \times 100$

$= 76\%$ (Ans)

(167) Determine the super elevation in inch for a 20' wide road with a design speed of 50 mph and degree of curvature 7° (BUET)

Soln

$e = \frac{73.33^2}{32.2 \times 818.57} - 0.14$

$= 0.064 \text{ ft/ft}$

$E = 0.064 \times 20 = 1.28 \text{ ft} \times 12$

$= 15.36 \text{ in}$

$R = \frac{5730}{7^\circ} = 818.57'$

$v = \frac{50 \times 5280}{60 \times 60} = 73.33 \text{ ft/sec}$

Max. $e = 0.067$ (এর চেয়ে বেশি হলে ধরা যাবে 2টি).

(168) One million gallon (mgd) water passes through a sedimentation tank of 50' x 20' x 10'. What will be detention period. (BUET)

Soln

$t = \frac{V}{Q}$

$= \frac{10,000}{1.54}$

$= 6493.50 \text{ sec}$

$= 1.8 \text{ hr}$ (Ans)

$Q = \frac{10^6}{7.48 \times 24 \times 3600}$

$= 1.54 \text{ ft}^3/\text{sec}$

$V = 10,000 \text{ ft}^3$

(169) Draw phase diagram of saturated soil mass. Calculate the lateral ~~diagram~~ force on a wall of 15' height with Sand back. $\gamma = 115$ pcf. $\phi = 30°$

[Sand back থাকার কারণ কি?]

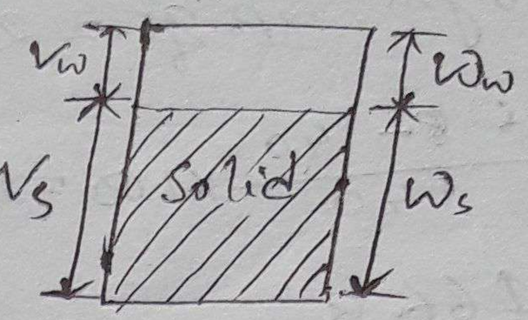
Soln

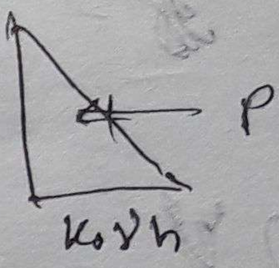
$K_0 = 1 - \sin 30°$ } (কেন K_a নয়?)
$= 0.5$

Total pressure $= \frac{K_a \gamma H^2}{2}$

$= \frac{0.5 \times 115 \times 15^2}{2}$

$= 6468.75$ lb/ft





Lateral force $= 6468.75 \times 15 = 97K$

(170) 21 নং problem এর Alternative Solution.

$W_1 = lb$ (1 - side lap) x scale
$= .75(1 - 0.25) \times 10,000$
$= 5625$ ft

$w = 9"$
$= 0.75'$
$w = 20 \times 5280$

Number of flight $= \frac{20 \times 5280}{5625} + 1 = 19.77 \approx 20$ Ans

(171) Calculate the weight of 20 ft long Steel bar (5no).

Soln

formula $= \frac{L \times D^2}{162 \times 3.28}$ [D in mm, L in (m); weight in kg/m]

$= \frac{20 \times 16^2}{162 \times 3.28}$ [for, L in ft, $W = \frac{LD^2}{162 \times 3.28}$]

$= 9.63$ kg Ans.

(A)

(172) Estimate the quantity of material required for plastering the area 100 m². Proportion 1:5 & t = 12mm

Soln Volume of mortar = $100 \times \frac{12}{1000} = 1.2\ m^3$

Assuming 25% loss = $1.2 + 1.2 \times \frac{25}{100} = 1.5\ m^3$.

Now,

$x + 5x = 1.5$

$\therefore x = \frac{1.5}{6} = 0.25\ m^3$

$= 8.82$ cft or 8 bag (About). (cement)

Sand = $0.25 \times 5 = 1.25\ m^3 = 44$ cft

1 truck = $5.87\ m^3$ $\therefore$ Required = $\frac{1.25}{5.87} = 0.21$ truck.

6t 1/2 truck

(173) Estimate the number of mastic tiles required for an area of 100 m² with 20mm thick line.

→ Size of tile = 20cm × 20cm

→ Proportion of mortar = 1:2:4.

Soln Area of tile = $20\ cm \times 20\ cm = 400\ cm^2 = 0.04\ m^2$

No. of tile required = $\frac{100}{0.04} = 2500$ nos.

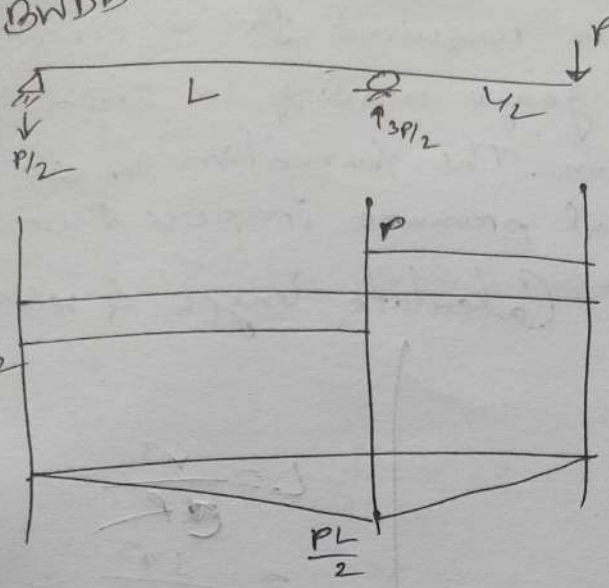
Volume of line bond = $100 \times \frac{20}{1000}$

$= 0.2\ m^3$

Assuming 25% loss = $0.2 + .2 \times .25$

$= 0.25\ m^3$

(176) BWDB



(177) A soil sample has a unit wt of 105.7 pcf & a saturation of 50%. When it's saturation is increased to 75%, it's unit wt raises to 112.7 pcf. Determine the void ratio & G_s.

Soln We know,

$$\gamma = \frac{\gamma_w (G_s + Se)}{1+e}$$

or, $$105.7 = \frac{62.4 \times (G_s + 0.5e)}{1+e} \quad \text{---(i)}$$

& $$112.7 = \frac{62.4 \times (G_s + .75e)}{1+e} \quad \text{---(ii)}$$

From (i)

$$105.7 + 105.7e = 62.4 G_s + 31.2e$$

or $$62.4 G_s - 74.5e + 105.7 = 0 \quad \text{---(iii)}$$

& $$112.7 + 112.7e = 62.4 G_s + 46.8e$$

or, $$62.4 G_s - 65.9e - 112.7 = 0 \quad \text{---(iv)}$$

Solving — $G_s = 2.65$ & $e = 0.814$

(Ans)

(178) A transition curve is required for a circular curve of 200m radius, the gauge reading is 1.5m and max. super elevation is 15cm. The transition is to be designed such that lateral pressure imposed on the rail & acceleration is 30cm/sec³. Calculate length & velocity.

Soln

$$\tan\theta = \frac{e}{G} = \frac{v^2}{gR}$$

or, $\frac{.15}{1.5} = \frac{v^2}{9.81 \times 200}$

or, $v = 14$ m/s. (Ans)

$$L = \frac{v^3}{CR}$$

$$= \frac{14^3}{0.3 \times 200}$$

$$= 46 \text{ m} \quad \text{(Ans)}$$

(179) In an area of 100 ha, the water table dropped by 4.5m. If the porosity is 30% and specific retention is 10%. Determine

(i) Specific yield.

(ii) Change in ground water storage.

Soln

(i) $n = S_y + S_R$

or, $0.3 = S_y + 0.1$

$\therefore S_y = 0.2$ or 20%.

(ii) Change in ground water storage,

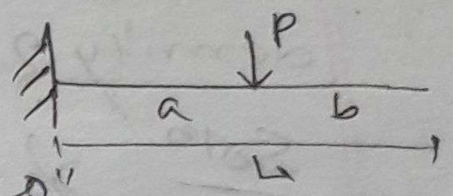
$$\Delta GWS = A_s * \Delta GWT * S_y.$$

$$= 100 \times 10^4 \times 4.5 \times .2$$

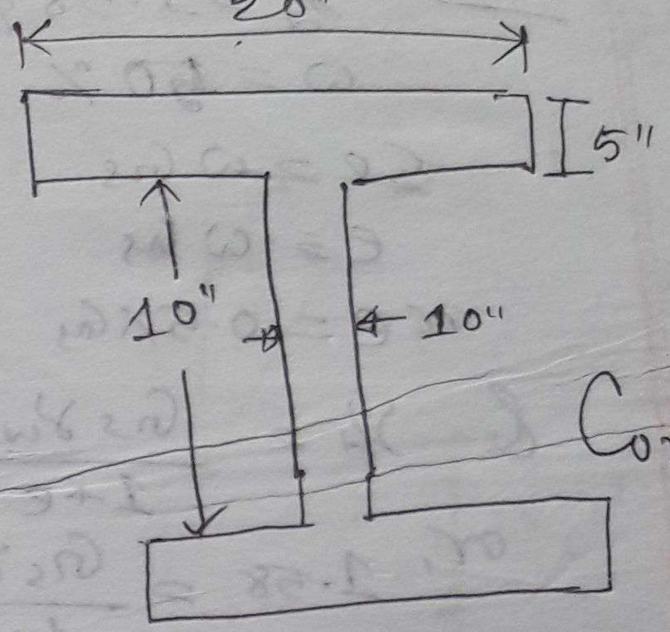
$$= 90 \times 10^4 \text{ m}^3.$$

ভূগর্ভস্থ পানির পরিবর্তন = GWT. A_{sy}

(180) Compute the minimum tensile Stress of the beam (consider a section of I-beam) with web dimension is 10" × 10" & flange dimension of 20" × 5".



Sol^n

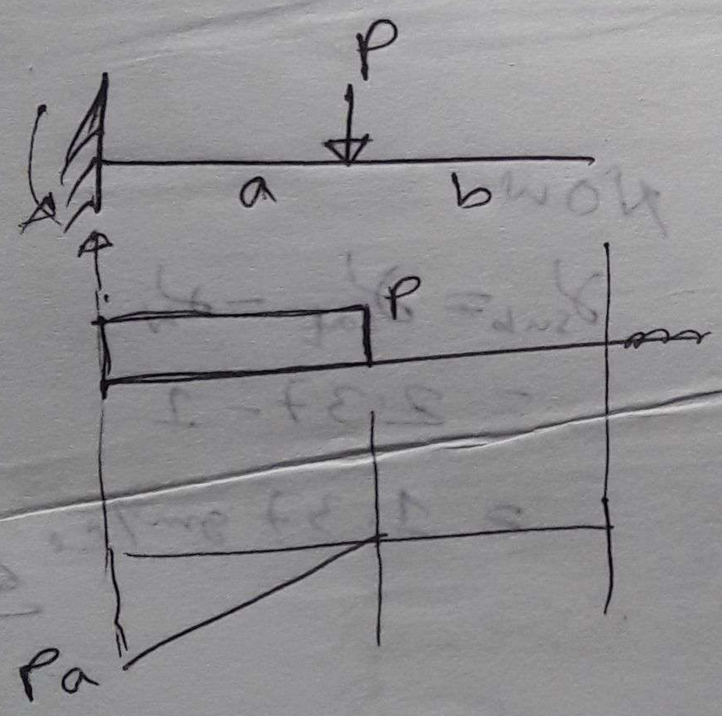


$$I = \frac{20\times5^3}{12} + 20\times5\times(10-2.5)^2 + \frac{10\times10^3}{12} + \frac{20\times5^3}{12} + 20\times5\times(10-17.5)^2$$

$$= 12500 \text{ in}^4$$

$$\bar{y} = c = 10$$

now,



Now, $\sigma = \frac{Mc}{I}$

$$= \frac{Pa\times10}{12500} \text{ (psi/ksi)}$$

(Ans)

(181) The dry density of a soil is 1.58 gm/cc. Water Content is 50%. What would be its saturated & Submerged density? (BPDB)

Soln $\gamma_d = 1.58$ gm/cc

$\omega = 50\%$.

$Se = \omega G_s$ [$S=1$]

$e = \omega G_s$

or $e = 0.5 \times G_s$ —(1)

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

or, $1.58 = \frac{G_s \times 1}{1+0.5 G_s}$

$\therefore G_s = 7.52$

$e = 3.76$

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

$= \frac{9.81 (7.52 + 3.76)}{1+3.76}$

$= 2.37$ gm/cc. (Ans)

NOW

$\gamma_{sub} = \gamma_{sat} - \gamma_w$

$= 2.37 - 1$

$= 1.37$ gm/cc Ans

(182) The thickness of a brickwall is 250mm, 2m in height. find horizontal distributed wind load for which the base shear is just negative. The unit wt of masonry is ~~1950~~ 25 kN/m3.

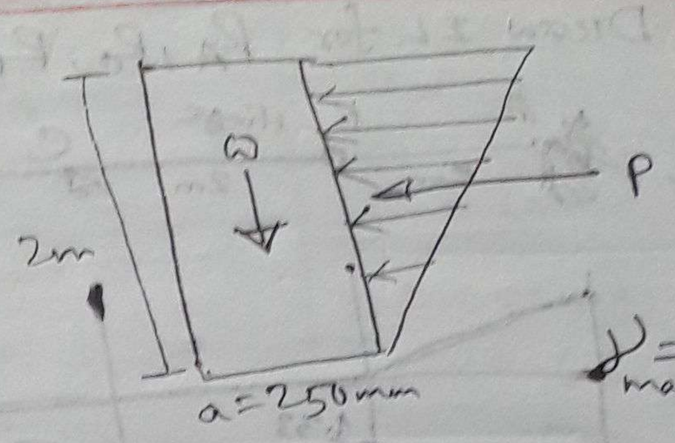
(GTCL-2016)

Soln

$$\omega \times \frac{a}{2} = P \times \frac{2}{3} \times h$$

Or, $2 \times .25 \times 25 \times \frac{.25}{2} = P \times \frac{2}{3} \times 2$

Or, $P = 1.17$ kN.

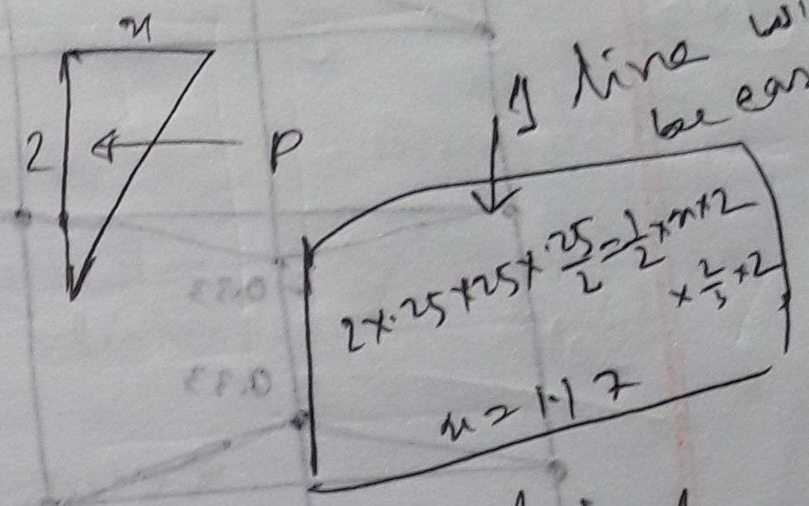


$\gamma_{macm} = 25$ kN/m3

Now, $\frac{1}{2} \times n \times 2 = P$

Or, $n = \frac{2 \times 1.17}{1}$

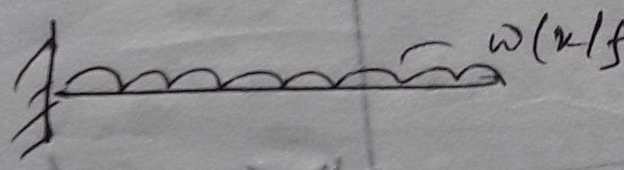
$= 1.17$ kN/m



⊗ Determine sieve size from graph for 40% retained.

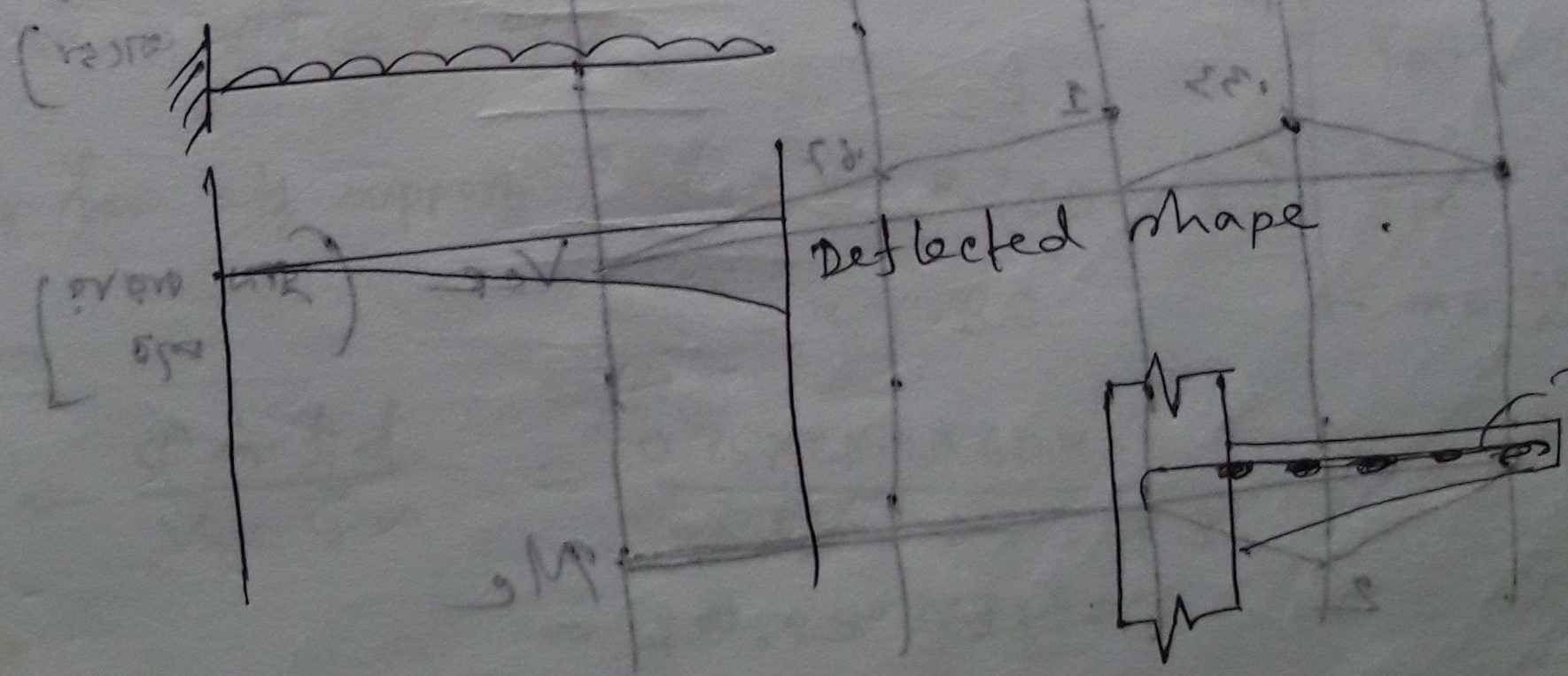
⟹ এর মানে হবে 40% retained মানে 60% finer. So, D60 এর Corresponding value will be the ans. Curve Pen. finer Vs grain size.

(183) Draw deflected shape & reinforcement details of the beam..

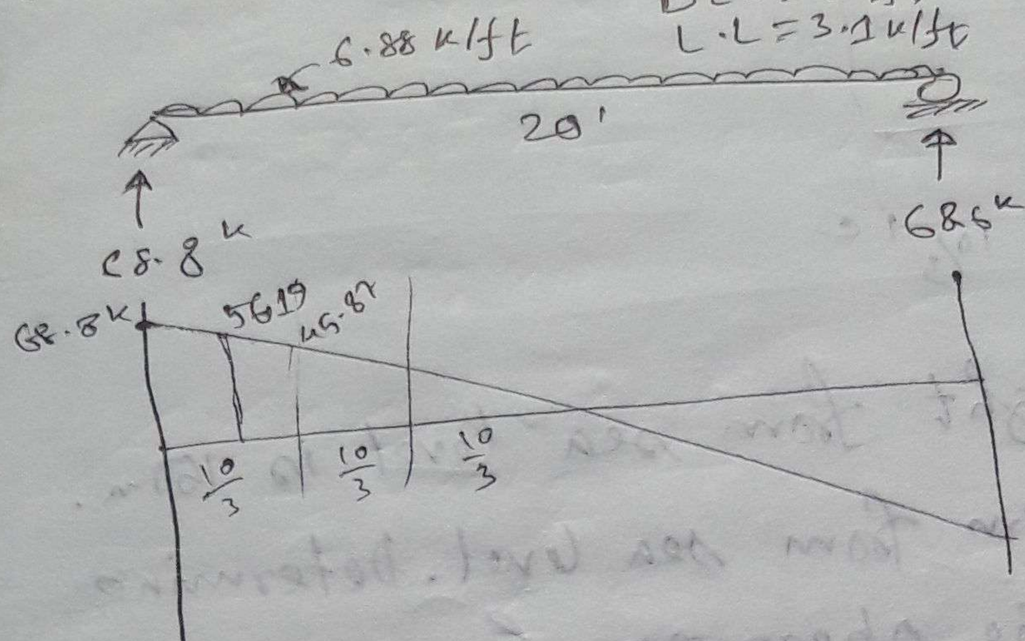


(WASA)

Soln



185) Design for stir-up for the following beam -



b = 12"
d = 22"
f_c' = 4 ksi
f_y = 60 ksi

T.D.L = 1.2 × 1.6 + 1.6 × 3.1
= 6.88 k/ft

Critical section lies at 22" distance from left

i.e, $V_u = 68.8 - 6.88 \times \frac{d}{12} = 56.19$ k

$\therefore V_u = 56.19$ k (Critical)

Spacing, $S = \frac{\phi A_v f_y d}{V_u - \phi V_c}$

$= \frac{0.75 \times 2 \times .11 \times 60 \times 22}{56.19 - 0.75 \times 33.39}$

$= 6.99" \simeq 7"$

$S_{max} = \frac{A_v f_y}{50 b_w} = \frac{2 \times .11 \times 60{,}000}{50 \times 12} = 22"$ Or, $S_{max} = \frac{d}{2} = 11"$

$S_{max} = 24"$ ..

So, use #3@7" c/c.

At $\frac{L}{3}$ from left support, $V_{u1} = \frac{V_u}{10} * (10 - \frac{10}{3})$

$= 45.87$

From similar trian

$\frac{68.8}{10} = \frac{x}{10 - \frac{10}{3}}$

$\therefore x = \frac{68.8 \times (10 - \frac{10}{3})}{10}$

$= 45.87$

$S' = \frac{\phi A_v f_y d}{V_u - \phi V_c} = \frac{0.75 \times 2 \times .11 \times 60 \times 22}{45.87 - 33.39 \times .75}$

$= 10.45" \simeq 11"$ c/c.

Use 3@11" c/c.

Critical section lies at 22" distance from left

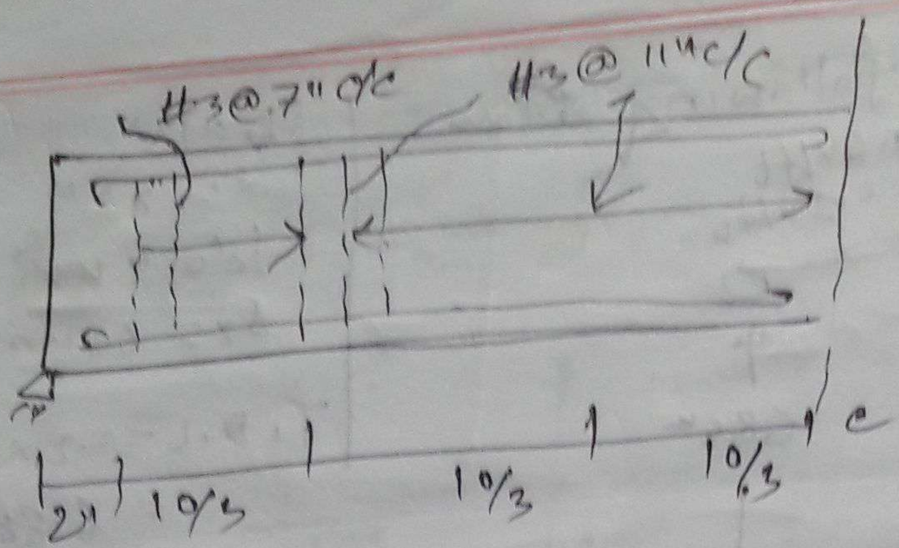
$\phi V_c = 2\phi \sqrt{f_c'} b d$

$= 2 \times \sqrt{4000} \times 12 \times 22$

$= 33.39$ k $\times 1.075$

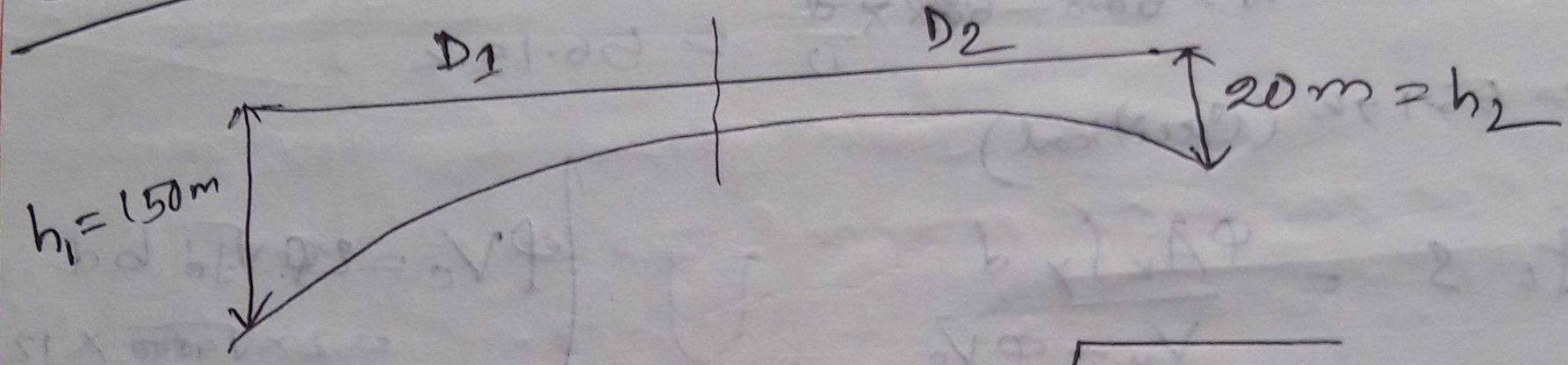
~~$\phi = 0.75$~~

Or



(186) Height of search light from sea level is 150m. Observer's eye at 20m from sea level. Determine the distance between the observer & searchlight.
(BD-Chaina)

Soln



$h_1 = 0.0673 D_1^2 \quad \therefore D_1 = \sqrt{\frac{h_1}{0.0673}}$

$= \sqrt{\frac{150}{0.0673}}$

$= 47.21\,m$

Similarly, $D_2 = \sqrt{\frac{h_2}{0.0673}}$

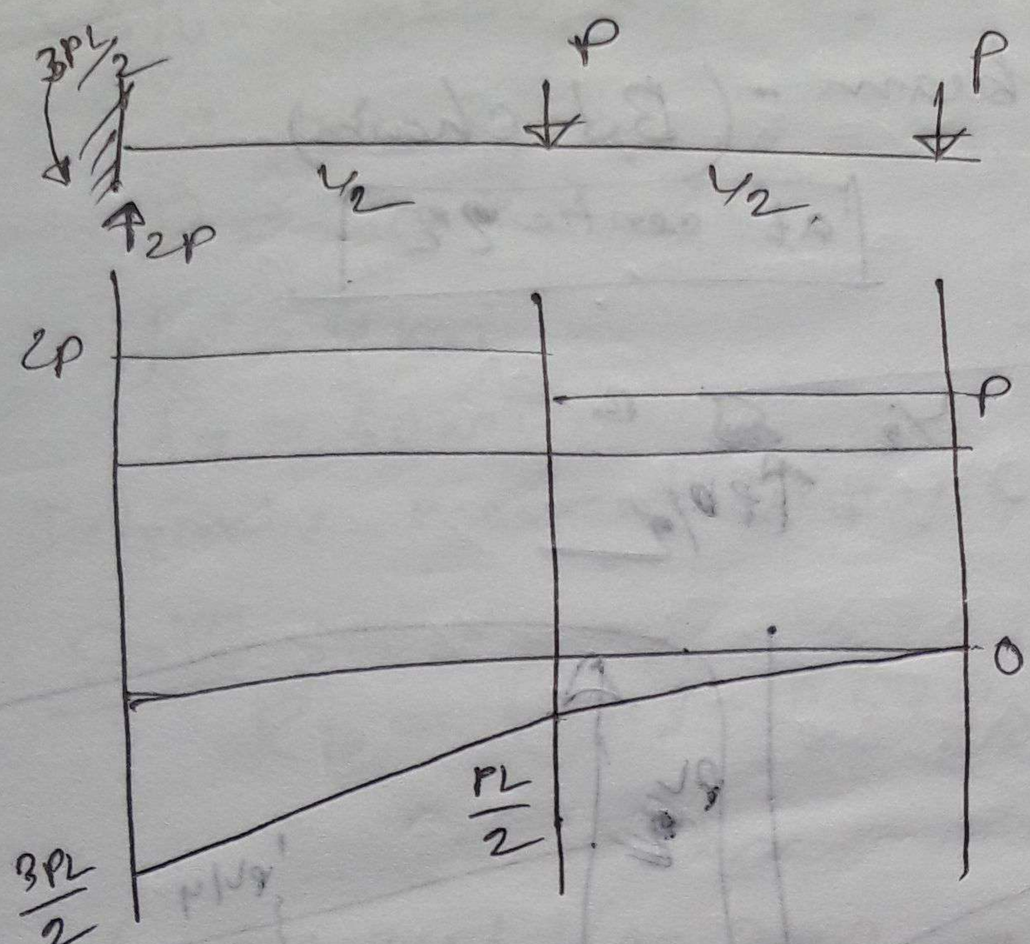
$= \sqrt{\frac{20}{0.0673}}$

$= 17.24$

Total distance $= (47.21 + 17.24)\,m$

$= 64.45\,m$ (Ans)

(187) DRAW SFD & BMD. (BD-Chaina)



(188) Shipward deck area 5000 sft. Height is 12'. If the height is increasing by 3", then ~~diameter~~ determine the load (in pound). Given, unit wt of material 64 lb/ft³.

(BD-Chaina)

Soln

New height = $12' + \left(\frac{3}{12}\right)' = 12.25'$

So, Volume = 5000×12.25

$= 61250\ ft^3$.

Then Weight = 61250×64

$= 3920000\ lb$

(Ans)

(191) footing size (2m × 2m), $\gamma = 20.4\ kN/m^3$, $\phi = 20$

$N_c = 25.13$, $N_q = 12.72$, $N_\gamma = 8.34$, $D_f = 5m$

F.S = 3. Calculate bearing capacity. $c = 20\ kPa$ (BD China)

Soln

$$q_u = 1.3cN_c + qN_q + 0.4\gamma BN_\gamma$$

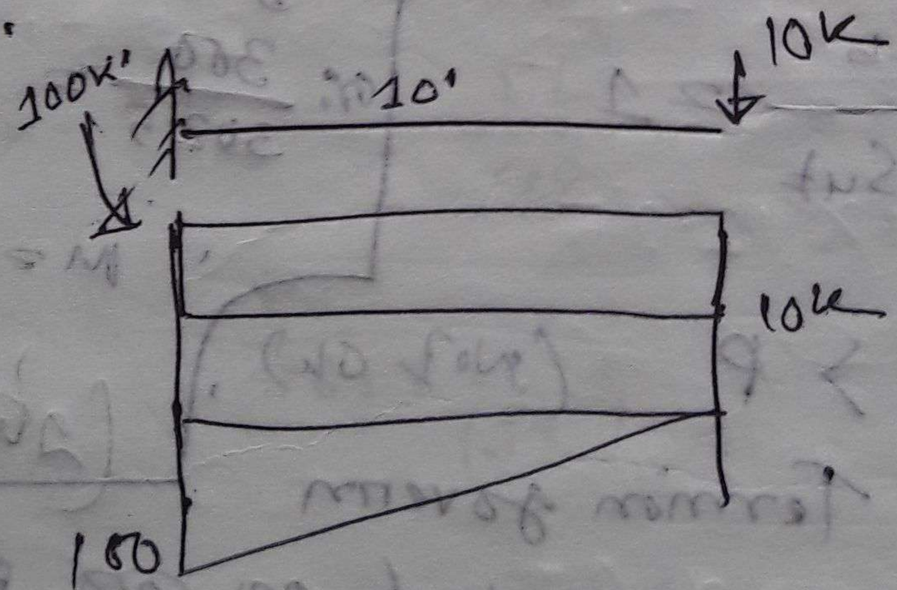
$$= 1.3 \times 20 \times 25.13 + 20.4 \times 5 \times 12.72 + 0.4 \times 20.4 \times 2 \times 8.34$$

$$= 2087\ kN/m^2.$$

$$q_{all} = \frac{2087}{3} = 696\ kN/m^2$$

[* γ স্থলে ভাসমান γ_{sat} থাকলে কিভাবে $\gamma = (\gamma_{sat} - \gamma_w)$ হবে?]

(192) What is the max. bending moment & max. shear of beam having cross section 1" × 1". (BIWTC)



Max. bending moment = 100 k'

" Shear = 10k

$$\frac{1 \times 1^3}{12} = \frac{1}{12}$$

$$Q = \frac{bh^2}{8} = \frac{1 \times 1}{8}$$

flexural stress, $\sigma = \frac{Mc}{I} = \frac{100 \times \frac{1}{2}}{\frac{1}{12}} = 7200\ kN/m^2$

Shear stress, $\tau = \frac{VQ}{Ib} = \frac{10 \times (1 \div 8)}{\frac{1}{12} \times 1} = 15\ kN/m^2$

(193) $d = 10''$, $f_c' = 3$ ksi, $f_y = 60$ ksi, $b = 10''$. What is the bending moment capacity. (~~BIWTC~~) (PDB-12)

Soln

~~$M = \frac{1}{2} f_c' k b d^2$~~

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

$$= \frac{2.36 \times 60}{0.85 \times 3 \times 10}$$

$$= 5.55$$

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

$$= 2.36 \times 60 \times \left(10 - \frac{5.55}{2}\right)$$

$$= 1023 \text{ kip-in.}$$

$f_c = 0.45 f_c' = 1.35$ ksi

$A_s = 3 * 25$ mm

$= 3 \times \frac{\pi \times 1^2}{4}$

$= 2.36$ in^2

check for under reinforcement

$M_u = \phi M_n$

$= 920.7$ kip-in.

(194) 4.75 mm Sieve retains 30gm & 0.075 mm retains 2gm. Find Percentage of F.A & C.A. (BIWTC-12).

Soln

$$C.A = \frac{30}{32} \times 100 = 93.75\% \text{ Ans}$$

& $$F.A = \frac{2}{32} \times 100 = 6.25\% \text{ Ans.}$$

(195) A car saw a crash in front of it. If the driver stopped the car 5m in front of the crash. Find the distance it has traveled. $t = 2.5$. (DESCO-14)

Soln

$$SSD = vt + \frac{v^2}{2gf}$$

$$= 27.8 \times 2.5 + \frac{27.8^2}{2 \times 9.81 \times 0.35}$$

$$= 182 \text{ m.}$$

Let

$v = 100$ km/hr

$= 27.8$ m/s

$f = 0.35$

∴ Traveled distance = 182.5 = 177m (Ans)

(196) The dry mass of a sample aggregate is 1988gm. The mass in a saturated surface dry condetion is 2006.7gm. The net volume of aggregate is 734.4 cm³. find the apparent sp. gravity, Bulk specific gravity & the percentage absorption. (P&E B).

(197)

Soln We know,

Unit wt. of water = 1 gm/cm³.

Wt. of aggregate in water = 734.4 × 1 = 734.4gm.

Wt. of sample (SSD), A = 2006.7gm

Wt. of sample (Dry), B = 1988 gm

Wt. of sample (water), C = 734.4gm.

Now,

1. Apparent sp. gravity = $\frac{1988}{1988-734}$ = 1.59 ✓

2. Bulk Sp. gravity (SSD) = $\frac{2006.7}{2006.7-734.4}$ = 1.58 (Ans) (= Bulk (dry) Ans / $\frac{1988}{2006.7-734.4}$ = 1.56)

3. Absorption (%) = $\frac{2006.7-1988}{1988}$ = 0.94 % Ans

[Alternative Soln at the end.] (See 300 Number prob.)

(199) An oil having kinematic viscosity of 21.4 stokes is flowing through a pipe of 300mm dia. Determine the type of flow. $Q = 15 \ell/s$ (IWM)

Soln $\nu = 21.4 \text{ Stokes} = 21.4 \times 10^{-4} m^2/s$

$d = 0.3$.

Now. $A = \frac{\pi \times d^2}{4} = 0.0707 m^2$, $Q = 0.015 m^3/s$.

$V = \frac{Q}{A} = 0.212 m/s$

$R_e = \frac{Vd}{\nu} = \frac{0.212 \times 0.3}{21.4 \times 10^{-4}} = 29.75$

$R_e < 2000$ (Pipe flow)

Flow is laminar.

(200) A water main gives a pressure of 490 kN/m². find the theoritical rate at which water is it escaped through a circular orifice of 2.5cm dia.

Soln $d = .025 m$.

$p = \gamma H \therefore H = \frac{p}{\gamma} = \frac{490}{9.81} = 49.59 m$ of water

$V = \sqrt{2gH}$

$= \sqrt{2 \times 9.81 \times 49.59}$

$= 31.19 m/s$.

$Q = \frac{\pi \times 0.025^2}{4} \times 31.19$

$= 0.015 m^3/s$ (Ans)

(205) A particular industrial sewage has a BOD_5 of 400 kg/day. Assuming the avg. population equivalent per capita per day as 80gm of 5-day BOD at 20°C. Calculate the equivalent population for which the industry can be charged?

Soln Equivalent population $= \frac{400}{0.08} = 5,000$ person. (Ans)

(206) Design a pumping station to raise water from an intake well to a sedimentation tank with the following data-

Water to be raised per day = 18,000 m^3

Length of suction pipe = 40m, length of rising main = 150m

Co-efficient of friction = 0.04, Dia. of pipe = 50cm. Shifts of working pump = 2, Combined eff. of motor & pump = 80% Duration of shift = 8h

Static head = 21 m.

Soln Water required per day = 18,000 m^3

Total pumping hour = $2 \times 8 = 16h$

pumping capacity per hour = $\frac{18,000}{16} = 1125\ m^3/hr = 0.31\ m^3/s$

$h_f = \frac{4flv^2}{2gd} = \frac{0.04 \times (40+150) \times 1.58^2}{2 \times 9.81 \times 0.5}$

$= 1.95m$

$v = \frac{Q}{A} = \frac{0.31 \times 4}{\pi \times .5^2} = 1.58$

$H = h_s + h_f = 21m + 1.95m = 22.95m.$

$Q = 310\ l/s$

$H = 22.95$

$WHP = \frac{QH}{76} = \frac{310 \times 22.95}{76} = 93.61$

$B.H.P = \frac{93.61}{E} = \frac{93.61}{0.8} = 117$ (Ans)

(207) Find the Specific capacity of well to yield under a head of 3m.

Initial depression head = 8m
final depression head = 5m
Time of recuperation = 2h
Dia of well = 4m

Soln

$$K = \frac{A}{T} \ln \frac{h_1}{h_2}$$

$$= 2.95 \text{ m}^2/\text{hr}$$

$$Q = KH$$
$$= 2.95 \times 3 = 8.85 \text{ m}^3/\text{h}.$$

Alternative

$$\Delta = \frac{1}{T} \ln \left(\frac{s_1}{s_2}\right)$$
$$= \frac{1}{2} \ln \left(\frac{8}{5}\right)$$
$$= 0.235 \text{ m}^2/\text{hr}$$
$$Q = \Delta A S$$
$$= 8.25 \text{ m}^3/\text{hr}$$ (Ans)

(208) find the dia. of an open well to given yield of 360 l/min. The working depression head is 4m & the aquifer soil consists of coarse sand.

Soln $Q = 360 \text{ l/min.} = 21.6 \text{ m}^3/\text{hr}$

$Q = (K) \cdot A \cdot S$ / $(K) = 1$ for coarse sand

$21.6 = 1 \times \frac{\pi d^2}{4} \times 4$

$\therefore d = 2.70 \text{ m}$ (Ans)

(209) Calculate the per capita water available and the capacity of the storage tank required for a family of 6 person having a roof area of $20 m^2$ with runoff coefficient of 0.8. The family lives in a part of Bangladesh having a yearly rainfall 2.5m. The distribution demand is 40% storage.

Soln

$Q = CIA \longrightarrow$

$= 0.8 \times 2.5 \times 20 = 40 m^3$

$V = hAc$
$= 2.5 \times 20 \times 0.8$
$= 40 m^3$

Storage volume $= 40 \times 0.4 = 16 m^3$.

Available rain water $= \frac{40 \times 1000}{6 \times 365} = 18.26$ lpcd.

(210) Ratio 1:2:3. fineness modulus of sand 2.62, 2.32, 2.40. find the mix fineness modulus.

$f_{mix} = \frac{2.62 \times 1 + 2.32 \times 2 + 2.40 \times 3}{1+2+3} = 2.41.$ Ans

(211)

Before incubation	DO (mg/l)
Dilution water	8.40
Sewage	8.60
After incubation	
water	8.20
Sewage	5.80

Calculate BOD_5 of the sewage.

Soln

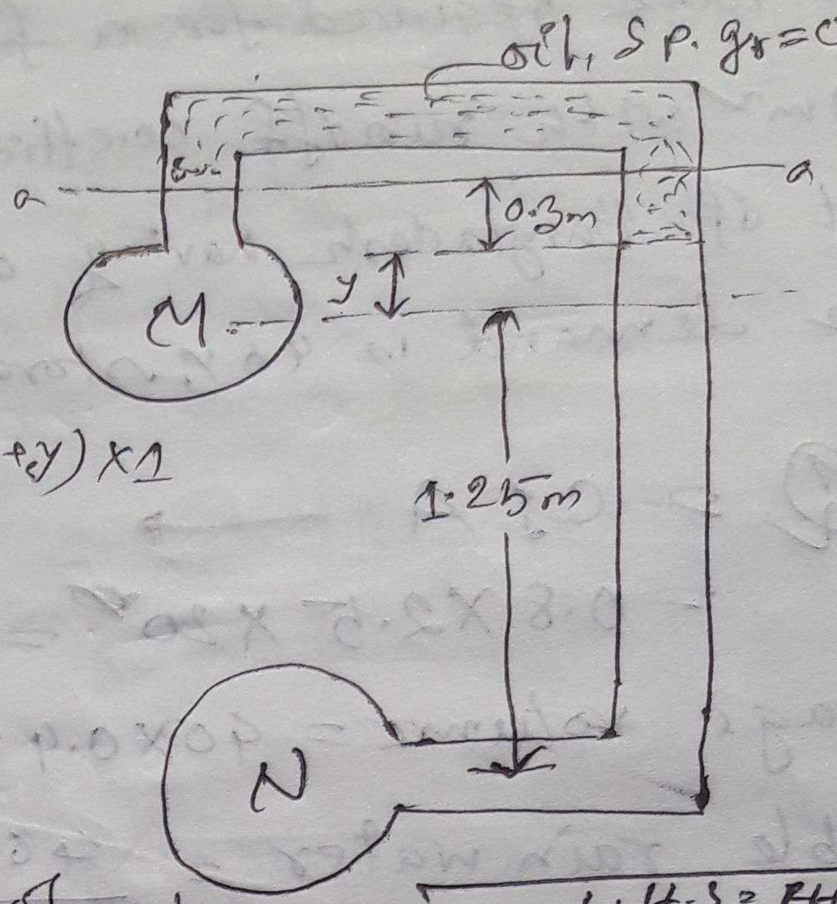
$D.f = \frac{100}{}$

$(BOD)_5 = \left[(8.60 - 5.80)_5 + (8.40 - 8.20)_{20}\right] \times 100$

$= 260$ mg/L (Ans).

(12) Find the pressure difference in pressure intensity at M & N.

[Left side = Right side (Section)]



$$\frac{P_M}{\gamma} - 1(y+0.3) = \frac{P_N}{\gamma} - (1.25+y)\times 1$$

$$- 0.3\times 0.9$$

$$\therefore \frac{P_M}{\gamma} - \frac{P_N}{\gamma} = +y*0.3 - 1.25 - y$$

$$-.27$$

$$\therefore \frac{P_M}{\gamma} - \frac{P_N}{\gamma} = -1.22 \text{ m of water}$$

$$\therefore P_N - P_M = 1.22\times\gamma \text{ m of w}$$

$$= 1.22\times 9.81$$

$$= 11.97 \text{ kN/m}^2$$

$P = \rho g h$
ρ = Sp. g = Un. wt
$h = h$

$P_M + (y+0.3)\times 9.81\times 1 = P_N$
$+(1.25+y)\times 1\times 9.81 + 0.3\times 0.9\times 9.4$
Follow this

[কোন কিছুর Sp. gravity × water unit wt = সেটার unit wt]

(13) The peak of unit hydrograph due to a 3-h duration of isolated storm in a catchment is 50 m³/s. The total depth of rainfall is 5.9 cm. Assuming an average infiltration loss of 0.3 cm/hr and a constant base flow of 20 m³/s, (a) estimate the ~~base flow~~ peak of the 3h flood hydrograph of the catchment.

(b) If the area of catchment is 567 km², determine

the base width of 3-h Unit hydrograph by assuming it a triangular in shape.

Soln

(a) Loss in 3-h = $0.3 \times 3 = 0.9$ cm.

P_{net} = Excess rainfall = $5.9 - 0.9 = 5$ cm.

We know, UG peak = $\frac{\text{DRO peak}}{\text{Excess rainfall}}$

$\therefore$ D.R.O. peak = $50 \times \frac{5 \text{ (cm)}}{1 \text{ (cm)}} = 250 \text{ m}^3/\text{s}$

T.R.O = DRO + 20 = $270 \text{ m}^3/\text{s}$

(b) Taking "B" as width we get

(Unit hydrograph 1 cm ই?)

Area of UG = Area of Catchment $\times$ 1 cm

or, $\frac{1}{2} \times B^{(hr)} \times 50^{m^3/s\,(cm)} \times (60 \times 60) = 567 \times 10^6 \times \frac{1}{1000}$

or, $B = 63$ hours (Ans)

(4) Show that, $E_c = 1.5 h_c$

Soln for critical flow, $F_r = 1$

$\frac{V_c}{\sqrt{g D_c}} = 1$ or $\frac{V_c^2}{g D_c} = 1$ or, $\frac{V_c^2}{2g} = \frac{D_c}{2} = \frac{h_c}{2}$

[$D_c = \frac{A}{T} = \frac{B h_c}{B_{(rectangle)}} = h_c$]

Now, $E_c = h_c + \frac{V_c^2}{2g}$

$= h_c + \frac{h_c}{2}$

$= 1.5 h_c$ (Showed)

(215) $\mu = 1\ N\text{-}s/m^2$, velocity distribution, $u = 0.9y - y^2$. find out shear stress at 0.45m. (BWDB-16)

Solⁿ

$$u = 0.9y - y^2$$

$$\frac{du}{dy} = 0.9 - 2y$$

Now, $\left(\frac{du}{dy}\right)_{0.45} = 0.9 - 2\times.45 = 0$

Now, Shear Stress, $\tau = \mu \cdot \frac{du}{dy}$

$= 1 \times 0$

$= 0$ (Ans

(216) A 2m×2m raft foundation. 5m depth. $N_c = 2$, Cohesion 40 kN/m². F.S = 2. What is the net allowable pressure? BIWTC

Solⁿ for raft foundation

$$q_{u(net)} = q_u - q = C_u N_c f_{cs} f_{cd}$$

$$= C_u N_c \left(1 + \frac{B}{L} \times \frac{N_a}{N_c}\right)\left(1 + 0.4\,\frac{D_f}{B}\right)$$

$$= 40 \times 2 \left(1 + \frac{2}{2} \times \frac{1}{2}\right)\left(1 + 0.4 \times \frac{5}{2}\right)$$

$$= 240\ kN/m^2$$

$$q_{net\ (Allowable)} = \frac{q_{u(net)}}{F.S}$$

$$= \frac{240}{2}$$

$$= 120\ kN/m^2$$

(217)

Vat
Speed,

At

2

Ultimate bearing capacity of foundation on clay soil

$$q_u = C_u N_c \left(1 + \frac{N_a}{N_c}\frac{B}{L}\right) + \gamma (1 + 0.4\,D_f/B)$$

$$q_{u(net)} = \frac{q_u}{A} - \gamma D_f$$

2nd, and

(217) An engineer is willing to identify the speed characteristics of an expressway. The confidence level is 95% & allowable speed is 1 km/hr. He collected 230 spot speed data & the avg. speed of the vehicles are given. Did the personnel collected sufficient data? (BUET)

Soln

Variance of speed, $s^2 = 25 \text{ km/hr}$.

$$n = \frac{z^2 s^2}{e^2}$$

$$= \frac{1.96^2 \times 25}{1^2}$$

$$= 96.04$$

$$= \frac{1.96^2 \times 10^2}{1^2}$$

$$= 384 > 230$$

not enough.

At Amin 30.230 is enough

(M. Murad)

$e = 1 \text{ km/hr}$

$z = 1.96$ (for 95% confidence level)

~~Avg. mean speed~~

s = Sample standard deviation, to be calculated from avg. mean speed. Let 10 km/hr.

(218) A ditch of 600 m^3 volume has to be filled using native soil with a relative compaction of 95% standard proctor. ~~compaction~~ max. dry density of the native soil is 17.6 kN/m^3. Calculate the amount of native soil required to fill the ditch.

Soln

We know,

$$R = \frac{\gamma_d \text{ (field)}}{\gamma_d \text{ (max)}}$$

$$\therefore 0.95 = \frac{\gamma_d \text{ (field)}}{17.6}$$

$$\therefore \gamma_d \text{ (field)} = 16.72 \text{ kN/m}^3$$

Now, Soil required $= 600 \times 16.72$

$= 10032 \text{ kN}$ (Ans)

$\gamma = \frac{W}{V}$

$\therefore W = \gamma \cdot V$

(223) A cantilever rectangular RCC beam wide 10", d=22". factored load=4K/ft, L=20', Use 4 #12, f_c'=4 ksi f_y=60ksi.

Determine the development length. n=10.

Soln For top bar,

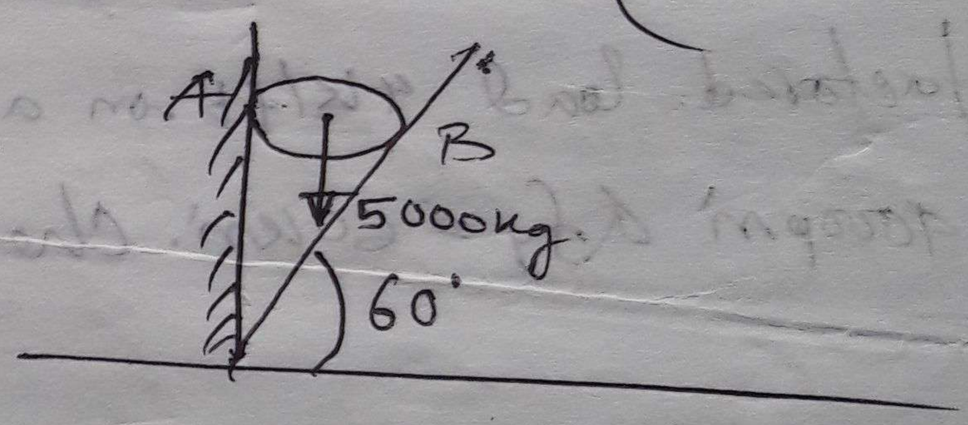
Allowable bond stress, $U_{all} = \frac{3.4\sqrt{f_c'}}{D}$

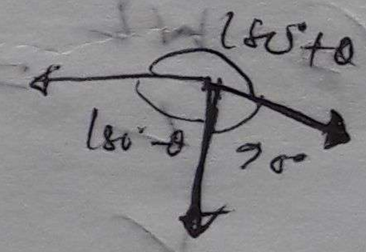
$= \frac{3.4\sqrt{4000}}{1.5} = 20.143$ ksi

Now, Development length $= \frac{f_s D}{4U} = \frac{24 \times 1.5}{4 \times .143}$

$= 5.24'$ (Ans)

(224) Determine R_A & R_B.





Lami's law

$$\frac{R_A}{\sin 90^\circ} = \frac{R_B}{\sin(180-\theta)} = \frac{5000}{\sin(180+\theta)}$$

$$\frac{R_A}{\sin 90^\circ} = \frac{R_B}{\sin 120^\circ} = \frac{5000}{\sin 240^\circ}$$

R_A = 5773.50 kg

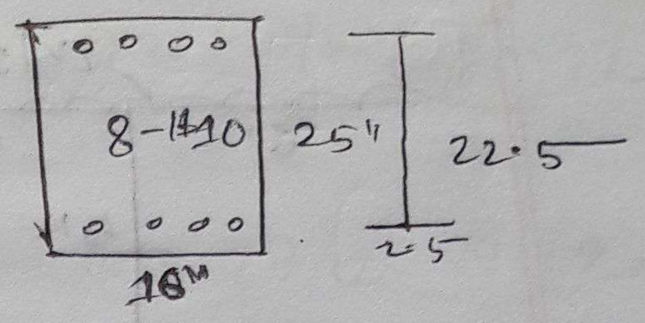
R_B = 5000 kg.

(232) A column Section is given

C.C = 2.5", Have to carry = 300 k.

Determine the moment.

B.D. Chaina



$f_c' = 4$ ksi, $f_y = 60$ k.s.i

Soln

$$C_b = \frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y} \times d = \frac{0.003}{0.003 + \frac{60}{29\times10^3}} \times 22.5 = 13.31 \text{ inch}$$

Now, $a = \beta_1 c \therefore a = 0.85 \times 13.31 = 11.31$ ".

$$f_s' = E_s \varepsilon_u \frac{c - d'}{c} = 29\times10^6 \times 0.003 \times \frac{13.31 - 2.5}{13.31}$$

$$= 70.66 \times 10^3 > 60,000 \text{ psi}.$$

Then $f_s' = f_y = f_s$.

No need may be. $f_s = f_y$ ~~=~~

Now,

$$\sum M_b = 0.85 f_c' a b \left(\frac{h}{2} - a/2\right) + A_s' f_s' (h/2 - d') + A_s f_s (d - h/2)$$

$$= 0.85 \times 4 \times 11.31 \times 16 \left(12.5 - \frac{11.31}{2}\right) + 4 \times 1.27 \times 60 \times (12.5 - 2.5) + 4 \times 1.27 \times 60 \times (22.5 - 12.5)$$

$$= 10.3 \times 103 \text{ kip-in}$$

(Ans)

Now, Total moment, $M = P\left(h/2 - a/2\right)$

$$= 300\left(12.5 - \frac{11.31}{2}\right)$$

$$= 2053.5 \text{ kip-inch.}$$

(Ans)

(237) A line was measured by a 20m chain which was accurate before starting the days work. chaining 900m, the length of chain 20.06m. After chaining 1575m, the chain was found to be 14cm too long. Find the distance of the line.

Sol^n

1st part

$$\text{True length} = \frac{20.03}{20} \times 900 = 901.35\text{m}$$

Avg. error $= \frac{20+20.06}{2}$

$= 20.03$

2nd part

$$\text{True length} = \frac{20.1}{20} \times (1575-900)$$

$$= 678.375\text{m}$$

Avg. error $= \frac{20.06+20.14}{2}$

$= 20.1\text{m}$

Total length $= 1579.725$

(238) A retaining wall that has a soft saturated clay. For undrained condition ($\phi=0$), determine,

(a) Maximum depth of tensile crack

(b) P_a before the tensile crack.

(c) P_a after tensile crack.

Sol^n $K_a = \frac{1-\sin 0^\circ}{1+\sin 0^\circ} = 1.$

At $h=0$, $P_a = K_a \gamma h - 2c\sqrt{K_a}$

$= -2c \times 1$

$= -2 \times 350$

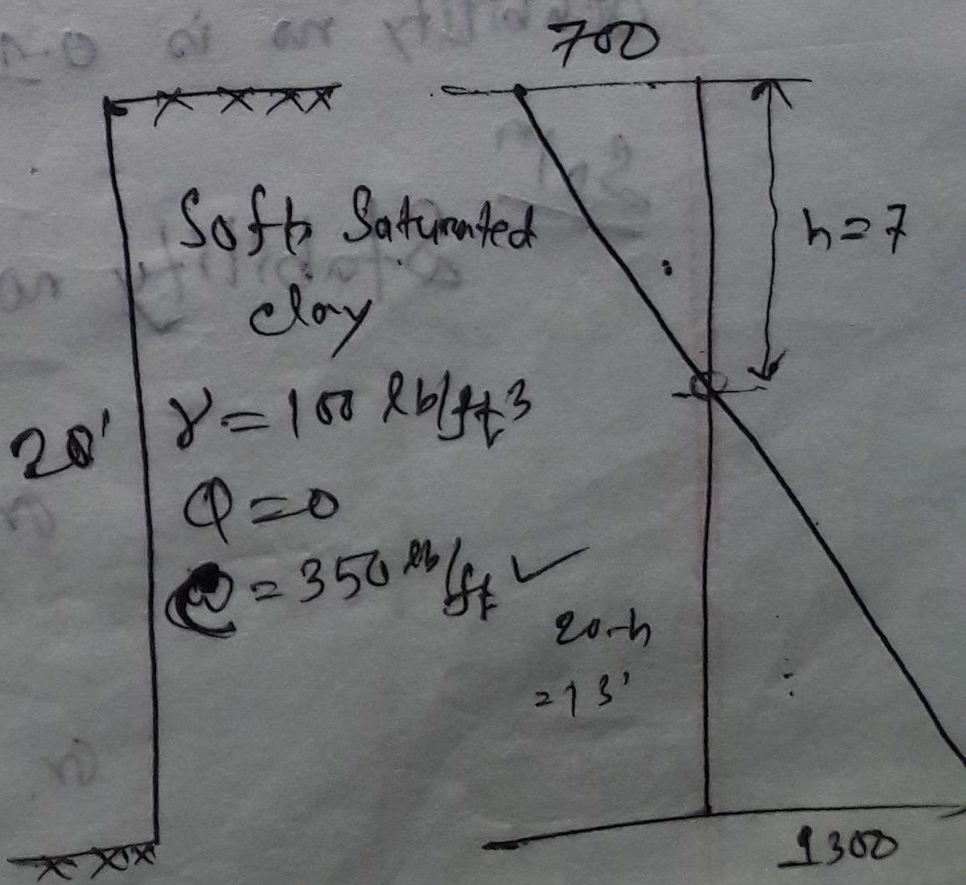
$= -700$

At $h = 20'$, $P_a = 100 \times 20 - 2 \times 350$

$= 1300\ \text{lb/ft}^2$

At tensile crack, $P = 0$.

Then,



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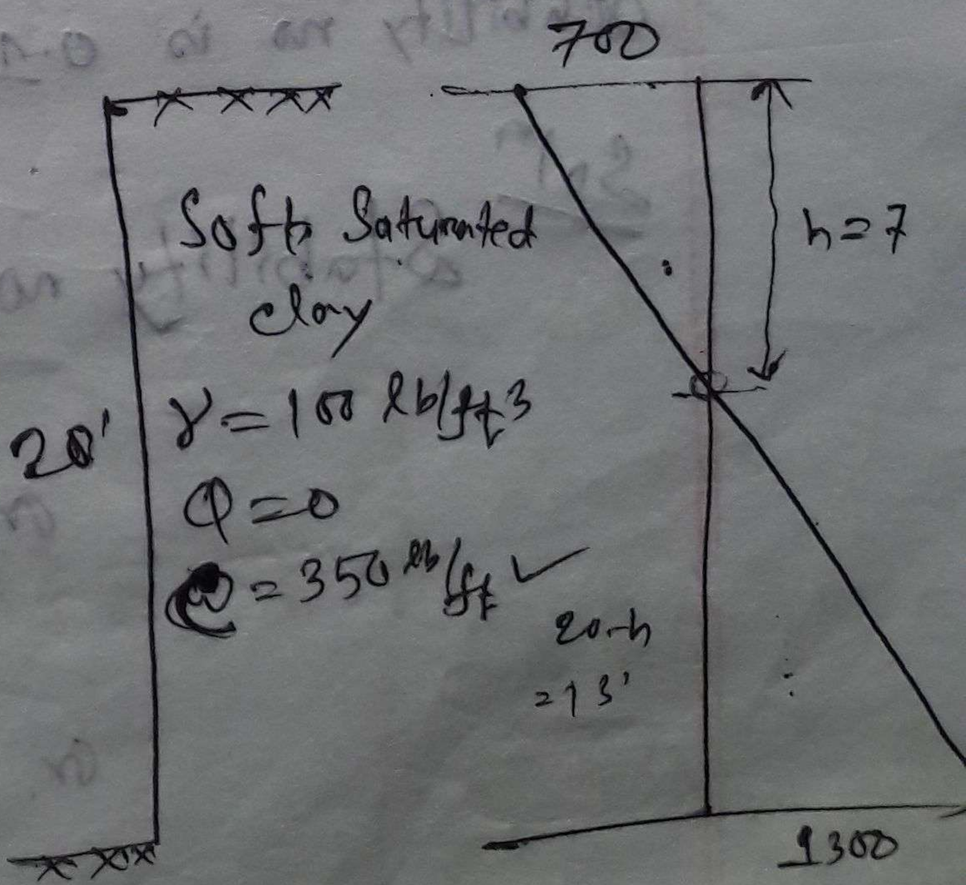


$K_a \gamma h = 2\sqrt{K_a} c$

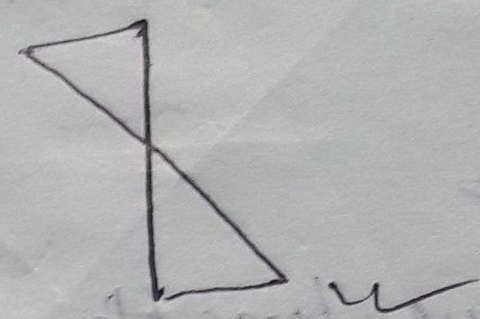
or, $h = \frac{2c}{\gamma}$

$= \frac{2 \times 350}{1800} = 7 ft$

Now, Before crack

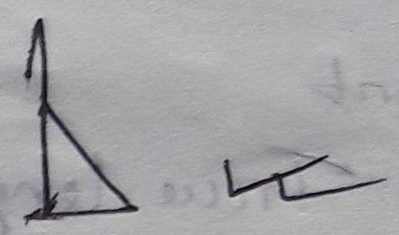
$P_a = \frac{1}{2} \times 1350 \times 13 = \frac{1}{2} \times 780 \times 7$

$= 8500$ lb/ft



After crack

$P_a = \frac{1}{2} \times 7300 \times 13 = 8450$ lb/ft



[যদি Surcharge থাকে তবে $K_a s + K_a \gamma h - 2c\sqrt{K_a}$]

[যদি Passive হয় তবে, $P = K_p \gamma h + 2c\sqrt{K_p}$]

(239) A cutting of 15m deep is made in clay having $\phi = 20°$ and $\gamma = 1.8$ t/m^3, the angle of slope is 40° & F.S = 2. Find the value of cohesion if stability no is 0.1.

Soln

Stability no, $N = \frac{c}{\gamma H (F.S)}$

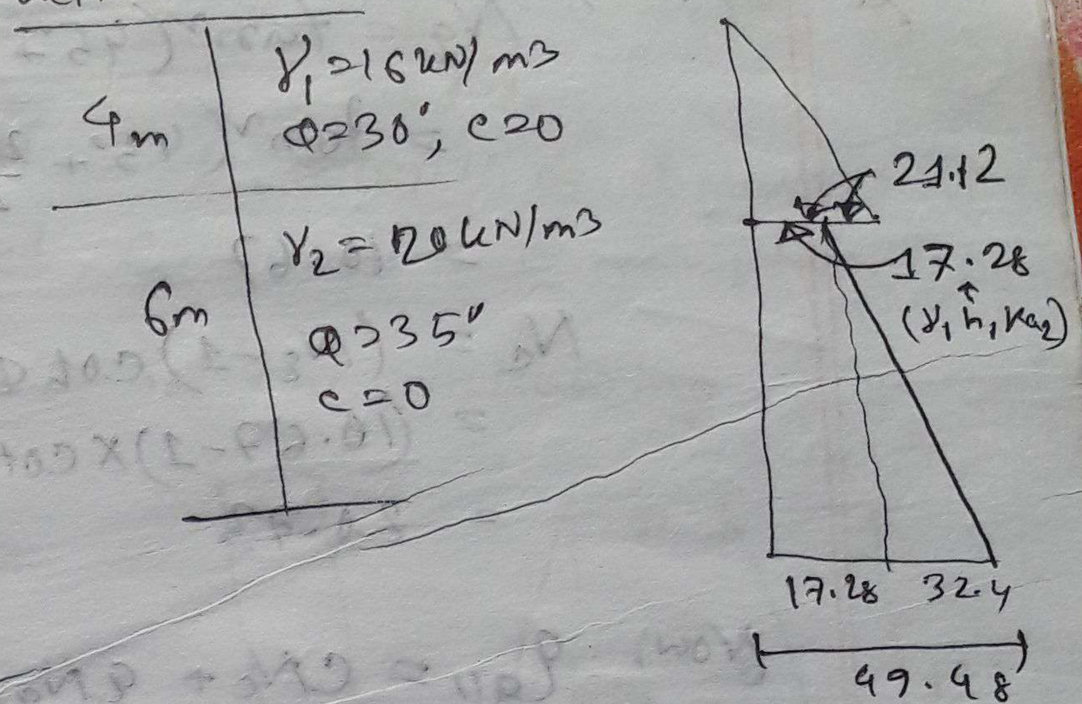
or, $0.1 = \frac{c}{1.8 \times 15 \times 2}$

or, $c = 5.4$ t/m

(অন্য চাইলে kg)

(240) Find Total thrust & point of action.

$K_{a_1} = 0.33$, $K_{a_2} = 0.27$



Total thrust = 243.12 kN/m

point of action,

$\bar{z}$ = নিচ থেকে লোডের লেভার / 243.12

= ☐ from bottom Ans

(241) Determine permeability of soil, which has effective size of particle 0.008 mm & co-efficient of curvature 0.5.

Soln We get $K = C D_{10(cm)}^2$

$= 100 \times (0.0008)^2$

$= 6.4 \times 10^{-5}$ cm/s. Ans

$C = 100$ (Allen hazen Const.)

$D_{10} = 0.008$ mm

$= 0.0008$ cm

(242) Determine the ultimate bearing capacity of strip footing 1.2m having depth of foundation 1m, if $c = 18 kN/m^2$, $\gamma = 18 kN/m^3$, $\phi = 35°$ $N_c = 57.7$, $N_q = 19.4$, $N_\gamma = 42.4$]

(i) General shear failure. (ii) Local shear failure.

(i) $q_{all} = cN_c + qN_q + \frac{1}{2}\gamma B N_\gamma$

$= 18 \times 57.5 + 18 \times 1 \times 14.4 + \frac{1}{2} \times 18 \times 1.2 \times 42.4$

$= 1755.7 kN/m^2$ Ans

~~(ii) $q_{all} = 12 \times 57.5 + 18 \times 1 \times 14.4 + \frac{1}{2}$~~

Local shear failure

$c' = \frac{2}{3} c = \frac{2}{3} \times 18 =$

~~$\phi = \frac{2}{3} \times 35° = \tan\phi = \frac{2}{3}$~~

$\phi' = \tan^{-1}\left(\frac{2}{3} \tan 3\right.$

$= 25°$

(ii) Now, $N_q = \tan^2(45° + \frac{\phi}{2}) e^{\pi \tan\phi}$

$= \tan^2(45° + \frac{25}{2}) e^{\pi \tan 25°}$

$= 10.67$

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

$= (10.67 - 1) \times \cot 25°$

$= 20.73$

$N_\gamma = 2(N_q + 1)\tan\phi$

$= 2(10.67 + 1)\tan 25°$

$\rightarrow 10.88$

Now, $q_{all} = cN_c + qN_q + \frac{1}{2}\gamma BN_\gamma$

$= 12 \times 20.73 + 18 \times 1 \times 10.67 + \frac{1}{2} \times 18 \times 1.2 \times 10.88$

$= 558 \text{ kN/m}^2$ (Ans)

[for Cohesive soil, $\phi = 0$, $N_q = 1$, $N_\gamma = 0$]

[Strip footing = ধারাবাহিক formula

Square " $= 1.3BCN_c + qN_q + 0.4\gamma BN_\gamma$

Circular " $= 1.3BCN_c + qN_q + 0.3\gamma BN_\gamma$]

[Effect of water table]

Case-1 $0 \le D_1 < B_f$

$q = \gamma D_1 + \gamma'(D_f - D_1)$ | $\gamma' = \gamma_{sat} - \gamma_w$

Case-2 $D_f \le d \le B$

$q = \gamma D_f$ (2nd term)

$\bar{\gamma} = \gamma' + \frac{d}{B}(\gamma - \gamma')$ (3rd term)

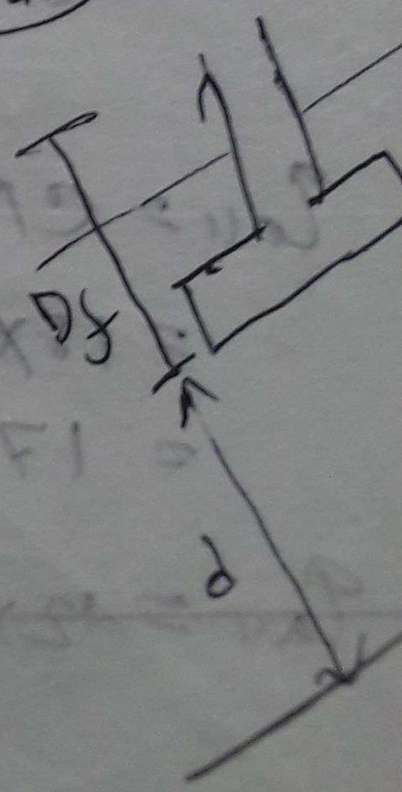
Case-3 $d \ge B$

যেখানে দূরে, কোন effect নাই।

স্বাভাবিক সূত্র—

142 th

159 page



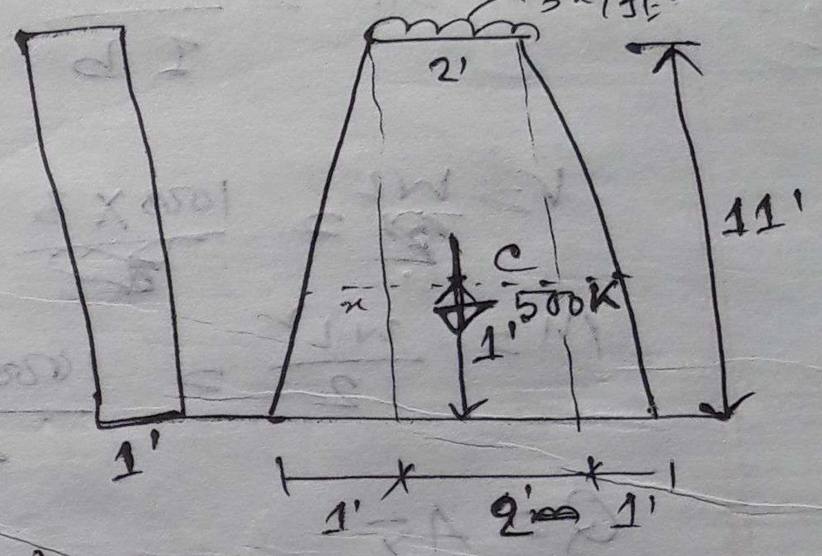
* $L_R = \frac{D_d}{D_i} = \frac{D_i - C_u}{D_i} \Rightarrow \frac{EC_i}{EC_d} = \frac{EC_i}{2EC_e}$

D_i = Depth of irrigation water, D_d = Depth of Drainage

EC_e = E.C of saturated extract, C_u = water consumption.

(243) find out the stress at point c in the following figure

DPP 14



Sol^n from Similar triangle,

$$\frac{x}{10} = \frac{1}{11} \therefore x = 0.909$$

Length of c = 2x.909 + 2'

= 3.82'

Cross-sectional area at c = 3.82 x 1

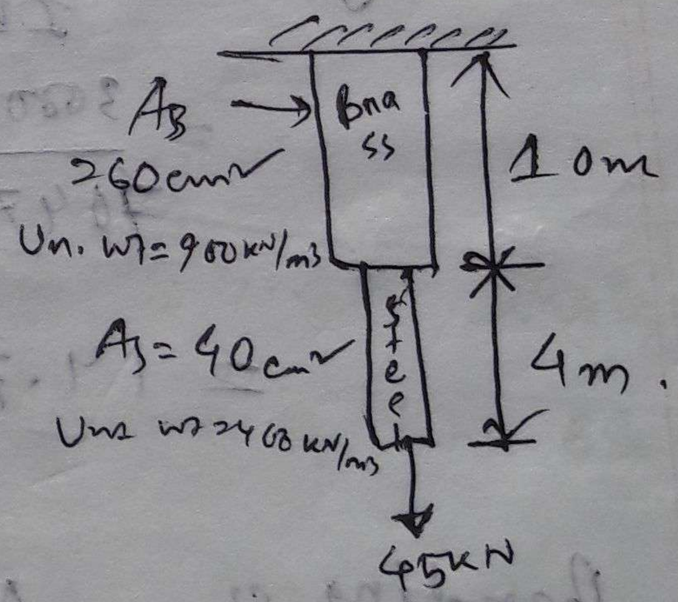
= 3.82 ft²

Total load at c = 3x(2x1) = 6K

$$\text{Stress, } S = \frac{P}{A} = \frac{500+6}{3.82} = 132.46 \text{ k/ft}^2$$

MIST

(244) Determine the shear stress of the following Structure.



Sol^n

Wt. of Bram = $\frac{60}{100} \times 900 \times 10$

= 54 kN

Wt. of steel = $\frac{40}{100} \times 900 \times 4 = 64$ kN

Shear Stress on Bram = $\frac{P}{A} = \frac{54+45}{60} = 1.65 \text{ kN/cm}^2$

Shear Stress on Steel = $\frac{P}{A} = \frac{64+45}{40} = 2.73 \text{ kN/cm}^2$

(246) A correct distance of 1000m was measured with a 25m was actually 24.9m long. Calculate the chain distance.

Soln

$$\frac{L}{L'} = \frac{D'}{D}$$

or, $D = \frac{L'D'}{L}$

$= \frac{24.9 \times 1000}{25}$

$= 996\text{m}$ (Ans)

$L' = 24.9\text{m}$
$L = 25\text{m}$
$D' = 1000\text{m}$ (measured)
$D = ?$

$D_{Ac} = \frac{L'}{L} \times D_m$

(247) previous RL of benchmark at two points is 108.78 & 114.95 respectively in a levelling by operation. Sum of back & fore bearing is 24.88 & 18.64 respectively. Calculate the closing error.

Soln

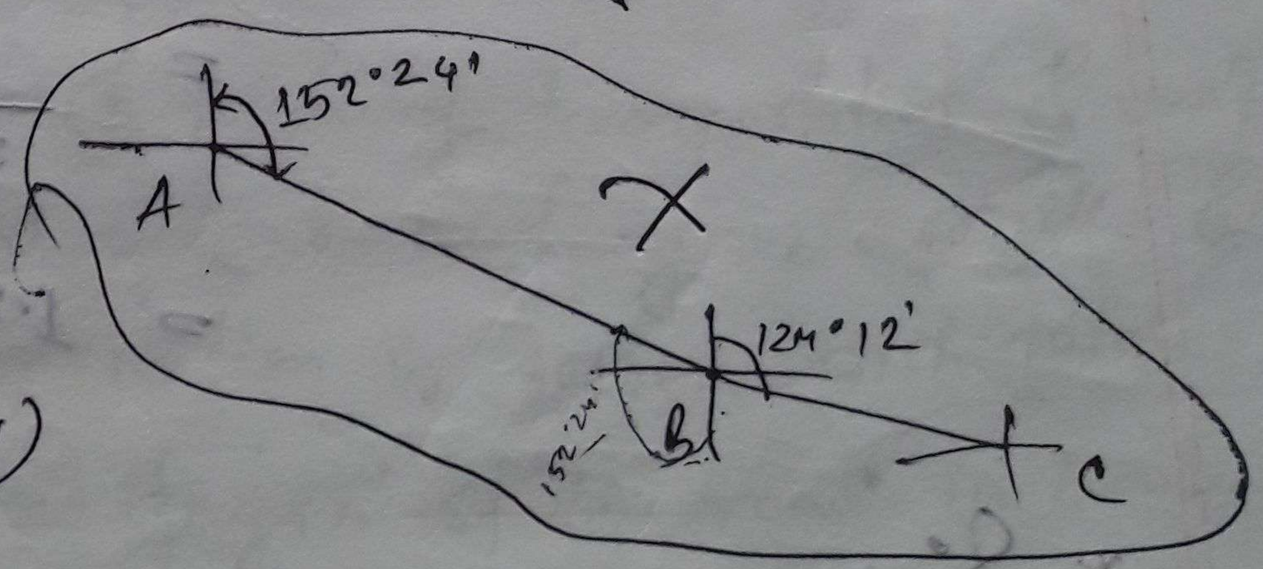
Difference of R.L = 114.95 − 108.78 = 6.17

Difference of Reading = 24.88 − 18.64 = 6.24

closing error = 6.24 − 6.17 = 0.07 (Ans)

(248) Bearing of line AB is 152°24' & the internal angle of ABC is 124°12'. Now determine the bearing of line BC.

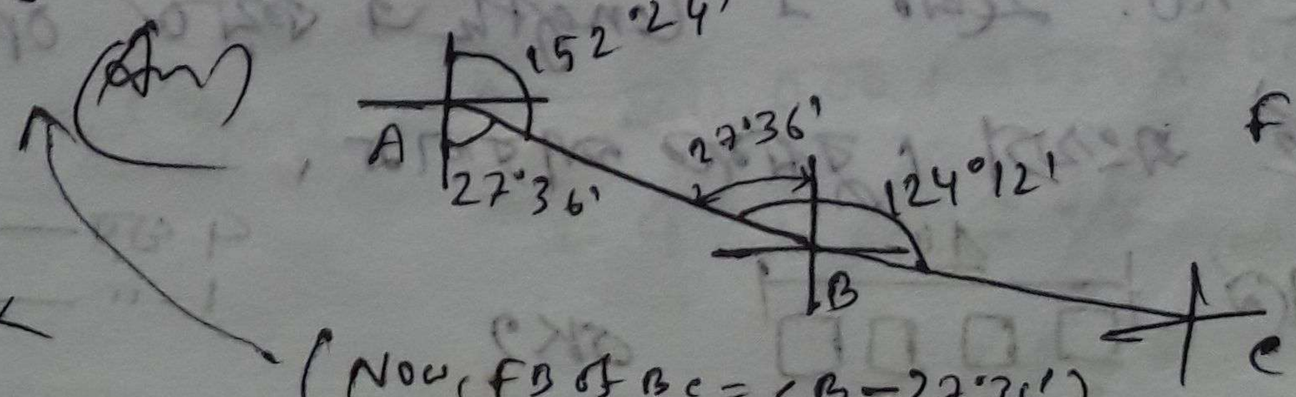
Soln



Bearing of line BC

$= 124°12' - (180° - 152°24')$

$= 96°36'$ (Ans)



F.B − BC (Ans)

OK

(Now, FB of BC = ∠B − 27°36')

= 4.2 tk per km per year

* Loss Angeles abrasion (LAA)

→ Machine dia - 28"

→ " length - 20"

→ Steel ball dia - 1.92" (48 mm) & 390 to 445gm e
(6 to 12 ball required).

→ Revolution per min. 30-33.

→ পরে 1.7mm sieve দিয়ে pan করানোর পর
ছাকতে হবে। (ভাংচুরের পর).

→ সর্বোচ্চ 500-1000 revolution দিতে হয়।

→ Bituminous surface dressing বা concrete
surface course এর জন্য abrasion value (<35) হতে

(25) Determine the abrasion value with the following data --

Given.

Original wt. of sample
$w_1 = 100g$

wt. retained, $w_2 = 40gm$

Paring through 1.7 mm
Sieve = 100 - 40 = 60gm

Abrasion value কত?

Sol^n

Ab. value = $\frac{w_1 - w_2}{w_1} \times 100$

$= \frac{60}{100} \times 100$

$= 60$

সর্বোচ্চ 60, WBM এর Sub-base
এ ব্যবহার করা যাবে।

(256) The value of direct run-off is ~~given in m³~~ 1000m³ Depth of rainfall is 4cm & runoff co-efficient is 0.5. find the area of catchment.

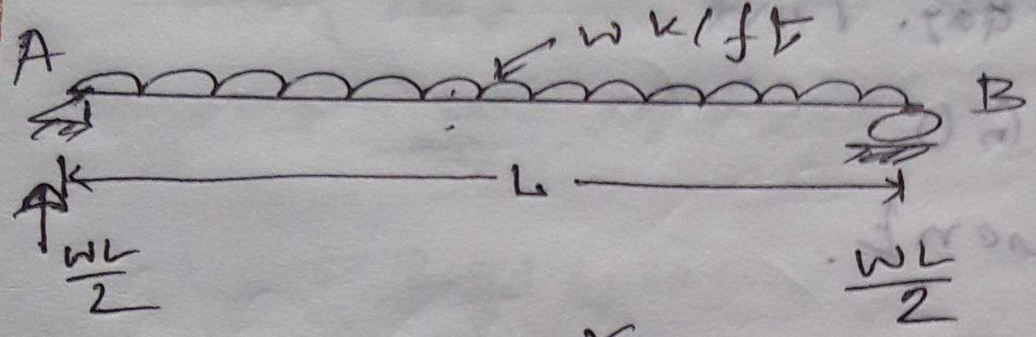
Soln

$V = CAh$ ——— hAC

$\therefore A = \frac{V}{Ch}$

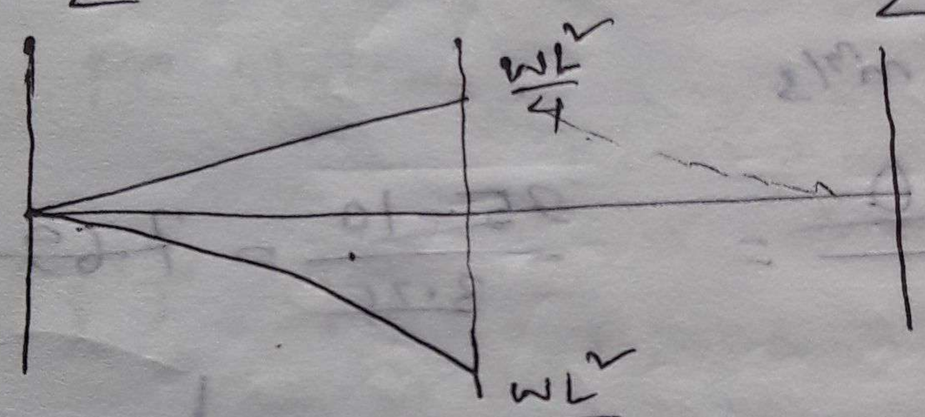
$= \frac{1000}{0.5 \times 0.04} = 500,000 m^2$ Ans

(257)



Find deflection. (BUET MSC-2014)

Area moment.



~~1/3~~ × WL/2 ×

$W \times \frac{L}{2} \times \frac{L}{4}$

$= \frac{WL^2}{8}$

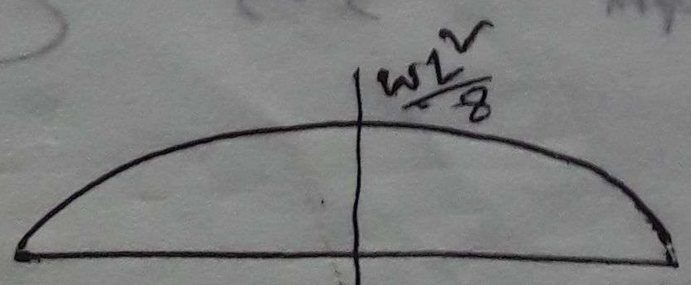
Consider from one side, as it is symmetric.

$\delta = \frac{\frac{1}{2} \times \frac{L}{2} \times \frac{WL^2}{4} \times \frac{2}{3} \cdot \frac{L}{2} - \frac{1}{3} \times \frac{L}{2} \times \frac{WL^2}{8} \times \frac{3}{4} \cdot \frac{L}{2}}{EI}$

$= \frac{\frac{WL^4}{48} - \frac{WL^4}{128}}{EI}$

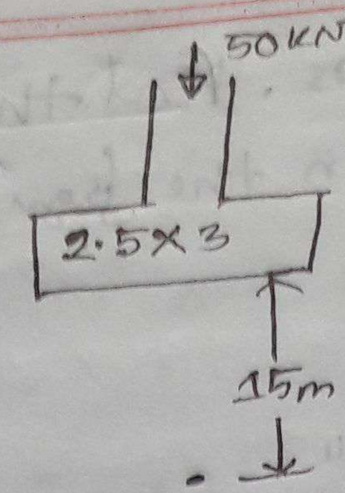
$= \frac{5WL^4}{384EI}$

Alternative আর Unit load method এভাবে 0 নং থেকে করা যাবে।



Deflection = $\frac{\frac{2}{3} \times \frac{L}{2} \times \frac{WL^2}{8} \times \frac{5}{8} \cdot \frac{L}{2}}{EI} = \frac{5WL^4}{384EI}$ Ans

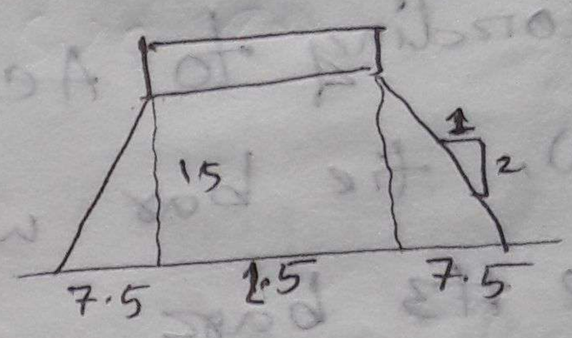
(259)



find the stress increase at a depth of 15m below the base of the footing.

Soln

from Approximate formula of BM Das book (228, 4th ed)



Stress increase at lower depth

$$= \frac{P}{(L+Z)(B+Z)} = \frac{50}{(2.5+15)(3+15)} = 159 \text{ N/m}^2 \quad \text{(Ans)}$$

N.B :- একটুকরা নাও 2টা পাবে।

(260) find Shrinkage limit →

Initial volume at saturated, $V_1 = 24.6 \text{ cm}^3$

final " " dry state, $V_2 = 15.9 \text{ cm}^3$

Initial mass at saturated, $m_1 = 44 \text{ gm}$

final mass dry state, $m_2 = 30.1 \text{ gm}$.

Soln

$$S.L = \left(\frac{M_1 - M_2}{M_2}\right) \times 100 - \left(\frac{V_1 - V_2}{M_2}\right) \times \rho_w \times 100.$$

$$= \frac{44 - 30.1}{30.1} \times 100 - \left(\frac{24.6 - 15.9}{30.1}\right) \times 1 \times 100$$

$$= 17.28\% \quad \text{(Ans)}$$

* $L.I. = \frac{\omega - PL}{LL - PL}$, * $C.I. = \frac{L.L - \omega}{LL - PI}$

Shrinkage

$S.R = \frac{M_2}{V_f}$

$G_s = \frac{1}{\frac{1}{SR} - \frac{S}{1}}$

=

(269) $\boxed{\text{Input power} = \frac{QH}{\eta \times 76}}$ (kW)

যার্ড় থাকে problem ডেট্রে--

Determine the input power of an 75% efficient pump to lift 40 lts of water to a height of 12m through a 160mm dia. pipe. The total head loss in the pipe is $13.\frac{v^2}{2g}$.

(BWDB-14)

$v = \frac{Q}{A}$

$A = (\pi \times .16^2)/4$

$= 0.02 m^2$

$v = \frac{40 \times 10^{-3}}{0.02}$

$= 2 m/s$

$h_f = 13. \frac{v^2}{2g}$ [$\frac{v^2}{2g}$ can be added for Safety]

$= 13 \times \frac{2^2}{2 \times 9.81}$

$= 2.65$

$H = 12 + 2.65$

$= 14.65 m$

$\text{power} = \frac{40 \times 14.65}{.75 \times 76}$

$= 10.28 HP$

(kgpm)

$\frac{QH}{3960}$ (HP)

যার্ড় থাকে 2টে ধারণা

Check it!! ok?

(270) A coal power plant uses 100 ton of coal which contain 15% of sulfer. Determine the sulfer di-oxide emission. (DESCO-16)

Soln $S + O_2 \longrightarrow SO_2$ (SI)

$32 \quad 16 \times 2 \longrightarrow 32 + 32 = 64$

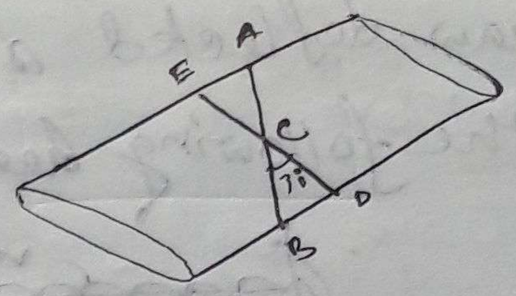
Let 10% of sulfer is emitted as SO_2.

Emission as $SO_2 = (100 \times 1000) \times \frac{15}{100} \times \frac{10}{100} \times 1000$

$= 1.5 \times 10^6$ g/sec —?

Emission rate $= 1.5 \times \frac{64}{32} = 3$ SO_2/sec.

** 236 নং Soln.



pipe dia = 4'

CD = CE = 2'

$\cos 30^\circ = \frac{CD}{BC}$

$\therefore BC = \frac{2}{\cos 30^\circ} = 2.31' = AC$

$P_c = 5$ psi (given)

(Now, $P_c = P_A + \gamma \cdot AC$

$\therefore P_A = P_c - \gamma \cdot AC$.

$= 5 \times 12^2 - 62.4 \times 2.31$

$= 575.856$ psf

$= 4$ psi (Ans)

$P_B = P_c + \gamma BC$

$= 5 \times 12^2 + 62 * 2.31$

$= 863.22$ psf

$= 6$ psi (Ans)

(271) for 100 cumec RCC work, 1% rod is needed. find the quantity of rod.

Ans: Total R.C.C work = 100 cumec

$Rod = 100 \times \frac{1}{100} = 1 m^3$.

Amount of rod = 1×7850 (Unit wt. of steel = 7850 kg/m³)

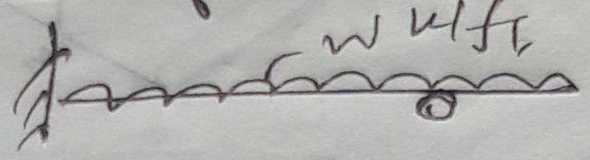
$= 7850$ kg Ans

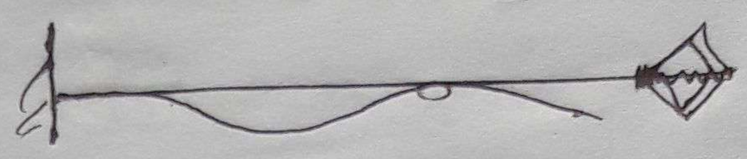
অর্থাৎ 7.850 ton.

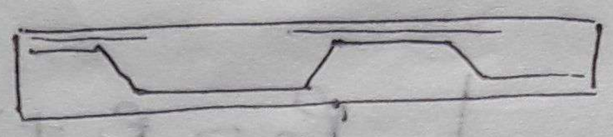
[এই অংশগুলোতে wt. কে dry হবে 1.5 বলেছে। কারন কাজ করার সময় ভেজানো হয়। But আমরা তখন তার ওজন পরিমাপ করেই আমরা ধরে নিব।]

এখানে 1.5 গুন হওয়ার কোন। কারন এটা আলাদা R.C.C work এর সাথে relation. [আমার মত]

(272) Draw deflected shape & show reinforcement of the following beam. (WASA)



D.S 

R.D 

(273) Void ratio 0.65 & volume of soil is 0.3 ft³. Determine the amount of volume of void & volume of solid. (WASA)

Soln:

$e = 0.65, \quad V = 0.3\ ft^3$

Now, $e = \frac{V_v}{V_s}$ or, $V_v = 0.65 V_s$

$V = V_v + V_s$

$0.3 = 0.65 V_s + V_s$

$\therefore V_s (1.65) = 0.3$

$\therefore V_s = 0.18\ ft^3$ Ans

$n = \frac{e}{1+e} = 0.39$. $n = \frac{V_v}{V} \therefore V = 0.3$

$e = \frac{V_v}{V_s} \therefore V_s = \frac{V_v}{e} = 0.18$ (Ans)

& $V_v = 0.65 \times 0.18$

$= 0.117\ ft^3$ Ans

(274) four vehicles are travelling at constant speeds between section X & Y (280 m) apart. An observer at point X observes the four vehicles passing point X during a period of 15 s. The speeds of the vehicles are 88, 80, 90 & 72 kmph respectively. Calculate the flow, density, time mean speed & space mean speed of the vehicle.

Solⁿ flow = $\frac{N \times 3600}{15} = \frac{4 \times 3600}{15} = 960$ vehicle/hr.

Density, $K = \frac{N}{L} = \frac{4 \times 1000}{280} = 14.2$ veh/km

[280m → 4 veh
1 m → $\frac{4}{280}$ x
∴ 1000 m → $\frac{4 \times 1000}{280}$]

TMS,

$V_t = \frac{\sum V}{N} = \frac{72+90+80+88}{4} = 82.5$ km/hr.

SMS, $V_s = \frac{\text{Total length}}{\sum t}$

$= \frac{4 \times .28}{\frac{.28}{72} + \frac{.28}{90} + \frac{.28}{80} + \frac{.28}{88}}$

$= 81.86$ km/hr.

// 1st class brick = 10.7 (N/mm²) ⟶ 1550 psi
2nd // // = 7 (N/mm²) ⟶ 1000 psi
3rd // // = 3.5 (N/mm²) ⟶ 500 psi //

(276) A RSF bed has an area of 366 sq.ft. If washing for 5 min at the rate of 24" per minute is contemplated. How much wash water will be required.

Soln

Wash water required = Area × Washing Rate × time

$= 366 \times \frac{24}{12} \times 5$

$= 3355$ cft (Ans)

(277) Find the total & effective pressure of a swimming pool having 5m depth of water level. (PDB-2016)

Soln

Total pressure = $5 \times 9.81 = 49.05$ kN/m²

Effective " = $5 \times 9.81 - 5 \times 9.81 = 0$ kN/m² (Ans)

(278) Two close wheel imparted 20.5 kN load each ~~other~~ on the road. The applied pressure is 0.7 MPa. If the two wheels are replaced by a single wheel of same property. Find the dia of single wheel. (PDB-2016)

Soln

$P = \frac{F}{A}$

$\therefore A = \frac{F}{P} = \frac{2 \times 20.5}{0.7 \times 10^3} = 0.029$ m² (0.06 m²)

~~0.7 × 10³~~

$\therefore d = \sqrt{\frac{4 \times 0.029}{\pi}} = 0.192$ m = 19.2 cm

= 0.276 = 27.6 cm

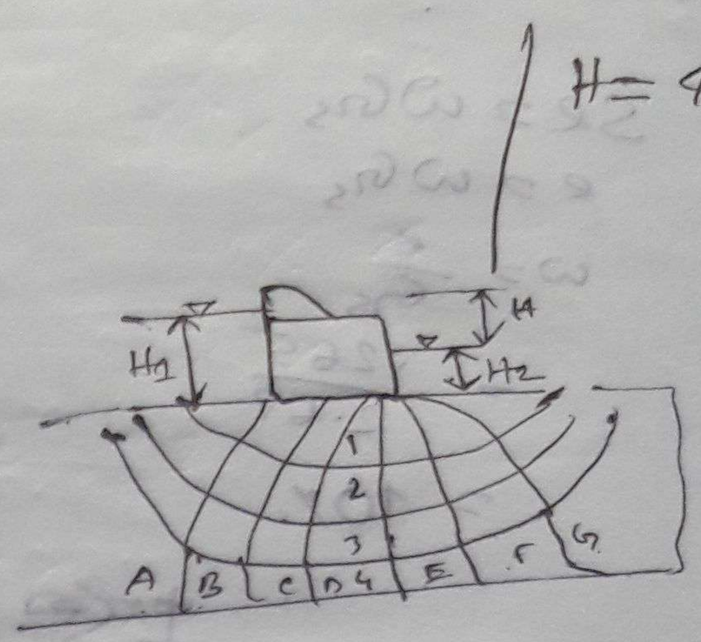
(291) A seepage flow net has 50m height and 2m free baand. the number of head drop is 24. find out the discharge. The co-efficient of permeability is 300 m/day.

Soln We know

$$q = KH/N_d$$

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

$$= 600 \text{ m}^3/\text{day/m}.$$



$N_f = 4$ = flow line
$N_d = 7$.

(299)

A সাধারণকাজের জন্য ও কনক্রিট F.M problems:-

(292) #30 retain 100%. find F.M of fine aggregate.

Sieve	% Retain	Cum. Retain
#30	100	100
#50	-	100
#100	-	100
		300

$$F.M = \frac{300}{100} = 3 \text{ (Ans)}$$

(293) #30, #50, #80, #100, retains 25% each. find F.M. of aggregates.

Sieve	% retain	Cum % retain
#30	25%	25
#50	25%	50
~~#80~~ #100	25%	75 (This is not 57. Sieve)
#100	25%	100
		175

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

Find F.M. of coarse agg. & fine agg.

(299)

Sieve no (mm)	Wt retain	% Wt retain	Cum. retain
3/4 19	175	35	35
x 12.5	125	25	60 x
#4 4.75	100	20	80
#8 2.36	50	10	90
#16 1.18	20	04	94
#30 0.6	10	02	96
#50 0.3	10	02	98
#100 0.15	4	0.8	98.8 =
#200 0.075	4	0.8	99.6
pan	2	0.4	100
	500		Total → 591.8

Only F.M of ~~coarse~~ agg. $= \frac{591.8}{100} = 5.91$. (Normal FM)

Again. (fine)

Sieve	Cum. Retain
#4, 4.75	80 → 80
#8 2.36	10 — 10
#16 1.18	04 — 14
#30 0.6	02 — 16
#50 0.3	02 — 18
#100 0.15	0.8 — 18.8
	Total = 176.8

$$F.M = \frac{176.8}{100}$$

(fine)

$= 0.768$

(Ans)

(आहेत coarse).

↓

F.M of coarse agg.

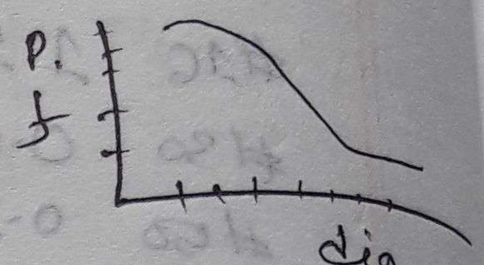
Sieve (mm)	Cum. retain
19	35
12.5	60 x
9.75	80
4.75	80
2.36	80+0 — 80
1.18	80
0.60	80
0.30	80
0.15	80
	515

F.M = 5.15 Ans

(295) #30, #80 & #100 retains 25% each. Find F.M.

Sieve	Wt. retain	Cum. wt. reta	Percent finer (100 - Cum.)
#30	25%	25%	75%
#50	—	25%	75%
#80	25%	50%	50%
#100	25%	75%	25%
	Total. 125		

$$F.M = \frac{125}{100} = 1.25$$

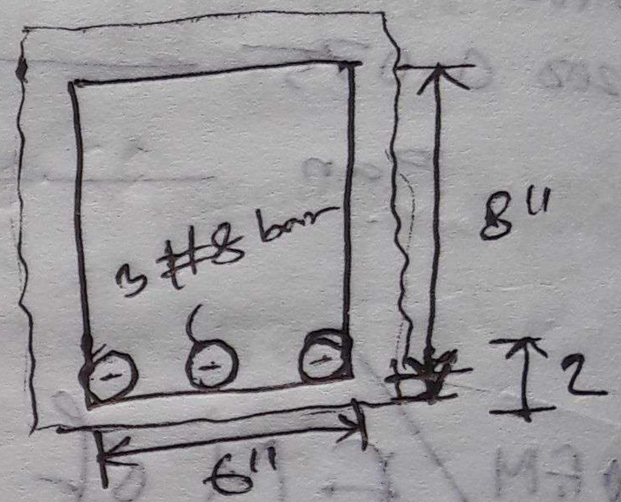


(296) $A_s = 3 \times .79 = 2.37 \text{ in}^2$

$$\rho = \frac{A_s}{bd} = \frac{2.37}{6 \times 8} = 0.049$$

$$\rho_{max} = 0.75 \times .85 \times .85 \times \frac{3}{60} \times \frac{0.003}{0.003 + \frac{60}{29 \times 10^3}}$$

$$= 0.016$$



$d = 8 - 2 = 6"$

$\rho_{provided} > \rho_{max}$ (Over reinforced).

(No need)

$$m = \frac{f_c \times f_s}{0.85 \times 3 \times \beta_1} = \frac{0.003 \times 29 \times 10^3}{0.85 \times .85 \times 3} = 40.14$$

$$K_u = -\frac{\rho m}{2} + \sqrt{\left(\frac{\rho m}{2}\right)^2 + \rho m}$$

$$= \frac{-0.049 \times 40.14}{2} + \sqrt{\left(\frac{-0.049 \times 40.14}{2}\right)^2 + 0.85 \times 40.14}$$

$$= 0.729$$

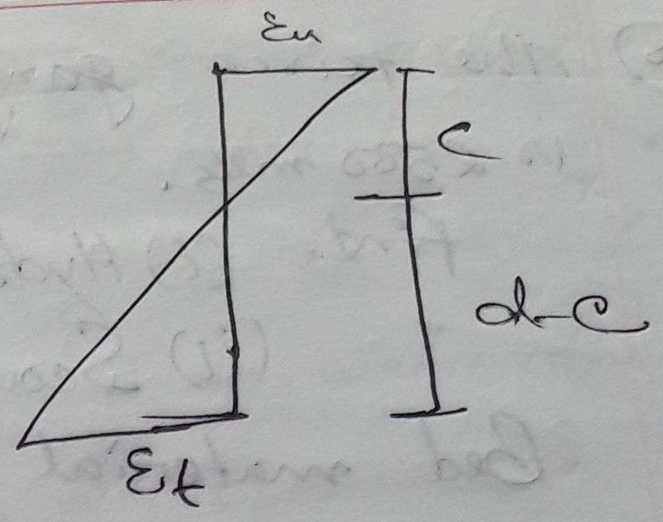
~~$c = \beta_1 c = 0.85 X$~~

$c = K_u d = 0.729 \times 6 = 4.374$

$a = \beta_1 c$

$= 0.85 \times 4.374$

$= 3.72$



$\varepsilon_t = \frac{d-c}{c} \times \varepsilon_u$

$= \frac{6-4.374}{4.374} \times 0.003$

$= 0.001$ (compression controlled)

$f_y' = \varepsilon_u E_s \times \frac{d-c}{c}$

$= 0.003 \times 29 \times 10^3 \times \frac{6-4.374}{4.374}$

$= 32.34$ ksi

$\phi = 0.483 + 83.3\varepsilon_t = 0.56$

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

$= 0.56 \times 2.37 \times 32.34 (6 - \frac{3.72}{2})$

$= 177.69$ kip-in (Ans)

(297) Two lane two way highway street having ADT 4000. If the commercial vehicle is 45% & loads 27k, then calculate the ESAL for commercial vehicle in one direction. (ERL).

KN 2(a) 80 (18)

Soln

$ESAL = \frac{4000 \times .45}{2} \times \left(\frac{27}{18}\right)^4$

$= 4556.25$

(298) The river ganga flows bank full of water is 2500 m³/s.

Find. (i) Hydraulic geometry.

(ii) Scour depth.

Bed material size is 0.15mm.

Soln $Q = 2500\ m^3/s$

$d_{50} = 0.15mm$

Silt factor, $f = 1.76\sqrt{d_{50}}$

$= 1.76 * \sqrt{.15} = 0.68$

(i) Hydraulic geometry,

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

$$= 1.42\ m/s$$

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

$$= \frac{5}{2} \times \frac{1.42^2}{0.68}$$

$$= 7.41m$$

(ii) Scour depth.

$$d = 0.473\left(\frac{Q}{f}\right)^{1/3}$$

$$= 0.473 \times \left(\frac{2500}{0.68}\right)^{1/3}$$

$$= 7.3m$$

(299) A rapid sand filter operating at 2 gpm per square feet needs to washing after 24 hr of operation. The filter has an area of 350 Sq. ft. and needs ~~water~~ washing at the rate of 15 gpm per square ft. for 5' min. What percent of water that is filtered will be required to wash water?

Soln

Obtained filter water = $350 \times 2 \times 24 \times 60$
$= 1,00,800$ gallon

Water required for washing $= 15 \times 350 \times 5$
$= 26,250$

percent of water $= \frac{26,250}{100800}$
$= 2.6\%$ (Ans)

(300) The dry mass of a sample of aggregate is 1982 gm. The mass in a saturated surface dry condition is 2006.7 g. The net volume of aggregate is 734.4 cm^3. Find apparent Sp. gravity, bulk sp. gravity & percentage absorption.

(মাঝের ছিদ্রসহ block) (PGCB) V.V.I

Soln Mass of absorbed water = 2006.7 − 1982 = 24.7 g.

Volume of absorbed water $= \frac{24.7 g}{1 g/cm^3} = 24.7 cm^3$.

Bulk volume = 734.3 + 24.7 = 759.1 cm^3.

~~Bulk sp. gravity~~

Dry mass of agg. = 734 ~~gm~~ cm³ × 1 gm/cm³
= 734 gm

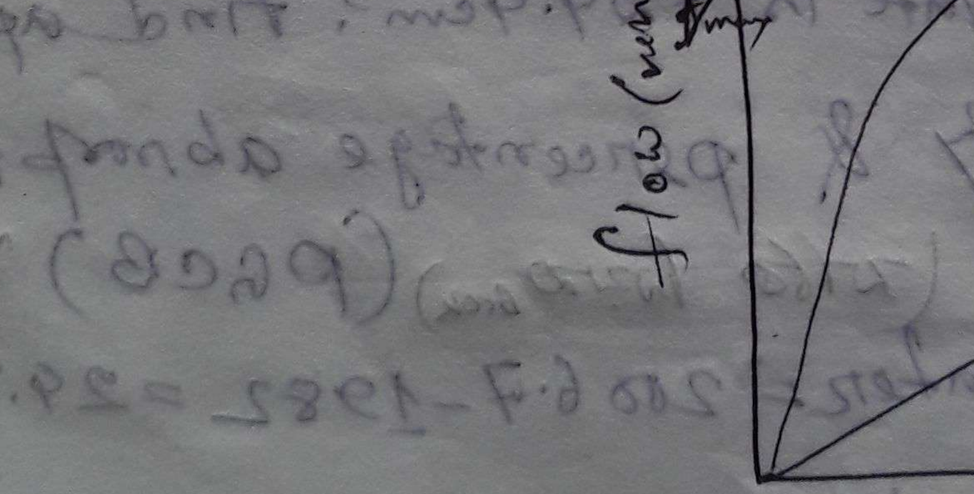
Apparent sp. gravity = $\frac{1982}{734.4}$ = 2.699 Ans

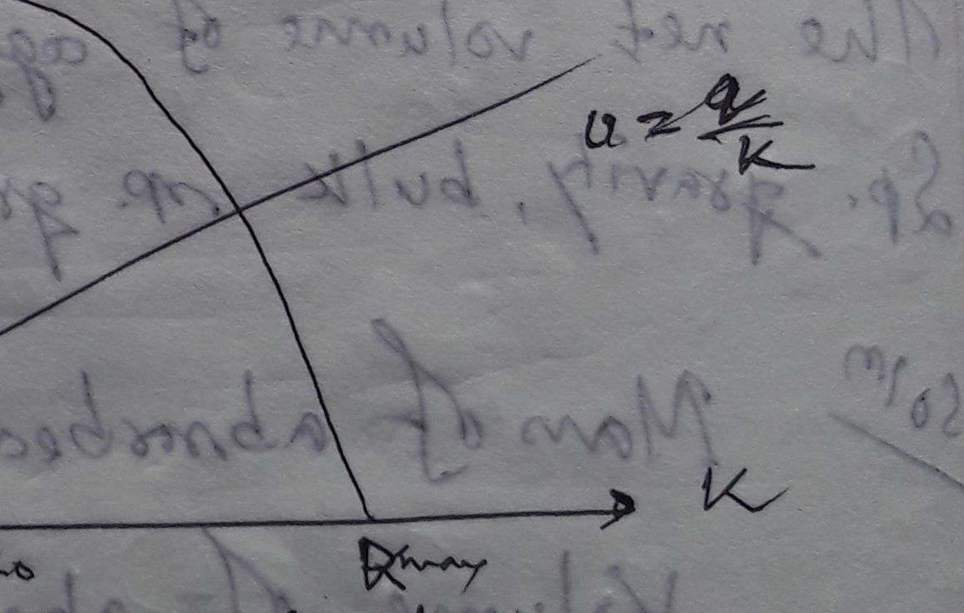
Bulk Sp. gravity = $\frac{1982}{759.1}$ = 2.611 Ans

percentage absorption = $\frac{2006.7 - 1982}{1982} \times 100$

= 1.25% Ans

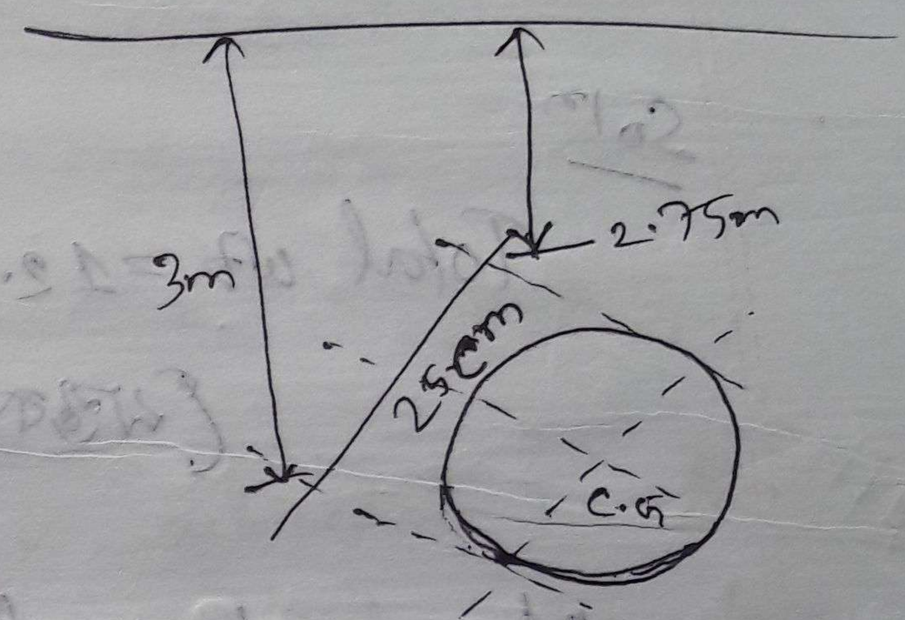
Speed-flow-density relationship





3.01 Find the resultant force on one side of a 25cm diameter vertical circular plate standing at the bottom of 3m pool of water. Density of water = 1000 kg/m³, g = 9.81. (3 GFL)

Soln



$$\bar{x} = \frac{3.0 + 2.875}{2}$$

$$= 2.875 \text{ m}$$

We know,

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

$$= 9810 \times \pi \times \frac{.25^2}{4} \times 2.875$$

$$= 1384 \text{ N}$$

$$= 1.384 \text{ kN (Ans)}$$

$$\bar{h} = 3 - \frac{.25}{2}$$

$$= 2.875$$

$$Q = \gamma A \bar{h}$$

$$= 9.81 \times \frac{\pi \times .25^2}{4} \times 2.875$$

$$= 1.384 \text{ kN. Ans}$$

3 - 25/100 = 2.75

302 Standard rail length of BG track is 12.80m. If 45kg rail is used in a particular BG track in Rajshahi. What is the total wt. of each individual rail girder? What max. axle load can be safely imposed on that track. (SGFL'17)

Soln

Total wt = 12.8 × 45 = 576 kg

(যেহেতু 45kg rail বলতে 45kg/m বুঝায়
উহাদের ভাষায়)

Max. axle load = 560 × Sectional area in lb/yrd or kg/m.

= 560 × 45

= 25,200 kg

= 25.2 ton. (Ans)

Determine the earth pressure co-eff. at point

2m $\gamma = 17.5 kN/m^3$

$= 32.55''$

$\simeq 33''$ (Ans)

(308) Calculate coefficient of volume compressibility for a settlement of 3cm, depth of 20m & change of pressure is 120 kN/m². (PDB-16)

Soln. We know

$$S = m_v \cdot \Delta p \cdot h$$

$$\therefore m_v = \frac{S}{\Delta p \cdot h}$$

$$= \frac{0.03}{120 \times 20}$$

$$= 1.25 \times 10^{-5} \text{ m}^2/\text{kN}$$

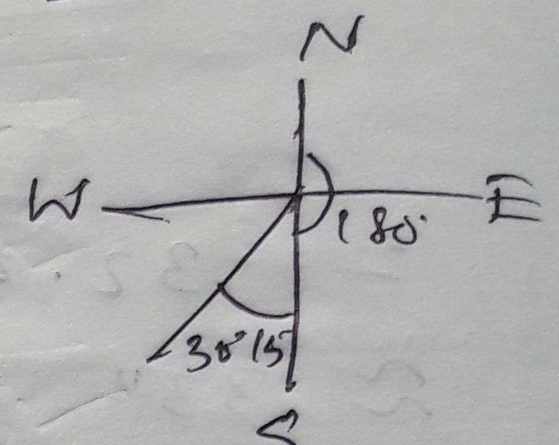
(Ans)

(309) The M.B. of a line is S30°15'W. Find T.B. If declination is 10°15'E.

Soln.

W.C.B = 180° + 30°15'

= 210°15'

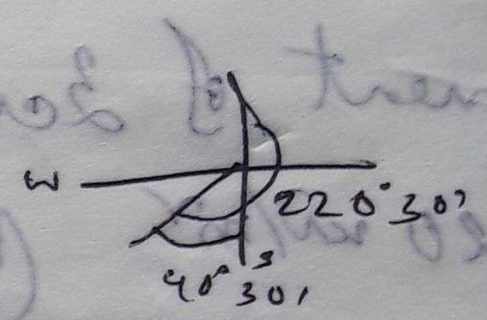


As declination is (E). So it is (+).

T.B = M.B. + Dec.

= 210°15' + 10°15'

= 220°30'



In the form of RB = (220°30' − 180°).

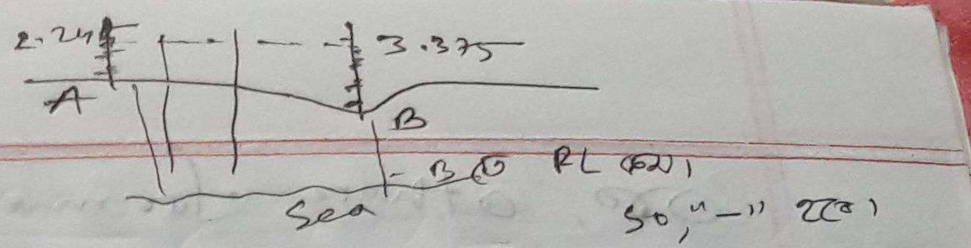
= S40°30'W

(310) In an operation of levelling, when staff is near at A, A & B was 2.245 & 2.375. When staff is near at B, A & B was 1.955 & 3.055. find their true difference. If R.L of A is 125.550. What is the R.L of B? (Am)

(PGCL '17), (BCEC '17)

Soln

P.T.O



First Setting

Difference = 3.375 − 2.245

= 1.130 m (fall from A to B)

2nd Setting

Difference = (3.055 − 1.955)

= 1.100 m (fall from A to B)

True difference = $\frac{1.130 + 1.1}{2}$ = 1.115

Actual R.L of B = (125.550 − 1.115) [As falling]

= 124.435m

(31) Dimensionless critical shear 0.045 N/m². Slope = 0.0001

Sediment Size = 0.2mm.

find out (i) Critical shear

(ii) incipient depth

let

Relative den. = 2.65

(BWDB '16)

Soln

Non-dimensional shear stress = $\frac{\tau_c}{(\gamma_s - \gamma_w)d}$

$0.045 = \frac{\tau_c}{9810 \times (2.65 - 1) \times \frac{0.2}{1000}}$

$\therefore \tau_c = 1.46$ N/m²

ooo, other formula can be used —

Critical shear

$$\tau_c = 0.155 + \frac{0.409\, d_{mm}^2}{\sqrt{(1 + 0.177 d_{mm})}}$$

$$= 0.155 + \frac{0.409 \times 0.2^2}{\sqrt{1 + 0.177 \times 0.2^2}}$$

$$= 0.171 \text{ N/m}^2 \quad (\text{Ans})$$

Again, Incipient depth

$$\tau_c = \gamma' D S_0$$

$$\therefore D = \frac{\tau_c}{\gamma' S_0} = \frac{0.171}{9790 \times 0.0001}$$

$$= 0.175 \text{ m}$$

RCC pile of length 50' with dia

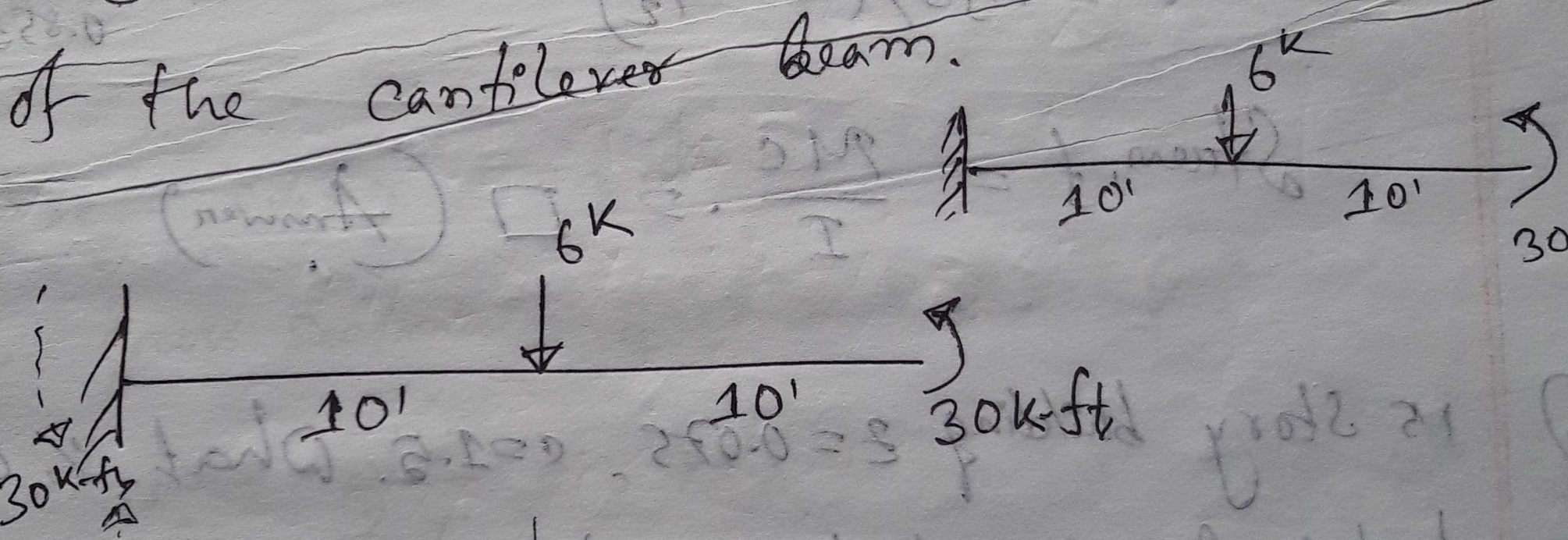
* Explain "Hardy principle for sanitary plumbing fixture"

Soln (i) The flow entering a junction must be equal to the leaving it.

(ii) The algebric sum of the pressure drops (head loss) around any close loop must be zero.

(31) Draw BMD & show the location of tensile reinforcement of the cantilever beam.

Soln



(322) Data obtained from waste water, $BOD_5 = 460 mg/l$ $K = 0.29 day^{-1}$. $NH_3 = 80 mg/l$. Estimate the total quantity of DO (mg/l) that will be required to complete stabilization of this waste water.

Soln We know,

$$Y_5 = L_0(1 - e^{-kt})$$

$$\therefore 400 = L_0(1 - e^{-0.29 \times 5})$$

$$\therefore L_0 = 522.58 mg/l.$$

Now, $NBOD = 4.83 \times NH_3 = 386.4 mg/l.$

$$\therefore DO = L_0 + NBOD$$

$$= 522.58 + 386.4$$

$$= 908.98 mg/l.$$

(323) If 10% feed is added to a sample & the BOD observed is determined to be 285 mg/l & the BOD of the pure feed is to be found 150 mg/l. Find BOD of the sample. (WASA)

Soln

$$BOD = \frac{285 - 0.1 \times 150}{0.9}$$

$$= 300 mg/l \text{ (Ans)}$$

(324) A Simply supported beam has a rectangular section $b = 12"$, $d = 21.5"$, & $h = 24"$. And reinforced with 4-#8 bars. Check if the section is adequate for

(a) $V_u = 12k$, (b) $V_u = 24k$ (c) $V_u = 54k$ etc.

Soln

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

$$\Rightarrow 2 \times .75 \times \sqrt{4000} \times 12 \times 21.5$$

$$= 24.48k$$

$$\frac{1}{2}\phi V_c = 12.24k.$$

(a) $V_u = 12k < \frac{1}{2}\phi V_c$.

No need of Shear reinforcement.

(b) $V_u = 24k > \frac{1}{2}\phi V_c$ & less than ϕV_c.

Tie is required. (You know how to design) ok?

(325) A wide channel is 6m & laid on a slope 0.25%. Calculate the shear Stress & shear velocity.

Soln

Shear Stress, $\tau = wRS = 9.81 \times 6 \times \frac{.25}{100} = 0.147 \text{ kN/m}^2$

[R=D, wide channel]

Shear velocity, $v = \sqrt{wRS} = \sqrt{9.81 \times 6 \times \frac{.25}{100}} = 0.384$

(373) A mat foundation 30m × 40m total live load & dead load 200 MN. The place over a layer of soft clay. The unit wt. of clay is 18.75 kN/m³. Find the depth of foundation, Df for a fully compensated foundation.

Soln We know,

$$q = \frac{Q}{A} - \gamma D_f$$

$$\& \quad \frac{Q}{A} = \gamma D_f$$

$$\therefore D_f = \frac{Q}{A\gamma}$$

$$= \frac{200 \times 10^3}{1200 \times 18.75}$$

$$= 8.9\,m \quad (Ans)$$

(374) The radius of a tyre imprint is approximate to a circle of 150mm. What is the maximum loading duration, if the speed is 70 Km/hr. (RPGCL-17)

Soln

$$\text{Duration} = \frac{2\pi \cdot 150}{19.44}$$

$$= 0.015\,s \quad (Ans)$$

$$70 \times \frac{5}{18}$$

$$= 19.44\,m/s$$

(33) clay Sample has atterberg limits - LL = 60, PL = 40, SL = 25. The Sample Shrinks from 15 cm³ to 9.57 cm³. When the moisture content is decreased from LL to SL. What is the dry Specific gravity of the clay sample? (GTCL, 2018)

Soln

$$SR = \frac{\text{Volume change as \% of dry volume}}{\text{change in moisture content.}}$$

$$= \frac{\frac{15-9.57}{9.57} \times 100}{LL - SL} = \frac{57.8947}{60-25}$$

$$= 1.62$$

Now,

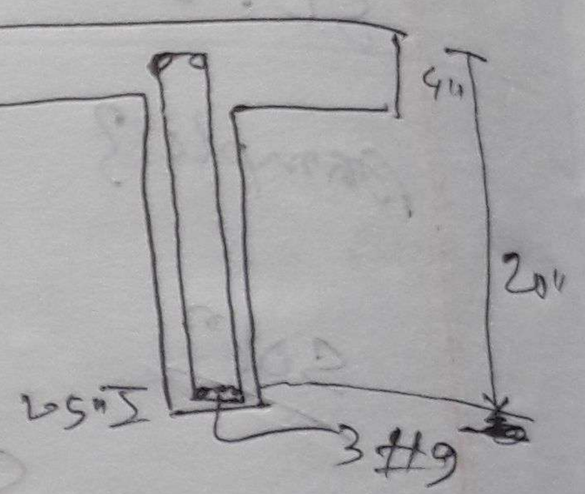
$$G_s = \frac{1}{\frac{1}{SR} - \frac{SL}{100}}$$

$$= \frac{1}{\frac{1}{1.62} - \frac{25}{100}}$$

$$= 2.72$$ Ans.

(378) A reinforced concrete T-beam has a cross-section in the positive region of span shown. Determine the positive moment capacity if $f_y = 60,000$ & $f_c' = 3000 psi$

GTCL



Soln Here, $h_f = 4"$

$$a = \frac{A_s f_y}{0.85 f_c' b = 30"}$$

$$= 2.35 < h_f$$

So, rectangular beam confirmed

$$\phi M_u = 0.9 \times A_s f_y (d - a/2)$$

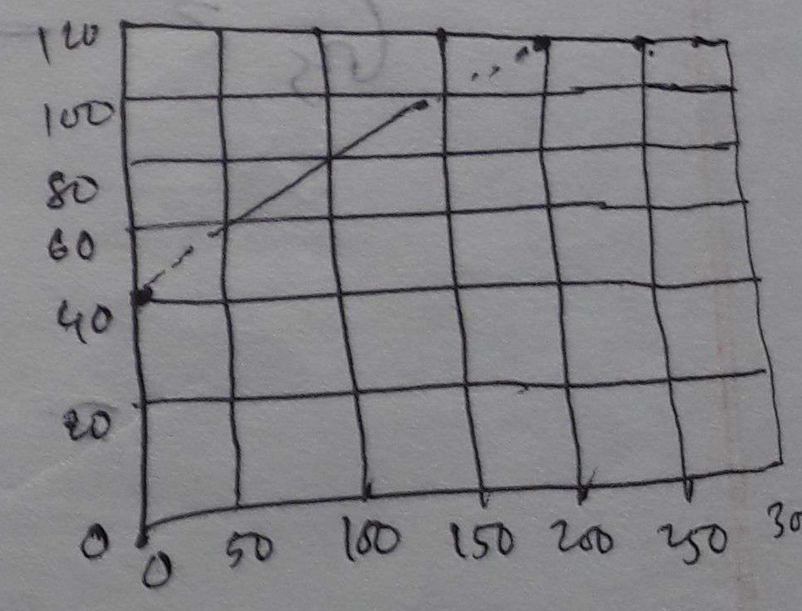
$$= 0.9 \times 3 \times 60 \times (20 - \frac{2.35}{2})$$

$$= 3049.65 \text{ k.in} \quad (\text{Ans})$$

(379) find c & φ.

Extending beyond, c = 40

From figure, τ = 120, σ = 200.



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

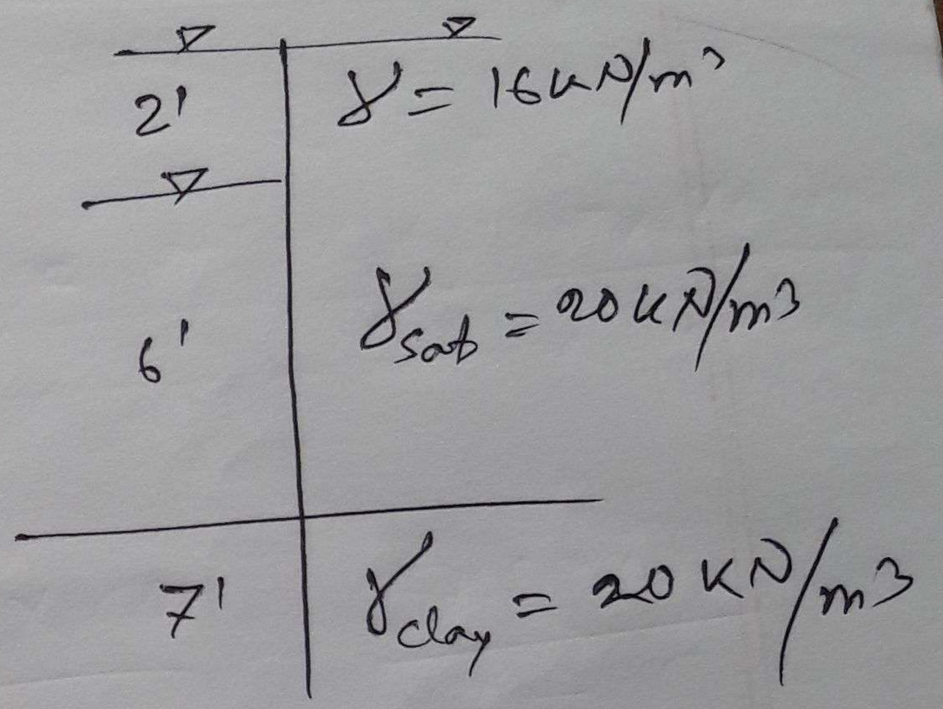
$$120 = 40 + 200 \times \tan\varphi$$

$$\varphi = 4.8$$

(380)

(380) A Sand layer has 8' depth. w.t. at 2' depth below GL. The Sand layer is overlaying a clay layer of large depth. find the effective pressure at 15m depth. Also total stress.

$\gamma_{moist} = 16 kN/m^3$, $\gamma_{sat(sand)} = 20 kN/m^3$ $\gamma_{sat(clay)} = 20 kN/m^3$ (GTCL)



Soln

$\sigma_{total} = 2 \times 16 + 6(20 - 9.81) + 7(20 - 9.81)$

$= 164.47 kN/m^2$ (Ans)

$\sigma_{water} = (6+7) \times (9.8$

$= 127.53$

$\sigma_{eff} = 164.47 - 127.53$

$= 39.94 kN/m^3$ (Ans)

প্রোগতে Buet যাব।

Bank ও BCS প্রস্তুতে চলবে।

Ta Ta ...