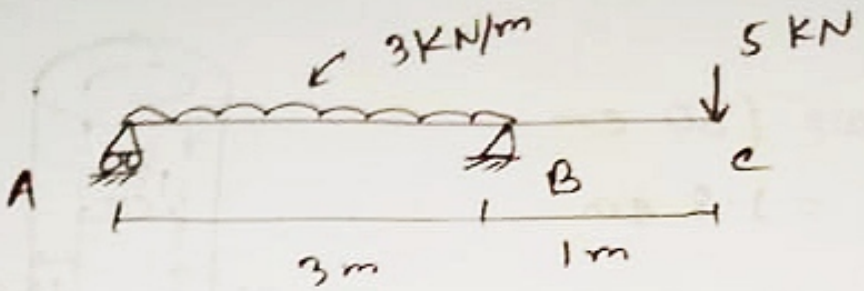
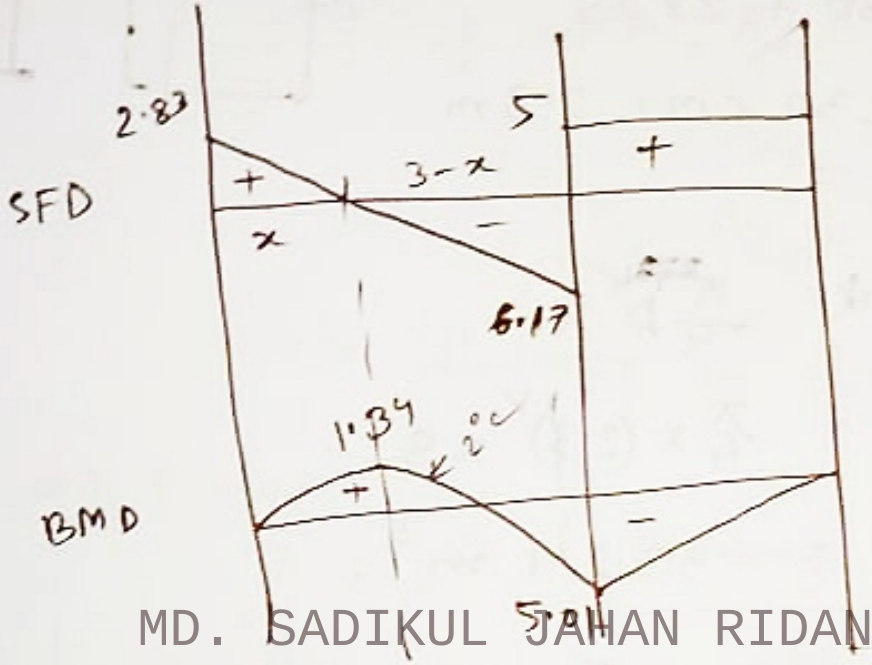
PSC Non-Cadre Dept. Math

Ques :- Page No :

2/





$\Sigma M_B = 0$ (⟲ +ve)

$\Rightarrow R_A \times 3 = 3 \times 3 \times 1.5 - 5 \times 1$

$\therefore R_A = 2.83$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 9 + 5$ $\quad \therefore R_B = 11.17$ KN

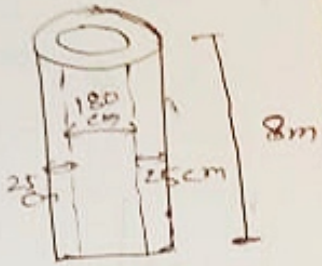
$$\frac{x}{2.83} = \frac{3-x}{6.17}$$

$\therefore x = 0.94$ m

21 (25)

Inner dia = 180 cm
= 1.8 m

Outer dia = 180 + 2×25
= 230 cm = 2.3 m



Earth work = $\frac{\pi}{4} D^2 h$

= $\frac{\pi}{4} \times (2.3)^2 \times 8$

= 33.24 m^3.

Brick work = $\frac{\pi}{4} (D^2 - d^2) h$

= $\frac{\pi}{4} (2.3^2 - 1.8^2) \times 8$

= 12.88 m^3

= 12.88 × 420 Nos

= 5410 Nos.

6/ (25)

RF of Scale = 1:50 = $\frac{1}{50}$

Given,

drawing area, A_{d_1} = 3 cm^2

" " , A_{d_2} = 6 cm^2

" " , A_{d_3} = 9 cm^2

Common distance in field, d_f = 10 m

we know,

$(RF)^2 = \frac{\text{Drawing Area}}{\text{Field Area}}$

$\Rightarrow (\frac{1}{50})^2 = \frac{A_d}{A_f}$

$\therefore A_f = A_d \times 50^2$

$\therefore A_{f_1} = 3 \times 50^2 = 7500\ cm^2 = 0.75\ m^2$

$\therefore A_{f_2} = 6 \times 50^2 = 15000\ cm^2 = 1.5\ m^2$

$\therefore A_{f_3} = 9 \times 50^2 = 22500\ cm^2 = 2.25\ m^2$

Volume of field = $\frac{d_f}{2} (A_{f_1} + A_{f_3} + 2A_{f_2})$

= $\frac{10}{2} (0.75 + 2.25 + 2 \times 1.5)$

= 30 m^3 = 30,000 litre

8/ ক)

Samle I, weight $= m_1$

$FM_1 = 2.4$

Sample II

weight $= m_2$

$FM_2 = 1.8$

$F_{com} = 2.0$

Ans, $m_1 + m_2 = w$

$\Rightarrow m_2 = w - m_1$

Now,

$$F_{com} = \frac{FM_1 \times m_1 + FM_2 \times m_2}{m_1 + m_2}$$

$$\Rightarrow 2.0 = \frac{2.4m_1 + 1.8m_2}{w}$$

$$\Rightarrow 2w = 2.4m_1 + 1.8(w - m_1)$$

$\therefore m_1 = 0.33w$

$\therefore m_2 = 0.67w$

$\therefore m_1 : m_2 = 0.33 : 0.67 \approx 1 : 2$.

2/ ক) Here,

Actual Length, $D = 620$ m

Measured " , $D' = 622.3$ m

chain " , $L = 30$ m

Now, $\frac{D}{D'} = \frac{L'}{L}$

$\Rightarrow L' = \frac{D \times L}{D'}$

$\Rightarrow L' = \frac{620 \times 30}{622.3}$

$\therefore L' = 29.889$ m

Error $= 30 - 29.889 = 0.111$ m.

৬/ ক)

$FM_1 = 2.12$

$m_1 = 950$ gm $= 0.95$ kg

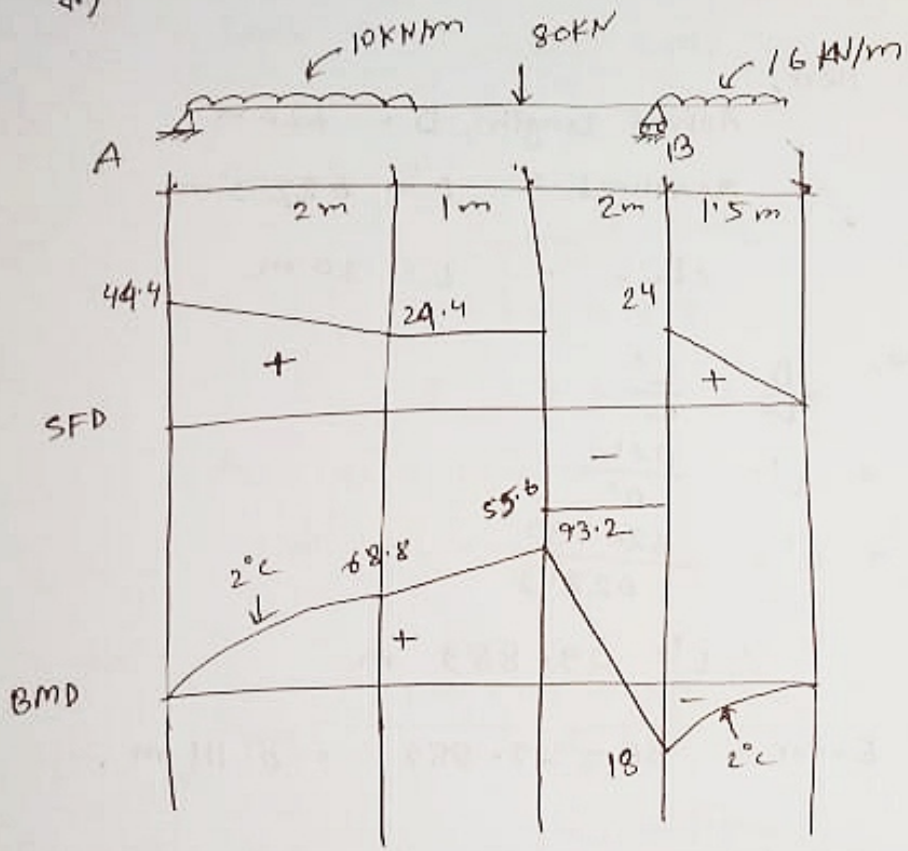
$FM_2 = 2.66$

$m_2 = 650$ gm $= 0.65$ kg

$$\therefore F_{com} = \frac{FM_1 \times m_1 + FM_2 \times m_2}{m_1 + m_2}$$

$$= \frac{2.12 \times 0.95 + 2.66 \times 0.65}{0.95 + 0.65} = 2.34$$

9/ ক)



$\Sigma M_A = 0$ (↺ +ve)

$\Rightarrow R_B \times 5 = 10 \times 2 \times 1 + 80 \times 3 + 16 \times 1.5 \times 5.75$

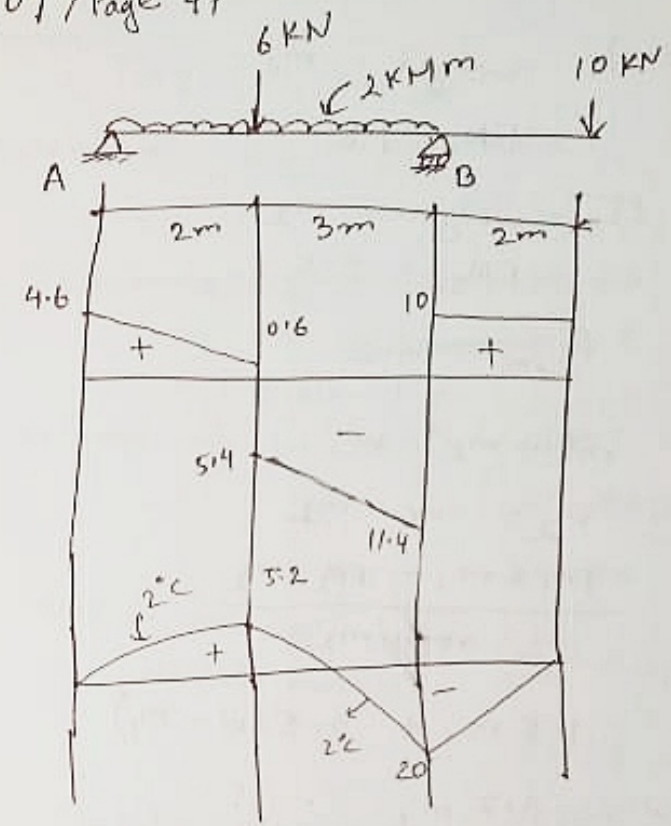
$\therefore R_B = 79.6$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 20 + 80 + 24$

$\therefore R_A = 44.4$ KN

খ)



$\Sigma M_A = 0$ (↺ +ve)

$\Rightarrow R_B \times 5 = 6 \times 2 + 2 \times 5 \times 2.5 + 10 \times 7$

$\therefore R_B = 21.4$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 6 + 10 + 10$

$\therefore R_A = 4.6$ KN

6/

Sample I. weight = m_1

$FM_1 = 1.8$

" II, weight = m_2

$FM_2 = 2.5$

$F_{com} = 2.2$

NOW,

$m_1 + m_2 = w$

$\Rightarrow m_2 = w - m_1$

$$F_{com} = \frac{FM_1 \times m_1 + FM_2 \times m_2}{m_1 + m_2}$$

$\Rightarrow 2.2\,w = 1.8\,m_1 + 2.5(w - m_1)$

$\Rightarrow 0.3w = 0.7\,m_1$

$\therefore m_1 = \frac{3}{7}w$

$\therefore m_2 = \frac{4}{7}w$

$\therefore m_1 : m_2 = \frac{3}{7}w : \frac{4}{7}w = 3:4$.

9/

Given,

$r = 2\,m, \quad h = 5\,m$

Volume of structure = $\pi r^2 h$

$= 62.83\ m^3$

~~Loose volume = 1.5×62.83~~

~~$= 94.25\ m^3$~~

Volume of bricks = 62.83×0.7

$= 94.25 \times 0.7$

$= 65.98\ m^3 = 4398\ m^3$

$= 23296$ cft $= 1553$ cft

Volume of one brick (without morter) = $\left(\frac{2.5}{12} \times \frac{4.5}{12} \times \frac{2.75}{12}\right)$ cft

$= 0.068$ cft

Bricks required = $\frac{2329.6}{0.068}$ Nos $= \frac{1553}{0.068}$ Nos

$= 34258$ Nos $= 22,839.4$

≈ 34260 Nos ≈ 22840 Nos

Volume of morter = $62.83 - 94.25 \times 0.3 \times 1.5$

$= 28.28\ m^3$

$= 998.57$ cft

Volume of cement = $(998.57 \times \frac{1}{6})$ cft

$= 166.4$ cft ≈ 133 bags

Volume of Sand = $(998.57 \times \frac{5}{6})$ cft $= 832.2$ cft .

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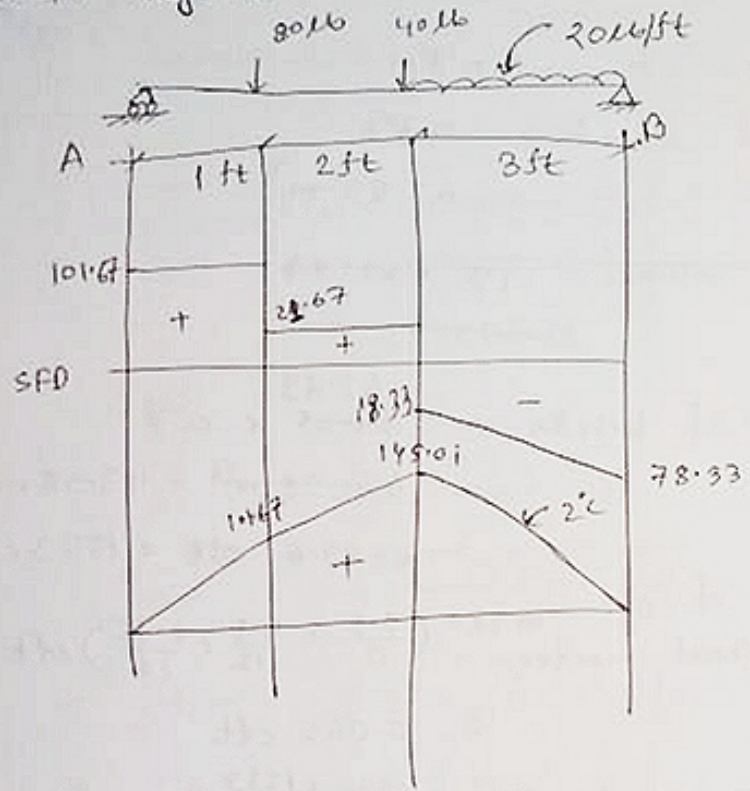


$\Sigma M_B = 0$ (↺ +ve)

$\Rightarrow R_A \times 6 = 80 \times 5 + 40 \times 3 + 20 \times 3 \times 1.5$

$\therefore R_A = 101.67$ KN

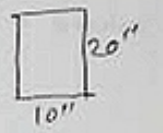
$\Sigma V = 0$ (↑ +ve)

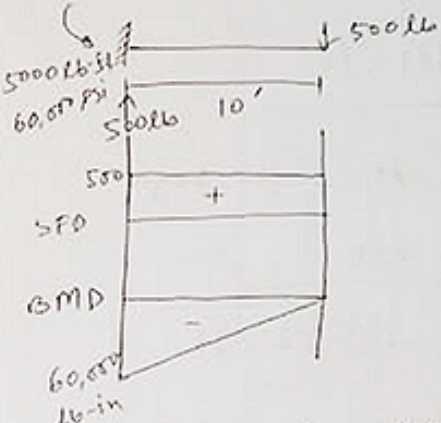
$\Rightarrow R_A + R_B = 80 + 40 + 60$

$\therefore R_B = 78.33$ KN

21 Given

Beam 10" × 20"





Here,

b = 10"

d = 20"

L = 10' = 120"

P = 500 lb

$I = \frac{10 \times 20^3}{12} = 6666.67 \text{ in}^4$

$Y_{max} = \frac{A_m \bar{x}}{EI} = \frac{-\frac{1}{2} \times 60000 \times 120 \times \frac{2}{3} \times 120}{30000 \times 6666.67}$

$= 1.44$ in (↓)

Or,

$Y_{max} = \frac{PL^3}{3EI}$

$= \frac{500 \times (120)^3}{3 \times 30,000 \times 6666.67}$

$= 1.44$ in (↓)

6/ [10.67] 20'-8"

Total volume = 20.75 × 22.42 × 0.46

= 214 cft

Dry " = 214 × 1.5 = 321 cft

cement = $\frac{321}{7}$ = 45.88 cft ≈ 37 bags

Sand = $\frac{321}{7} \times 2$ = 91.76 cft

Coarse Aggregate = $\frac{321}{7} \times 4$ = 183.52 cft

Length short direction = 6.3 m

Long " = 6.83 m

[Let, Clear cover = 1"]

no of rod = $\frac{6.3 - 2 \times 0.025}{0.15} + 1$

= 43 (Short direction)

no. of rod = $\frac{6.83 - 2 \times 0.025}{0.15} + 1$

= 47 (Long direction)

Total length = (43 × 6.275 + 47 × 6.78) = 587.41 m

Amount of rod = 587.41 × 0.888

= 521.62 ≈ 522 Kg.

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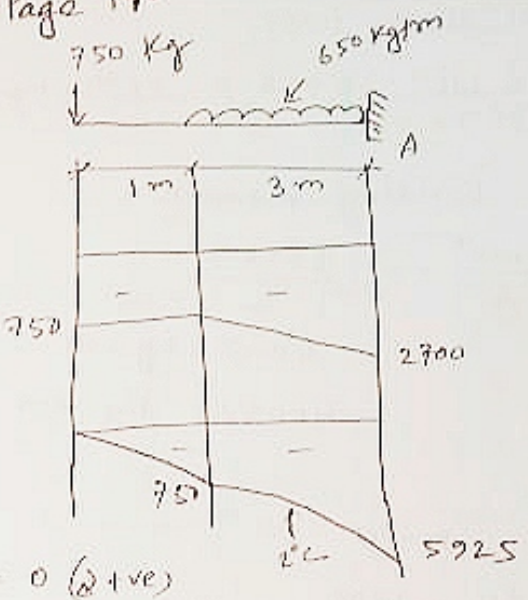
2/45)



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

$\Rightarrow M = 750 \times 4 + 650 \times 3 \times 1.5$

= 5925 Kg-m

$R_A = 750 + 650 \times 3 = 2700$ Kg.

2/ Step 1 ;

Let, D = 45 cm

B = 25 cm

Self weight of beam = 0.45 × 0.25 × 2400 × 1

= 270 Kg/m

Applied Load = 620 Kg/m

w = 890 Kg/m

Step 2: Maxm Shear force

$V = wL = 890 \times 3 = 2670$ Kg

Step 3: Maxm bending moment

$M = \frac{wL^2}{2} = \frac{890 \times 3^2}{2}$

$= 4005$ Kg-m

$= 400500$ Kg-cm

Step 4:

Given, $n = 9$

$r = \frac{f_s}{f_c} = \frac{1300}{210} = 6.2$

$k = \frac{n}{n+r} = \frac{9}{15.2} = 0.59$

$j = 1 - k/3 = 1 - \frac{0.59}{3} = 0.803$

$M = \frac{f_c}{2} j k b d^2$

$\Rightarrow d = \sqrt{\frac{2M}{f_c j k b}}$

$\Rightarrow d = \sqrt{\frac{2 \times 400500}{210 \times 0.803 \times 0.59 \times 25}}$

$\therefore d = 17.95$ cm ≈ 18 cm

Total depth = (18 + 5) cm, cover = 5 cm

= 23 cm < 45 cm (OK)

Step 5:

$A_s = \frac{M_s}{f_s j d} = \frac{400500}{1300 \times 0.803 \times 23}$

$= 21.31$ cm^2.

use 20 mm ϕ bar $= \frac{21.31}{(\frac{\pi}{4}) \times (2)^2}$

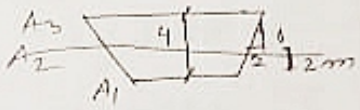
$= 6.78$

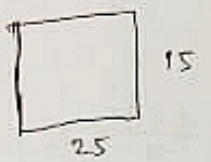
≈ 7 nos

use 7 - 20 mm ϕ bar on top row.

b)

a)





Bottom Section:

$A_1 = LB = 25 \times 15 = 375$ m^2

Middle section:

$L = 25 + 2 \times 2 \times 2 = 33$ m

$B = 15 + 2 \times 2 \times 2 = 23$ m

$\therefore A_2 = 33 \times 23 = 759$ m^2

Top Section:

$L = 25 + 2 \times 2 \times 4 = 41$ m

$B = 15 + 2 \times 2 \times 4 = 31$ m

$A_3 = 41 \times 31 = 1271\ m^2$

Volume of Excavation $= \frac{2}{3}(A_1 + A_3 + 4A_2)$

$= \frac{2}{3}(375 + 1271 + 4 \times 759)$

$= 3121.5\ m^3$.

7/ 1f)

Loose volume $= 15 \times 1.5$

$= 22.5\ m^3$

Cement $= \frac{22.5}{7} = 3.21\ m^3 = 113.35\ cft$

≈ 91 bags

Sand $= \frac{22.5}{7} \times 2 = 6.42\ m^3 = 226.7\ cft$

CA $= \frac{22.5}{7} \times 4 = 12.84\ m^3 = 453.4\ cft$.

8/ Given,

$\frac{w}{c} = 0.4$ 3 bag cement = 150 kg

$\Rightarrow \frac{w}{150} = 0.4$

$\therefore w = 60$ Litre $= 13.22$ gal.

[1 gal = 4.54 kg/litre]

20/ 3f) Here,

$w = 22$ KN

$H = 1\ m = 100$ cm [Height of fall of hammer in cm]

$s = 5$ mm $= 0.5$ cm

$c = 2.5$ for drop hammer

$\eta = 0.7 \sim 0.9$ for ... hammer

$R = \frac{WH\eta}{6(s+c)} = \frac{22 \times 100 \times 0.7}{6(0.5+2.5)} = 122.22$ KN

$= 85.6$ KN

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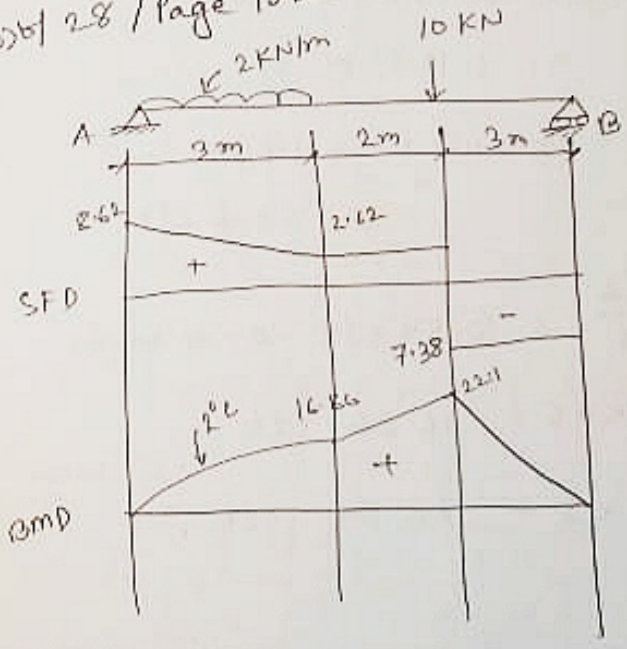

$\Sigma M_A = 0$ (↺ +ve)

$\Rightarrow R_B \times 8 = 2 \times 3 \times 1.5 + 10 \times 5$ $\therefore R_B = 7.38$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 6 + 10$ $\therefore R_A = 8.62$ KN

2/

$A_g = 250 \times 500 \text{ mm}^2$

$= 0.1875 \text{ m}^2$

$P = 2.5\% = 0.025$

$A_{st} = 0.1875 \times 0.025 = 4.6875 \times 10^{-3} \text{ m}^2$

Amount of steel reqd $= 4.6875 \times 10^{-3} \times 6 \times 7850$

$= 220.8 \text{ Kg} \approx 221 \text{ Kg}$

Concrete volume $= 0.25 \times 0.75 \times 6$

$= 1.125 \text{ m}^3$.

Loose " $= 1.5 \times 1.125 = 1.6875 \text{ m}^3$

$= 59.6 \text{ cft}$.

Cement $= \frac{59.6}{5.5} = 10.84 \text{ cft} \approx 9 \text{ bags}$.

Sand $= \frac{59.6}{5.5} \times 1.5 = 16.26 \text{ cft}$

CA $= \frac{59.6}{5.5} \times 3 = 32.51 \text{ cft}$.

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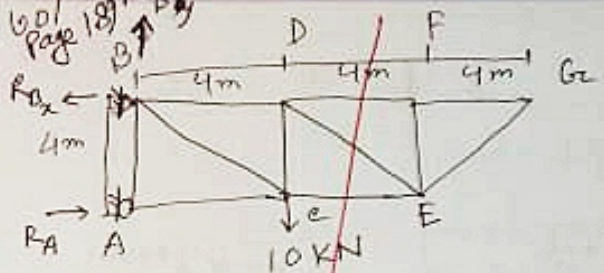


$\Sigma M_A = 0$ (↻ +ve)

$\Rightarrow R_{Bx} \times 4 + 10 \times 4 = 0$

$\therefore R_{Bx} = -10 \text{ KN}$

$= 10 \text{ KN} (\leftarrow)$

$\Sigma V = 0$ (↑ +ve)

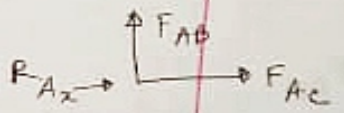
$\Rightarrow R_{By} - 10 = 0 \quad \therefore B_y = 10 \text{ KN}$

$\Sigma F_x = 0$ (→ +ve)

$\Rightarrow R_{Bx} + R_{Ax} = 0$

$\therefore A_x = 10 \text{ KN}$.

Joint A



$\Sigma F_x = 0$ (→ +ve)

$\Rightarrow R_{Ax} + F_{AC} = 0$

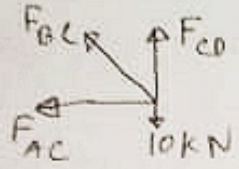
$\therefore F_{AC} = -10 \text{ KN}$

$= 10 \text{ KN} (\leftarrow)$

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow F_{AB} = 0$

nt C



$\theta = \tan^{-1}\frac{4}{4} = 45°$

$\Sigma F_x = 0$ (→ +ve)

$-F_{AC} - F_{BC}\cos 45 = 0$

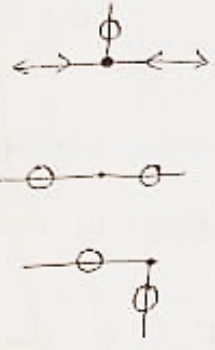
$\therefore F_{BC} = -14.14\,kN$

$= 14.14\,kN(c)$

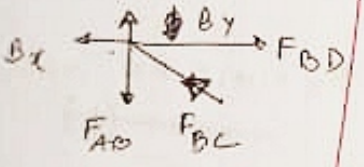
$\Sigma V = 0$ (↑+ve)

$= F_{BC}\sin 45° + F_{CD} - 10 = 0$

$\therefore F_{CD} = 0$.



oint B

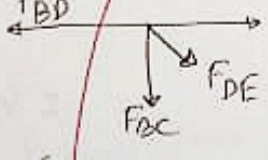


$\Sigma F_x = 0$ (→ +ve)

$\Rightarrow -B_x + F_{BD} + F_{BC}\cos 45° = 0$

$\therefore F_{BD} = 0$.

oint D

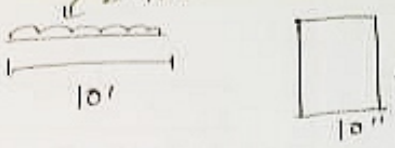


$\Sigma F_x = 0$ (→ +ve)

$\therefore F_{BD} = F_{DF} = 0$.

$F_{DE} = 0$, $F_{EC} = 0$.

2/



Self weight $= \left(\frac{18\times 10}{144}\right)\times 150$

$= 187.5$ lb/ft

$W = 2000 + 187.5 = 2187.5$ lb/ft

$M = \frac{wl^2}{8} = \frac{2187.5\times 10^2}{8}$

$= 27343.75$ lb-ft $= 328\times 10^3$ lb-in

$j = 0.87$ $\quad f_s = 0.4 f_y = 0.4\times 60000 = 24000$ psi

Effective depth, $d = 18 - 1.5 = 16.5"$ [Clear cover 1.5"]

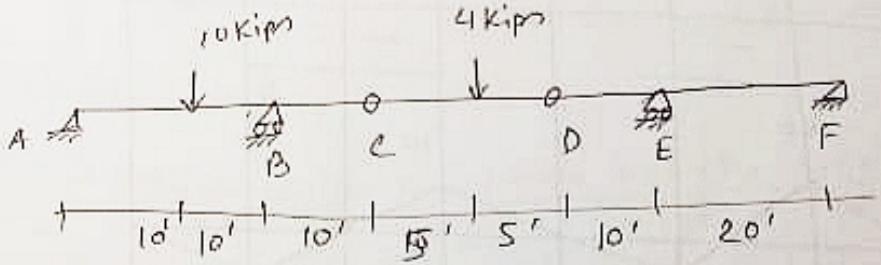
$M = f_s A_s j d$

$\Rightarrow A_s = \frac{M}{f_s j d} = \frac{328\times 10^3}{24000\times 0.87\times 16.5}$

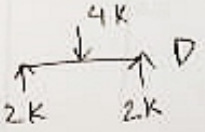
$= 0.95\,in^2$

use #5 (16 mm) bar $= \frac{0.95}{0.31} = 3.07 \approx 4$ Nos

2/



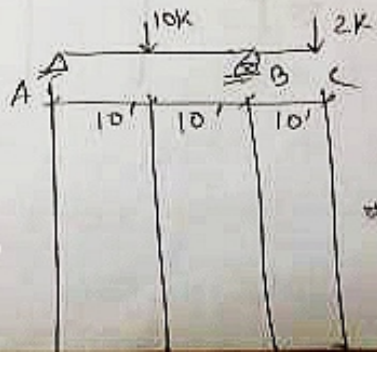
For



$\Sigma M_A = 0$ (↺ +ve)

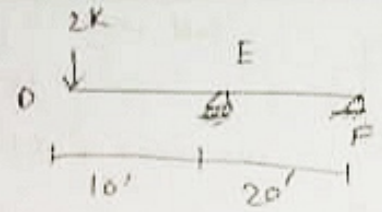
$\Rightarrow R_B \times 20 = 10\times 10 + 2\times 30$

$\therefore R_B = 8\,K$



$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A = 4K$

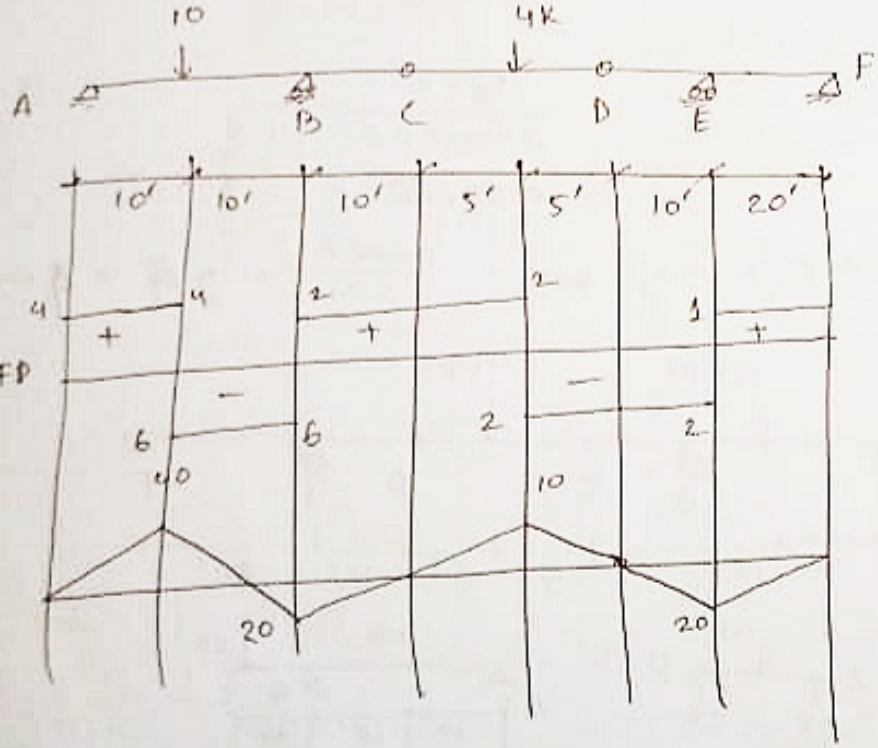


$\Sigma M_F = 0$ @

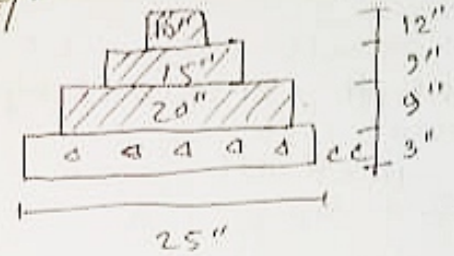
$\therefore 2 \times 30 = R_E \times 20 \quad \therefore R_E = 3\,K$

$\Sigma V = 0$ (↑ +ve)

$\therefore R_F = -1\,K$



b/*



Concrete work:

Volume = $\frac{25 \times 9}{144} \times 100 = 52.08$ cft

Dry " = $52.08 \times 1.5 = 78.12$ cft

Assume mixing proportion 1 : 2 : 4

Cement = $\frac{78.12}{7} = 11.16$ cft $= 8.93 \approx 9$ bags

Sand = $\frac{78.12}{7} \times 2 = 22.32$ cft

CA = $\frac{78.12}{7} \times 4 = 44.64$ cft $= 44.64 \times 8.5$

$\approx 379.44 \approx 380$ nos

Brick work:

Volume of brick = $\frac{(10 \times 12 + 15 \times 9 + 20 \times 9) \times 100}{144}$

$= 302.08$ cft

$= 302.08 \times 12$

$= 3625$ nos

Mortar required = 0.45×302.08 cft

$= 135.94$ cft

Assume, mixing proportion = 1:4

Cement = $\frac{135.94}{5}$ = 27.2 cft = 21.75 ≈ 22 bags

Sand = $\frac{135.94}{5} \times 4$ = 108.8 cft .

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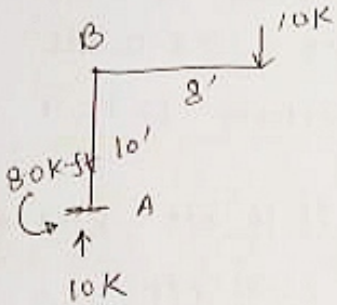
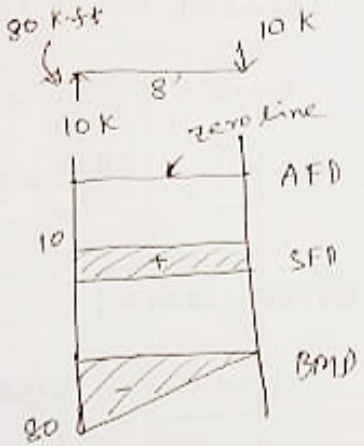
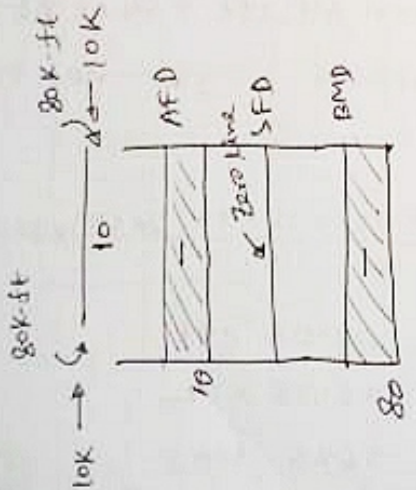
2/



$(\overset{\circlearrowleft}{+ve}) \Sigma M_A = 0 \Rightarrow M_A + 8 \times 10 = 0$

$\therefore M = -80$ k-ft





9/ (a) Cross section 12" × 20"

V = 1.5% = 0.015

$A_s = 0.015 \times \frac{1}{3.28} \times \frac{1.67}{3.28} = 0.015 \times 0.305 \times 0.509$

$= 2.33 \times 10^{-3}$ m²

Amount of Steel = $2.33 \times 10^{-3} \times \frac{22}{3.28} \times 7850$

= 122.7 kg ≈ 123 kg.

Volume of concrete = 1 × 1.67 × 22

= 36.74 cft

Dry volume = 1.5 × 36.74 = 55.11 cft

cement = $\frac{55.11}{7}$ = 7.87 cft = 6.3 ≈ 7 bags

Sand = $\frac{55.11}{7} \times 2$ = 15.74 cft

Coarse Aggregate = $\frac{55.11}{7} \times 4$ = 31.48 cft

(Brick Khoa) = 31.48 × 8.5 = 267.5 ≈ 268 No's Bricks

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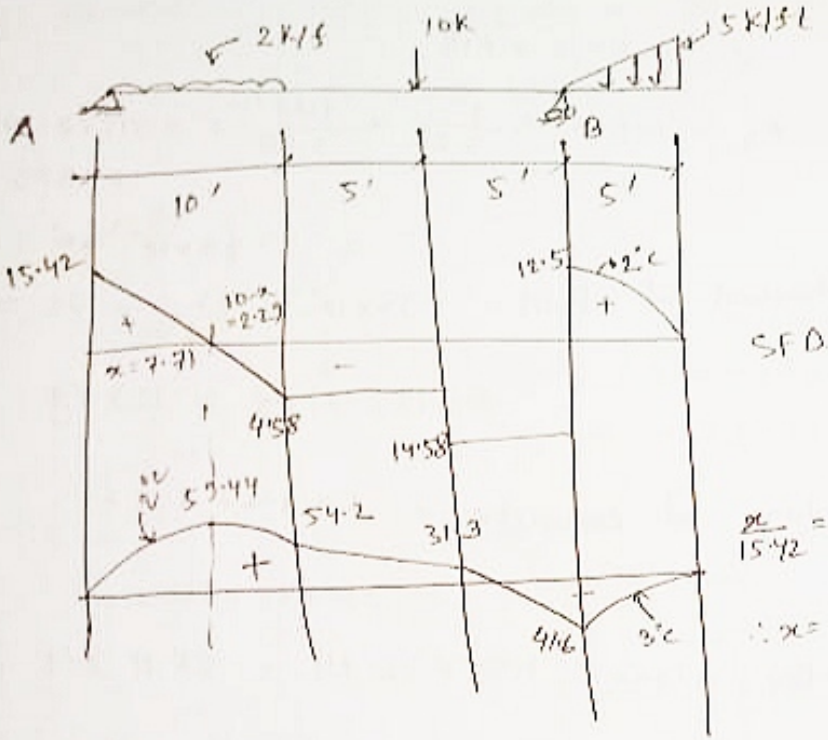
2/



$\frac{x}{15.42} = \frac{10-x}{4.58}$

$\therefore x = 7.71 ft$

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

$= R_B \times 20 = 2 \times 10 \times 5 + 10 \times 15 + \frac{1}{2} \times 5 \times 5 \times (\frac{2}{3} \times 5 + 20)$

$\therefore R_B = 27.08$ K

$\Sigma V = 0$ (↑+ve)

$\Rightarrow R_A + R_B = 20 + 10 - \frac{1}{2} \times 5 \times 5$

$\therefore R_A = 15.42$ K

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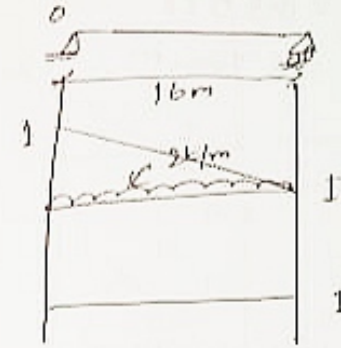
$\frac{ab}{L}$ = Height of Moment area

at 4m $\frac{4 \times 12}{16} = 3m$

at 8m $\frac{8 \times 8}{16} = 4m$

2/(ii)

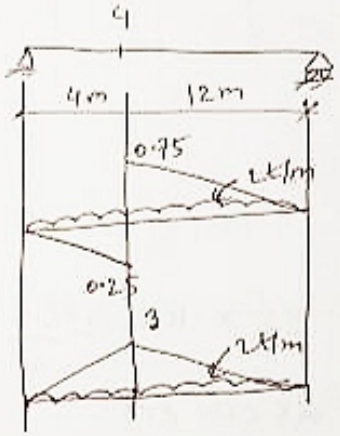


$V_0 = \frac{1}{2} \times 16 \times 1 \times 2 = 16$ Ton

$M_0 = 0$

Il of V_0

Il of M_0

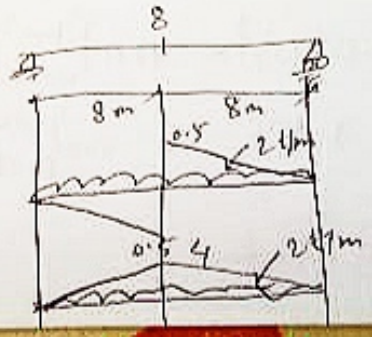


$V_4 = \frac{1}{2} \times 12 \times 0.75 \times 2$

$= 9$ Ton

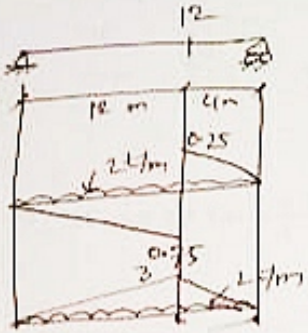
$M_4 = \frac{1}{2} \times 16 \times 3 \times 2$

$= 48$ Ton-m



$V_8 = \frac{1}{2} \times 8 \times 0.5 \times 2 = 4$ Ton

$M_8 = \frac{1}{2} \times 16 \times 4 \times 2 = 64$ Ton-m

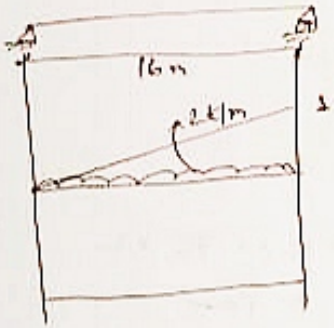


$V_{12} = \frac{1}{2} \times 4 \times 0.25 \times 2$

$= 1$ Ton

$M_{12} = \frac{1}{2} \times 16 \times 3 \times 2$

$= 48$ Ton·m



$V_{16} = \frac{1}{2} \times 16 \times 1 \times 2 = 16$ Ton

$M_{16} = 0$.

a/

Volume of brick work $= 25 \times 100 \text{ sq·cm/m}$

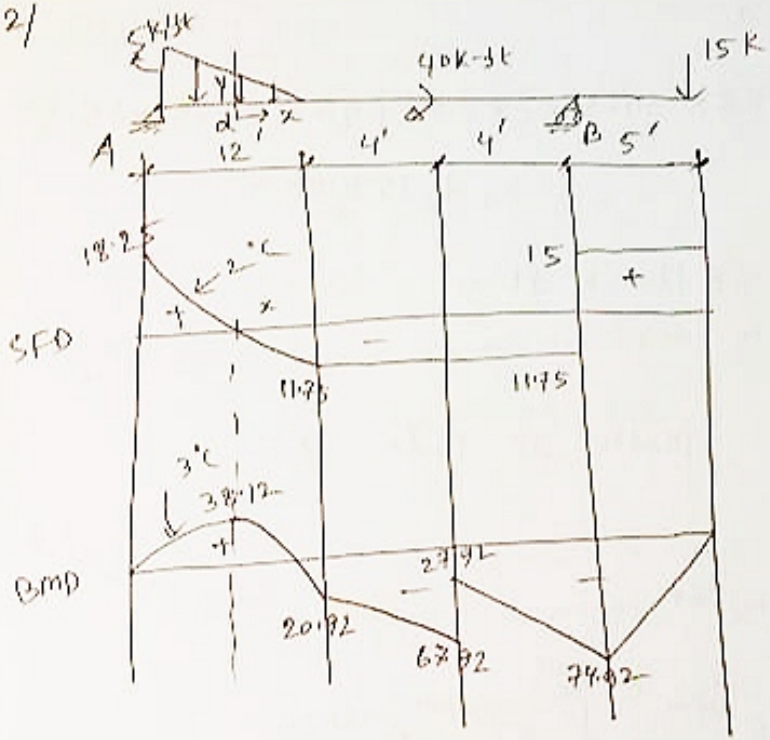
$= 2500 \text{ cm}^3$

$= 2.5 \times 10^{-3} \text{ m}^3$

$= 2.5 \times 10^{-3} \times 420$ [1 m^3 brick work = 420 nos Bricks]

≈ 1 nos

2/



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

$\Rightarrow R_B \times 20 = \frac{1}{2} \times 5 \times 12 \times \frac{1}{3} \times 12 + 40 + 15 \times 25$

$\therefore R_B = 26.75$ K

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = \frac{1}{2} \times 5 \times 12 + 15$ $\therefore R_A = 18.25$ K

Shear at $d = 0$

$\Rightarrow -\frac{1}{2} \times y + 26.75 - 15 = 0$

$\Rightarrow \frac{1}{2} \times x \times \frac{5x}{12} = 11.75$ $\therefore x = 7.5$ m

$\frac{y}{x} = \frac{5}{12}$

$\therefore y = \frac{5x}{12}$

$= \frac{5 \times 7.5}{12}$

$= 3.125$ k

Moment at d,

$$M = \frac{1}{2} \times 7.5 \times 3.125 \times \frac{1}{3} \times 7.5 + 40 - 28.75 \times 15.5 + 15 \times 20.5$$

$$= 38.12 \text{ K-ft.}$$

3/ 2f)

Math 30 Data Sent

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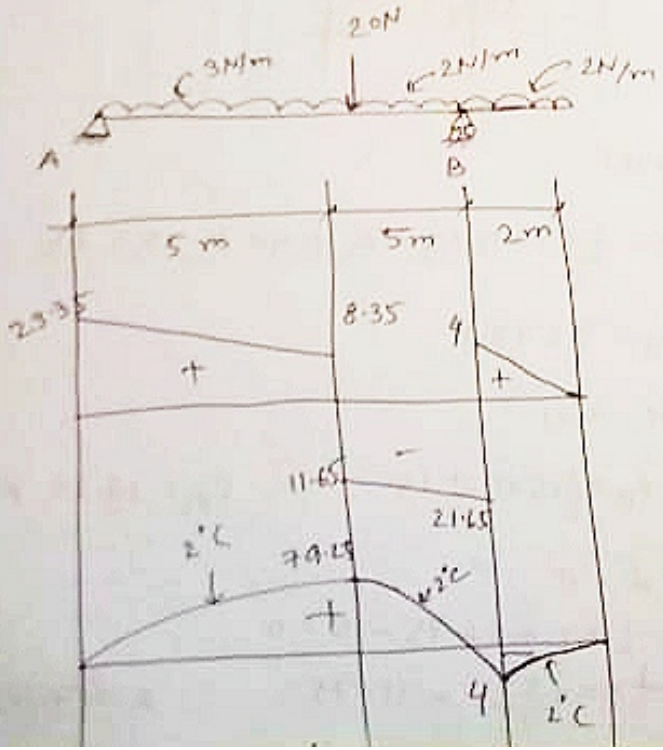
3/



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

$\Rightarrow R_B \times 10 = 3 \times 5 \times 2.5 + 20 \times 5 + 2 \times 5 \times 7.5 + 2 \times 2 \times 11$

$\therefore R_B = 25.65$ K

$\Sigma V = 0$ (↑+ve)

$\Rightarrow R_A + R_B = 15 + 20 - 25.65 + 14$

$\therefore R_A = 23.35$ K

8/41)

Total Sewage = 200×135 Litre

$= 27000$ Litre $= 27 \text{ m}^3$.

Duration 1 day

Capacity of tank K = $27 \times 1 = 27 \text{ m}^3$.

Let, Depth of tank K = 1.5 m

Area = $\frac{27}{1.5} = 18 \text{ m}^2$

$\therefore A = L \times B$

$\Rightarrow 18 = 3B \times B$

$\therefore B = 2.45$ m

$\therefore L = 3B = 7.35$ m

Free board = 0.3 m

So, Total D = 1.5 + 0.3 = 1.8 m

check, V = 7.35 × 2.45 × 1.8

= 32.41 m^3 > 27 m^3.

(b) (i) Given,

$FM_1 = 2.5$

$m_1 = 400\ gm = 0.4\ Kg$

$FM_2 = 1.8$

$m_2 = 600\ gm = 0.6\ Kg$

$$F_{com} = \frac{FM_1 \times m_1 + FM_2 \times m_2}{m_1 + m_2}$$

$$= \frac{2.5 \times 0.4 + 1.8 \times 0.6}{1}$$

$$= 2.08.$$

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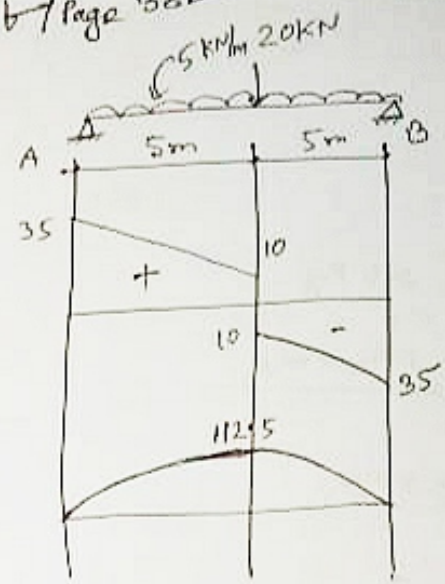
2/



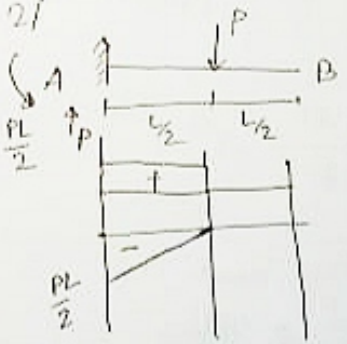
$\Sigma M_A = 0$ (↺ +ve)

$\Rightarrow R_B \times 10 = 20 \times 5 + 5 \times 10 \times 5$ $\therefore R_B = 35$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 70$ $\therefore R_A = 35$ KN

2/



$$\Delta = \frac{\frac{1}{2} \times \frac{L}{2} \times \frac{PL}{2} \times \left(\frac{L}{2} + \frac{2}{3} \times \frac{L}{2}\right)}{EI}$$

$$= \frac{\frac{PL}{8} \times \left(\frac{L}{2} + \frac{L}{3}\right)}{EI}$$

$$= \frac{\frac{PL}{8} \times \frac{5L}{6}}{EI}$$

$$= \frac{5PL^3}{48EI} \ (\downarrow).$$

3)

a)

$FM_1 = 2$

$m_1 = 1\ kg$

$FM_2 = 2.5$

$m_2 = 500\ gm = 0.5\ kg$

$$F_{com} = \frac{FM_1 \times m_1 + FM_2 \times m_2}{m_1 + m_2}$$

$$= \frac{2 \times 1 + 2.5 \times 0.5}{1.5}$$

$$= 2.17$$

b)

Bulk unit weight, $\gamma = 19\ KN/m^3$

$w = 25\% = 0.25$

$G_s = 2.7$

$$\gamma_d = \frac{\gamma}{1 + 0.25} = \frac{19}{1.25} = 15.2\ KN/m^3$$

$$e = \frac{G_s \gamma_w}{\gamma_d} - 1 = \frac{2.7 \times 9.81}{15.2} - 1$$

$$= 0.74$$

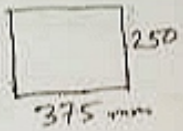
$$S = \frac{wG_s}{e} = \frac{0.25 \times 2.7}{0.74} = 0.912$$

$$= 91.2\%$$

5)

$f'_c = 8.75\ N/mm^2$

$f_s = 130\ N/mm^2$



$\therefore f_s = 0.4 f_y \quad \therefore f_y = 325\ N/mm^2$

$A_g = 375 \times 250 = 93750\ mm^2$

$A_{st} = 6 \times \frac{\pi}{4} \times (16)^2 = 1206.37\ mm^2$

Load, $P = \alpha\phi\ [0.85 f'_c (A_g - A_{st}) + f_y A_{st}]$

$= 0.8 \times 0.65\ [0.85 \times 8.75 (93750 - 1206.37) + 325 \times 1206.37]$

$= 561.8\ KN$.

Spacing:

1) $S = 48\ d_{tie}$ (use 10 mm ϕ)

$= 48 \times 10 = 480\ mm$

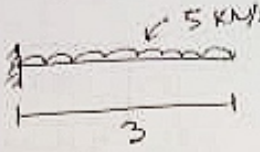
2) $S = 16\ d_{main}$

$= 16 \times 16 = 256\ mm$

3) Least dimension 250 mm

use 10 mm ϕ @ 250 mm c/c

6/



$M = \frac{wL^2}{2}$

$= \frac{5 \times 9}{2} = 22.5$ KN-m

Here,

$b = 0.25$ m

$f_c = 10$ MPa

$= 10 \times 10^3$ KN/m²

$f_s = 140$ MPa

$= 140 \times 10^3$ KN/m²

Modular ratio, $n = 15$

$r = \frac{f_s}{f_c} = 14$

$\therefore K = \frac{n}{n+r} = \frac{15}{29} = 0.52$

$j = 1 - K/3 = 0.83$.

$M = \frac{1}{2} f_c j K b d^2$

$\Rightarrow d = \sqrt{\frac{2M}{f_c j K b}}$

$= \sqrt{\frac{2 \times 22.5}{10 \times 10^3 \times 0.83 \times 0.52 \times 0.25}}$

$= 0.204$ m $\approx$ 20.4 cm

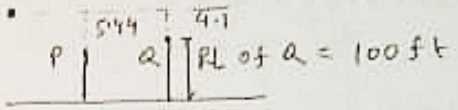
Again, $M = f_s A_s j d$

$\Rightarrow A_s = \frac{M}{f_s j d} = \frac{22.5}{140 \times 10^3 \times 0.204 \times 0.83}$

$= 9.5 \times 10^{-4}$ m² $= 9.5 \times 10^{-4} \times (39.37)^2$ in²

$= 1.47$ in² .

8/ a)



Height of instrument = 100 + 4.1 = 104.1 ft

RL of P = 104.1 − 5.44 = 98.66 ft .

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b/ Given,

$f_s = 18000$ psi

$f'_c = 2500$ psi

$f_c = 0.45 f'_c = 1125$ psi

$M = 50$ K-ft $= 600$ K-in

$b = 10$"

Let, clear Cover = 1.5" $\therefore d = 18 - 1.5 = 16.5$"

$n = 10$

$r = \frac{f_s}{f_c} = 16$

$K = \frac{n}{n+r} = 0.39$

$J = 1 - K/3 = 0.87$

$M = f_s A_s j d$

$\Rightarrow A_s = \frac{M}{f_s j d}$

$$\Rightarrow A_s = \frac{600 \times b^3}{18000 \times 0.87 \times 16.5}$$

$$\therefore A_s = 2.32 \text{ in}^2$$

use #8 bar (25 mm) $= \frac{2.32}{0.79}$

$= 2.94 \approx 3$ Nos.

Q (5)

Amount of Reinforcement $= 10 \times 0.025$

$= \left(\frac{0.25}{0.375} \times 7850\right)$ Kg

~~$= 2943.8$ Kg~~ $= 1962.5$ Kg

~~≈ 2944 kg~~ ≈ 1963 Kg

Dry Volume of Concrete $= 10 \times 1.5$

$= 15 \text{ m}^3 \times 35.31$

$= 529.65$ cft

$\text{cement} = \frac{529.65}{5.5} = 96.3$ cft $= 77.04 \approx 78$ bags

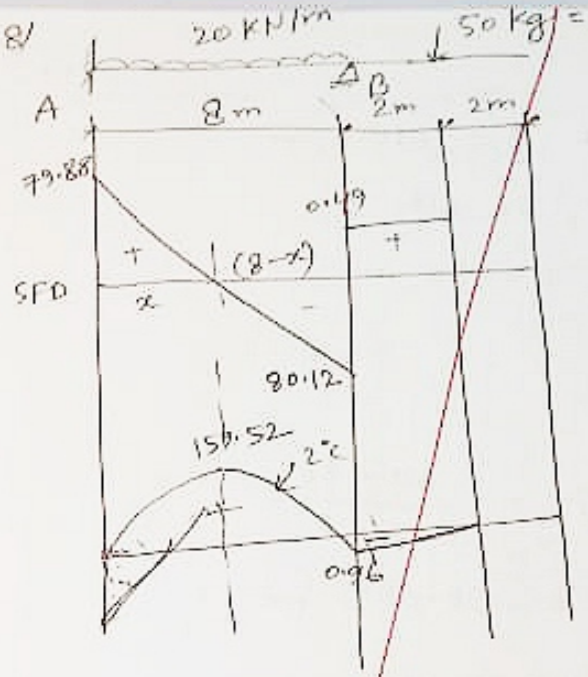
$\text{Sand} = \frac{529.65}{5.5} \times 1.5 = 144.45$ cft

$\text{Brick chips} = \frac{529.65}{5.5} \times 3 = 288.9$ cft

$= 288.9 \times 8.5 = 2455.65$

≈ 2456 Nos Brick

Q



$M_A = 20 \times 8 \times 4 + 4.9 - 80.61 \times 4$

$= 644.9$ KN-m

$\Sigma M_A = 0$ (+ve)

$\Rightarrow R_B \times 8 = 20 \times 8 \times 4 + 0.49 \times 10$

$\therefore R_B = 80.61$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 160 + 0.49$ $\quad \therefore R_A = 79.88$ KN

Now,

$\frac{x}{79.88} = \frac{8-x}{80.12}$

$\Rightarrow x = \frac{79.88 \times 8}{(79.88 + 80.12)}$

$= 3.994$

7/ 4E) Measured Length, $D' = 610.2$ m

Actual " , $D = 612$ m

$L = 30$ m

Now, $\frac{D'}{D} = \frac{L}{L'}$

$\Rightarrow L' = \frac{DL}{D'} = \frac{612 \times 30}{610.2}$

$= 30.085$ m

Error $= (30.0885 - 30) = 0.0885$ m.

21/ 4E) $FM_1 = 2$

$m_1 = 750$ gm

$FM_2 = 2.6$

$m_2 = 500$ gm

$\therefore F_{com} = \frac{2 \times 750 + 2.6 \times 500}{1250}$

$\therefore F_{com} = 2.24$.

6/ 4E) Given, $R = 300$ m

$M = 0.15$

$B = 15$ m

$E = 30$ cm $= 0.3$ m

$\therefore e = \frac{E}{B} = \frac{0.3}{15} = 0.02 < 0.07$

$V = ?$

$e + M = \frac{V^2}{127R}$

$\Rightarrow 0.02 + 0.15 = \frac{V^2}{127 \times 300}$

$\therefore V = 80.5$ km/hr

8/ 2E) Given, $E = 30 \times 10^6$ psi

$V = 0.25$

Now, $G = \frac{E}{2(1+V)}$

$= \frac{30 \times 10^6}{2 \times 1.25}$

$= 12 \times 10^6$ psi.

9/ 2E) Given, $P = 68$ HP

$\eta = 90\% = 0.9$

$h = 65$ m, $\frac{m}{t} = ?$

We know,

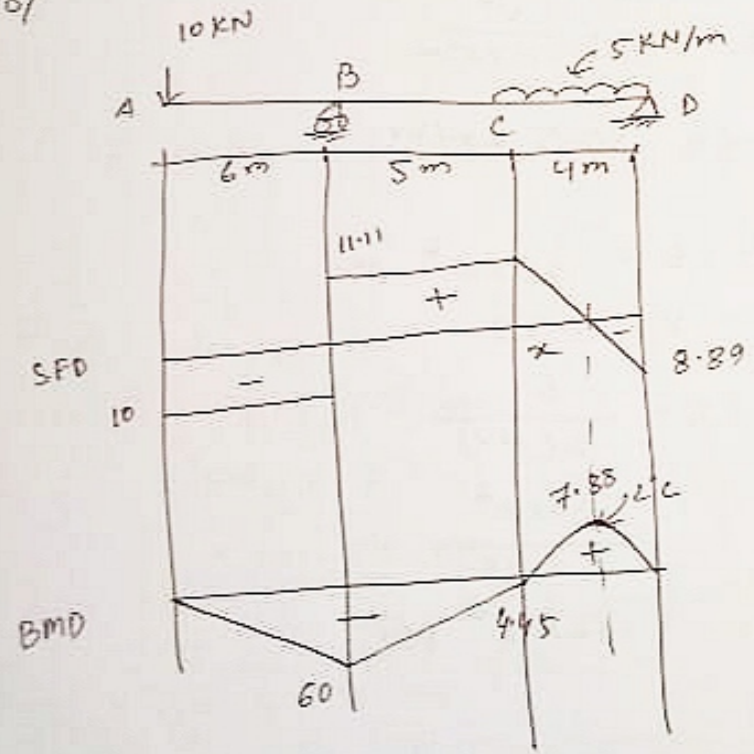
$$P = \frac{mh}{75nt}$$

$$\Rightarrow \frac{m}{t} = \frac{P \times 75n}{h}$$

$$= \frac{68 \times 75 \times 0.9}{65}$$

$$= 70.62 \text{ litre/sec.}$$

8/



$$\frac{x}{11.11} = \frac{4-x}{8.89}$$

$$\therefore x = 2.22$$

$\Sigma M_D = 0$ (+ve)

$\Rightarrow 10 \times 15 + 5 \times 4 \times 2 = R_B \times 9$

$\therefore R_B = 21.11$ KN

$\Sigma V = 0$ (+ve)

$\Rightarrow 10 + 20 - 21.11 = R_D$ $\quad \therefore R_D = 8.89$ KN

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2/

$$M = \frac{WL^2}{8} = \frac{300 \times 5^2}{8} = 937.5 \text{ kg-m}$$

$$= 93750 \text{ kg-cm}$$

Given, $d = 1.5b$

$$I = \frac{bd^3}{12} = \frac{b \times (1.5b)^3}{12} = \frac{3.375b^4}{12}$$

$$y = \frac{d}{2} = \frac{1.5b}{2} = 0.75b$$

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

$$\Rightarrow 50 = \frac{93750 \times 0.75b \times 12}{3.375b^4}$$

$$\Rightarrow b^3 = \frac{93750 \times 0.75 \times 12}{50 \times 3.375}$$

$$\therefore b = 17 \text{ cm}.$$

$\therefore d = 1.5b = 17 \times 1.5 = 25.6$ cm

$t = 25.6 + 5 = 30.6 \approx 31$ cm

Dimension of beam 17 x 31 cm².

4) er)

We know,

$$P = \frac{mh}{75t}$$

$$\Rightarrow P = \frac{93600 \times 21}{75 \times 3600}$$

$$\therefore P = 7.28 \text{ HP}.$$

9/ a)

Length of 16 mm bar = 6 x (600 − 75) [Clear Cover 3.75 cm]

= 6 x 5925 cm

= 6 x 5.925 m

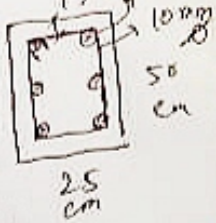
= 35.6 m

Amount of 16 mm bar = (35.6 x 1.578)

= 56.187 Kg ≈ 57 Kg

Stirr up = $\frac{600}{150} + 1 = 5$ Nos

Length of Stirr up = 2(a+b) + (No. of hooks x 10d tie) − (No. of bends x 2d tie)



a = 25 − 2 x 3.75 − 2 x 1 = 15.5 cm

b = 50 − 2 x 3.75 − 2 x 1 = 40.5 cm

Cutting length = 2(15.5 + 40.5) + (2 x 10 x 1) + (3 x 2 x 1)

= 126 cm = 1.26 m

Amount of 10 mm bar = 5 x 1.26 x 0.617

= 3.887 Kg ≈ 4 Kg.

Volume of Concrete = 6 x 0.25 x 0.5

= 0.75 m³

Dry volume = 1.5 x 0.75 = 1.125 m³

= 39.72 cft

cement = $\frac{39.72}{7}$ = 5.67 cft = 4.54 bags ≈ 5 bags

Sand = $\frac{39.72}{7} \times 2 = 11.34$ cft

Brick chips = $\frac{39.72}{7} \times 4 = 22.68$ cft

= (22.68 x 8.5) Nos Bricks

= 192.78 ≈ 193 Nos "

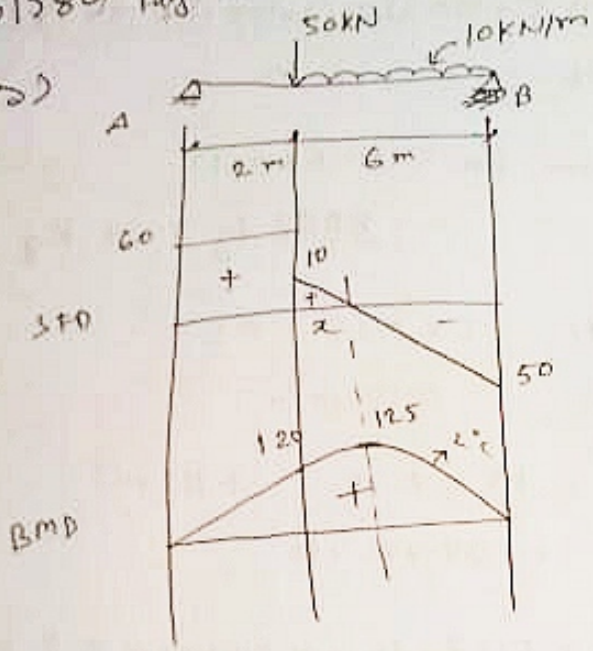
Given, $\frac{w}{c} = 0.4$

$$\Rightarrow w = \frac{5.67 \times 50 \times 0.4}{1.25}$$

= 90.72 Kg ≈ 91 Kg.

2020/2080/ Page 983

3)



$\frac{x}{10} = \frac{6-x}{50}$

$\therefore x = 1$

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

$\Rightarrow R_B \times 8 = 50 \times 2 + 10 \times 6 \times 5$

$\therefore R_B = 50$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 50 + 60 \quad \therefore R_A = 60$ KN

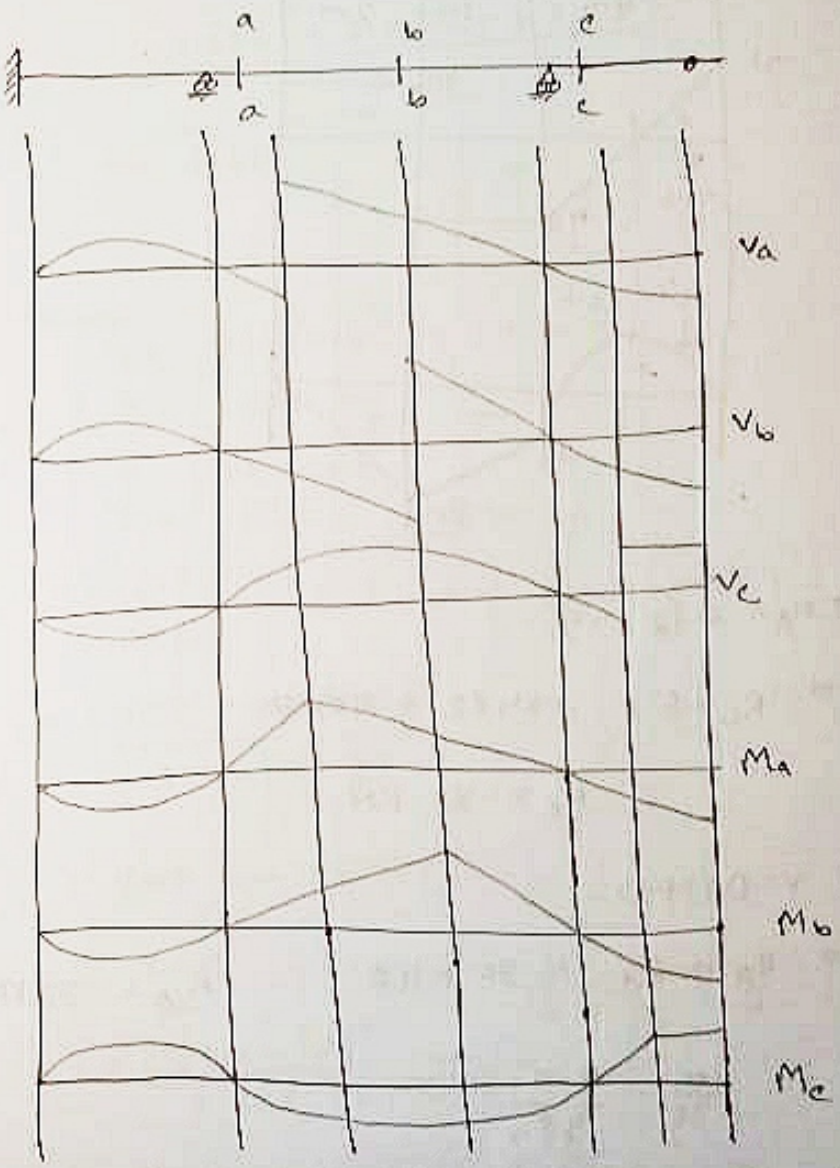
4) $\frac{W}{C} = 0.45$

$\Rightarrow W = 50 \times 0.45 = 22.5$ kg

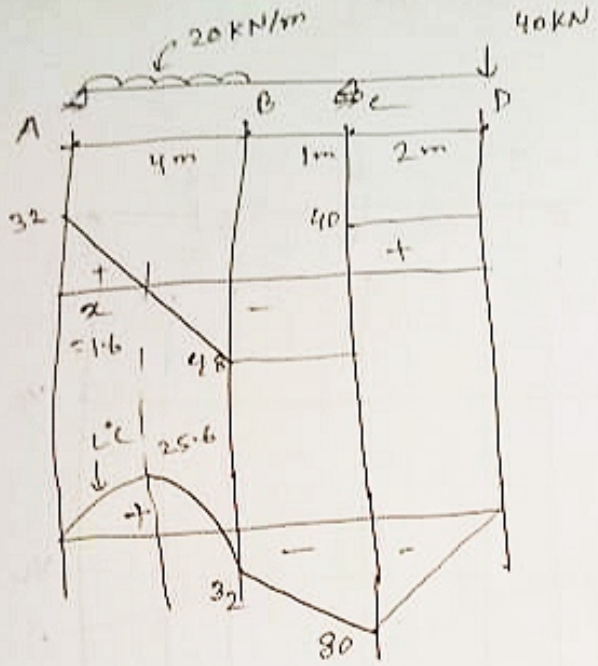
$= 22.5$ Litre .

HED 2017 (AE)

3) a)



6/



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

$\Rightarrow R_c \times 5 = 20 \times 4 \times 2 + 40 \times 7$

$\therefore R_c = 88$ KN

$\Sigma V = 0$ (↑+ve)

$\Rightarrow R_A + R_c = 80 + 40 \quad \therefore R_A = 32$ KN

$\frac{x}{32} = \frac{4-x}{48}$

$\Rightarrow 8 - 2x = 5x$

$\therefore x = 1.6$

21)

$$F_{com} = \frac{FM_1 \times 1 + FM_2 \times 2 + FM_3 \times 3}{1+2+3}$$

$$= \frac{2.62 \times 1 + 2.02 \times 2 + 2.8 \times 3}{6}$$

$$= 2.61 .$$

2/

a) Given,

$V = 72$ Km/hr $= 20$ m/s

$G_L = 1.676$ m

$V = 72$ Km/h

$R = \frac{1719}{4} = 429.75$ m

$$e = \frac{GV^2}{127R} \qquad [V \text{ in km/hr}, e \text{ in cm}]$$

$$= \frac{1.676 \times (72)^2}{127 \times 429.75}$$

$= 15.92$ cm

or,

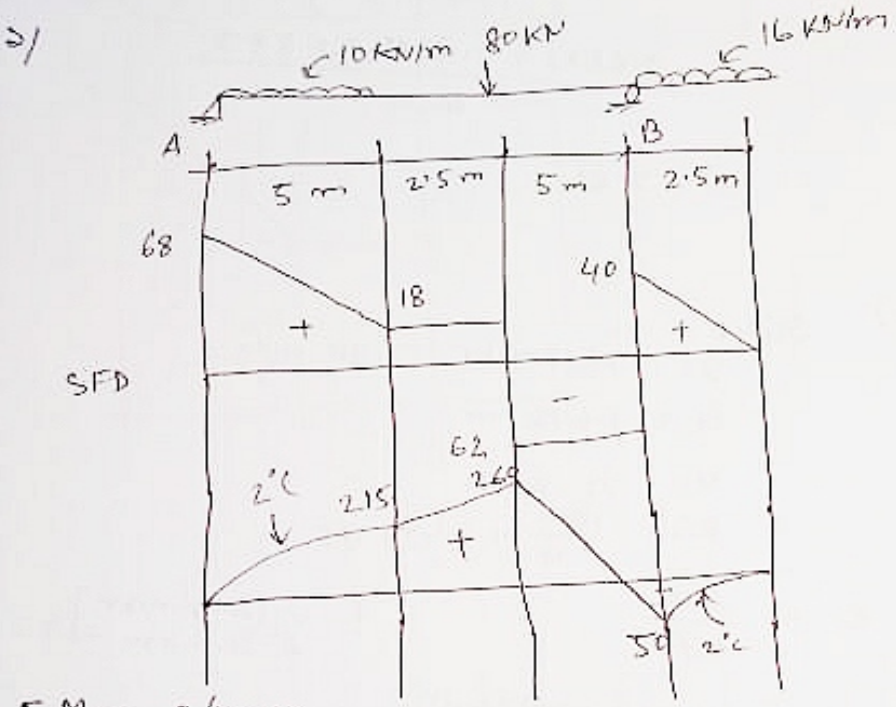
$$e = \frac{GV^2}{gR} \qquad [V \text{ in m/s}, e \text{ in m}]$$

$$= \frac{1.676 \times (20)^2}{9.81 \times 429.75}$$

$= 0.159$ m $= 15.9$ cm

HED 2016 (AE)

2/



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

$\Rightarrow R_B \times 12.5 = 10 \times 5 \times 2.5 + 80 \times 7.5 + 16 \times 2.5 \times 13.75$

$\therefore R_B = 102$ KN

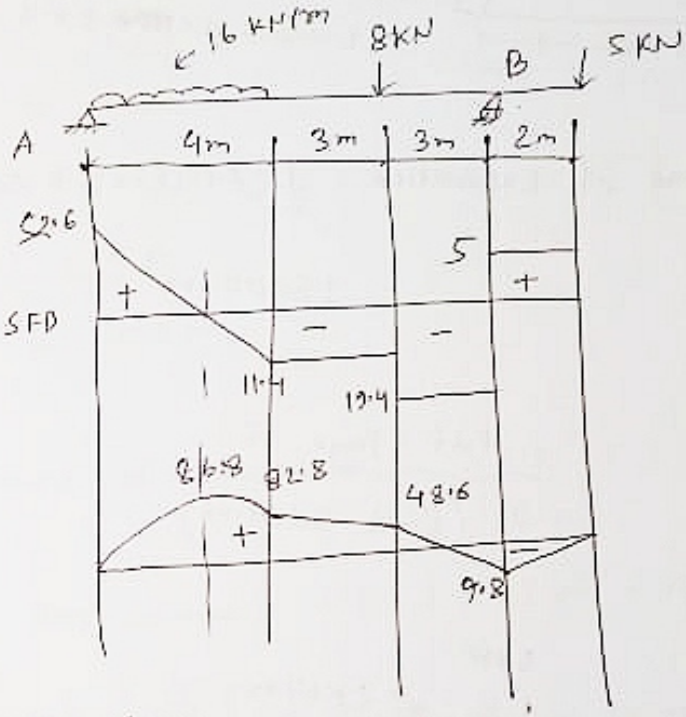
$\Sigma V = 0$ (↑+ve)

$\Rightarrow R_A + R_B = 10 \times 5 + 80 + 16 \times 2.5$

$\therefore R_A = 68$ KN

LGED 2017 (AE)

2/



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

$\Rightarrow R_B \times 10 = 16 \times 4 \times 2 + 8 \times 7 + 5 \times 12$

$\therefore R_B = 24.4$ KN

$\Sigma V = 0$ (↑+ve)

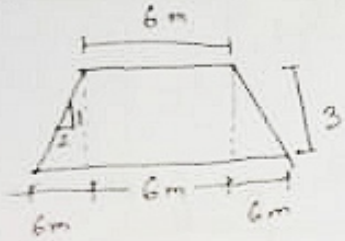
$\Rightarrow R_A + R_B = 64 + 8 + 5$

$\therefore R_A = 52.6$ KN

$\frac{x}{52.6} = \frac{4-x}{11.4}$

$\therefore x = 3.3$

9/



$L = B + 2Sh$

$L = 6 + 2 \times 2 \times 3 = 18\ m$

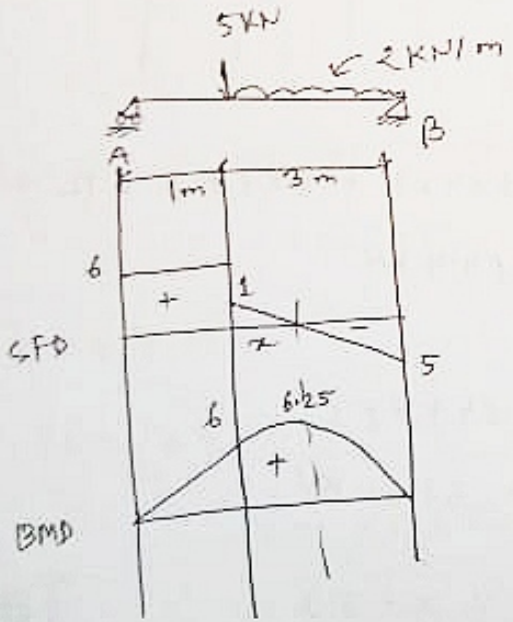
Volume of Excavation $= \frac{1}{2}(6+18) \times 3 \times 500$

$= 18000\ m^3$.

Pdf Page 18

(Civil Solution)

3/



$\Sigma M_B = 0$ (a+ve)

$\Rightarrow R_A \times 4 = 5 \times 3 + 2 \times 3 \times 1.5$

$\therefore R_A = 6\ KN$

$\Sigma V = 0$ (↑+ve)

$\Rightarrow R_A + R_B = 5 + 6 \quad \therefore R_B = 5\ KN$

$\frac{x}{1} = \frac{3-x}{5}$

$\therefore x = 0.5\ m$

2/

Volume of concrete $= 2 \times 2 \times 0.5$

$= 2\ m^3$

Dry volume $= 1.5 \times 2 = 3\ m^3 = 105.93\ cft$

Cement $= \frac{105.93}{7} = 15.13\ cft = 12.11\ bags$

$\approx 13\ bags$

Sand $= \frac{105.93}{7} \times 2 = 30.26\ cft$

Stone $= \frac{105.93}{7} \times 4 = 60.52\ cft$

Length of reinforcement $= (2 - 2 \times 0.075)\ m$ [cover = 3" = 7.5 cm]

$= 1.85\ m$

Reinforcement in one direction $= \frac{1.85}{0.1125} + 1$

$= 15.8 \approx 16$ nos

Total Amount of reinforcement = $(2 \times 16 \times 1.85 \times 1.578)$ kg

$= 93.42$ kg

≈ 94 kg

6/

$$F_{com} = \frac{FM_1 \times m_1 + FM_2 \times m_2}{m_1 + m_2}$$

$$= \frac{1.9 \times 0.5 + 2.8 \times 0.75}{1.25}$$

$$= 2.44$$

Technical College teacher 2017(AE)

5/ Volume of Concrete $= 4 \times 7.5 \times 0.15$

$= 4.5\ m^3$

Dry volume $= 1.5 \times 4.5 = 6.75\ m^3$

$= 238.34$ cft

cement $= \frac{238.34}{7} = 34.1$ cft $= 27.24$ bags ≈ 28 bags

Sand $= \frac{238.34}{7} \times 2 = 68.2$ cft

Brick chips $= \frac{238.34}{7} \times 4 = 136.4$ cft.

4/ $P = 250$ metric ton $= 250 \times 10^3$ kg

$f'_c = 200$ kg/cm^2

$f_y = 3500$ kg/cm^2 Here, $\phi = 0.75$

Let, $\rho = 0.02$

$\therefore \frac{A_{st}}{A_g} = 0.02 \Rightarrow A_{st} = 0.02\ A_g$

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

$\Rightarrow 250 \times 10^3 = \frac{0.85 \times 0.7}{0.75} [0.85 \times 200 (A_g - 0.02 A_g) + 3500 \times 0.02 A_g]$

$\Rightarrow 250 \times 10^3 = \frac{0.85 \times 0.7}{0.75} [166.6\ A_g + 70\ A_g]$

$\Rightarrow A_g = \frac{250 \times 10^3}{0.85 \times 0.7 \times 236.6}$

$\therefore A_g = 1775.9$ cm^2 $= 1776$ cm^2

Now, $\frac{\pi}{4} D^2 = 1776$

$\therefore D = 47.55$ cm ≈ 48 cm

So, $A_g = \frac{\pi}{4}(48)^2 = 1809.6\ cm^2$

Again, Load carried by concrete

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

$\Rightarrow P_c = 0.85 \times 0.7 [0.85 \times 200 (1809.6 - A_{st}) + 0.02 \times 1809.6)]$

$= 179.4 \times 10^3\ kg$ ~~$3500 A_{st}$~~]

~~$420.2 \times 10^3 = 307.6 \times 10^3 - 170 A_{st} + 3500 A_{st}$~~

Load carried by Steel, $P_{st} = (250 - 179.4) \times 10^3\ kg$

~~$\therefore A_{st} = 33.82\ cm^2 = 5.24\ in^2$~~ $= 70.6 \times 10^3\ kg$

NOW, $P_{st} = \alpha \phi f_y A_{st} \Rightarrow A_{st} = \frac{70 \times 10^3}{0.85 \times 0.7 \times 3500}$

use # 8 bar $= \frac{5.25}{0.79}$ Nos $= 33.9\ cm^2$
$= 5.25\ in^2$

$= 6.63 \approx 7$ Nos.

$\rho = \frac{A_{st}}{A_g} = \frac{33.9}{1809.6} = 0.019 < 0.02$ (OK)

3/ b) $R = 1m$

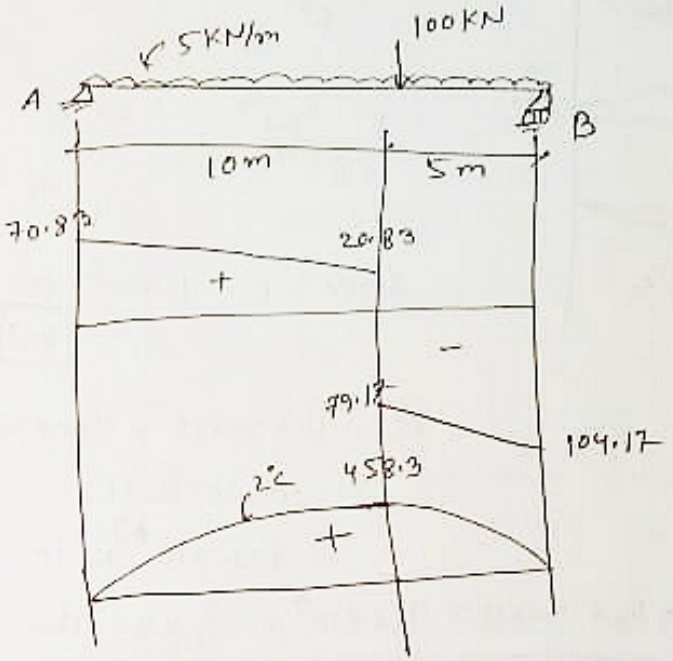
$V = 70\ km/hr = 19.44\ m/s$

$R = \frac{1719}{4} = 429.75\ m$

$e = \frac{GV^2}{gR} = \frac{1 \times (19.44)^2}{9.81 \times 429.75}$

$= 0.0896\ m = 8.96\ cm$.

1/



$\Sigma M_A = 0$ (+ve)

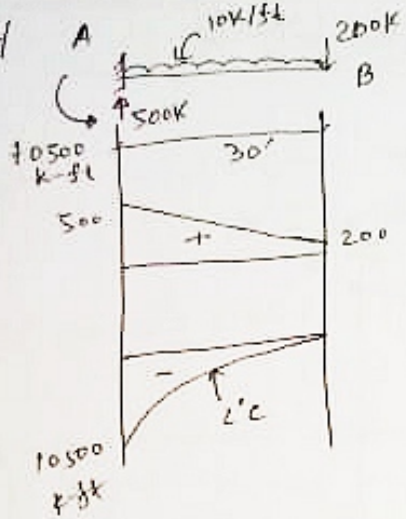
$\Rightarrow R_B \times 15 = 5 \times 15 \times 7.5 + 100 \times 10$

$\therefore R_B = 104.17\ KN$

$\Sigma V = 0$ (+ve)

$\Rightarrow R_A + R_B = 75 + 100 \quad \therefore R_A = 70.83\ KN$

কুদ্দুসিয়াত ইনস্টিটিউট (2022)

2/ 

$I = \frac{bd^3}{12} = \frac{6 \times 12^3}{12}$

$= 864 \text{ in}^4$

Given, $E = 12 \times 10^5$ psi (ksi)

$M = 10 \times 30 \times 15 + 200 \times 30$

$= 10500$ k-ft

$= 126 \times 10^3$ k-in

$$y_{max} = \frac{-1/3 \times 30 \times 12 \times 126 \times 10^3 \times \frac{3}{4} \times 30 \times 12}{12 \times 10^5 \times 864}$$

$= -3.94$ in

$= 3.94$ in (↓).

(3/ ধ্রু)

Given,

$L = 100$ m

$W = 5$ Kg

$A = 0.017$ m^2

$P_m = 30$ Kg

$P_o = 0$ Kg

$ML = 2000$ m

$E = 2.1 \times 10^6$ Kg/cm^2 $= 2.1 \times 10^{10}$ Kg/m^2

$n = 2$

Pull correction, $C_p = \frac{P_m - P_o}{AE} \times L$

$= \frac{(30-0)}{2.1 \times 10^{10} \times 0.017} \times 100$

$= 8.4 \times 10^{-6}$ m

Sag " , $C_s = \frac{LW^2}{24n^2 P_m^2}$ (Always Negative)

$= \frac{100 \times (5)^2}{24 \times 2^2 \times (30)^2}$

$= 0.029$ m

$L' = 100 + 8.4 \times 10^{-6}\ m - 0.029$

$= 99.97\ m$

True Length $= \frac{99.97}{100} \times 2000$

$= 1999.4\ m.$

8/ 21) Given,

$G = 1\ m\ (M.G)$

$R = \frac{1719}{6} = 286.5\ m$

$V = 100\ Km/hr = 27.78\ m/s$

$SE = \frac{GV^2}{gR}$

$= \frac{1 \times (27.78)^2}{9.81 \times 286.5}$

$= 0.275\ m$

Theoritical cant deficiency $= (0.275 + 0.051)$

$= 0.326\ m$

[upto 100 Km/hr. C.D. MG = 5.1cm. B.G = 7.6cm]

$SE = \frac{GV^2}{gR}$

$\Rightarrow V = \sqrt{SE \times g \times R}$

$= \sqrt{0.326 \times 9.81 \times 286.5}$

$= 30.27\ m/s = 109\ Km/hr \ldots\ (1)$

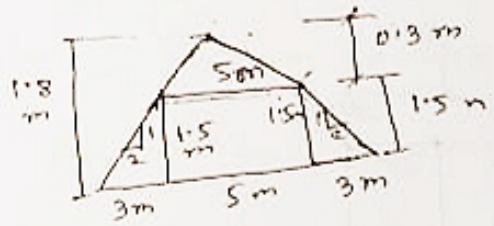
Again, $V = 4.4\sqrt{R - 70}$

$= 4.4 \times \sqrt{286.5 - 70}$

$= 64.8\ km/hr \ldots\ (2)$

Lower value in the Answer between (1) & (2).

9/ 25)



Area of excavation $= \frac{1}{2}(5+11) \times 1.5 + \frac{1}{2} \times 5 \times 0.3$

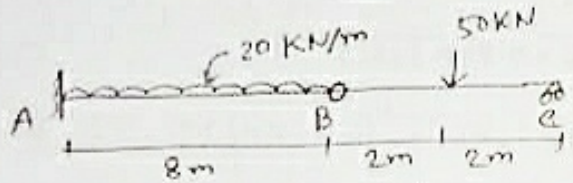
$= 12.75\ m^2$

Volume " " $= (12.75 \times 300)\ m^3$

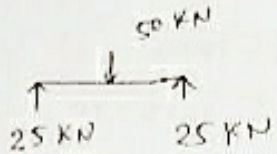
$= 3825\ m^3.$

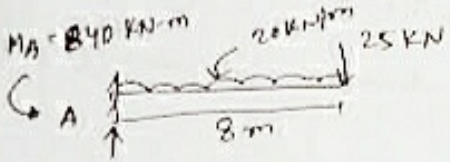
Correction of (39) page

SFD & BMD



For BC

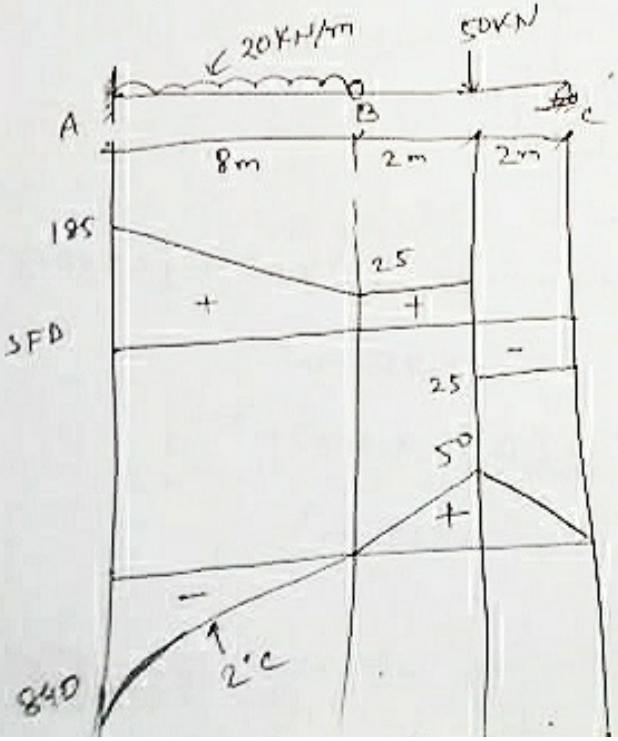




$M_A = 20 \times 8 \times 4 + 25 \times 8$

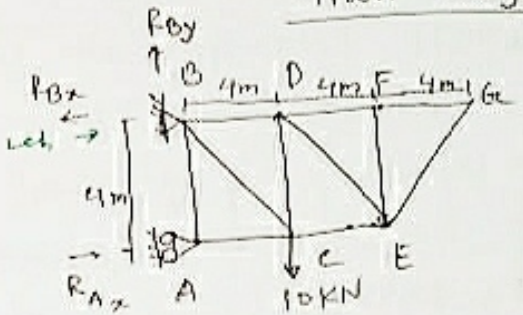
$= 840$ KN-m

$R_A = 185$ KN



Correction of (19) page

Truss analysis



$\Sigma M_A = 0$ (⟲ +ve) $\Rightarrow R_{Bx} \times 4 + 10 \times 4 = 0$

$\Rightarrow R_{Bx} \times 4 = -10 \times 4$ $\therefore R_{Bx} = -10$ KN

$= 10$ KN (←)

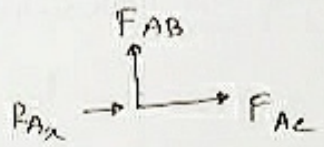
$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_{By} - 10 = 0$ $\therefore R_{By} = 10$ KN.

$\Sigma F_x = 0$ (→ +ve) $\Rightarrow R_{Ax} + R_{Bx} = 0$

$\Rightarrow R_{Ax} = -R_{Bx}$ $\therefore R_{Ax} = 10$ KN.

joint A



$\Sigma F_x = 0$ (→ +ve)

$\Rightarrow R_{Ax} + F_{AC} = 0$

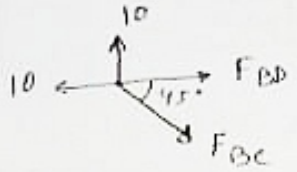
$\therefore F_{AC} = -10$ KN

$= 10$ KN (←)

$\Sigma F_y = 0$ (↑ +ve)

$\Rightarrow F_{AB} = 0$.

Joint B



$\theta = \tan^{-1}\left(\frac{4}{4}\right)$

$= 45^\circ$

$\Sigma F_x = 0$ (→ +ve)

$\Rightarrow -10 + F_{BD} + F_{BC}\cos 45^\circ = 0$

$\Rightarrow -10 + F_{BD} + 14.14 \times \cos 45^\circ = 0$

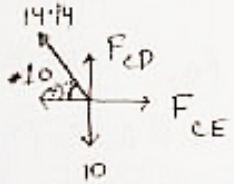
$\therefore F_{BD} = 0$.

$\Sigma F_y = 0$

$\Rightarrow 10 - F_{BC}\sin 45^\circ = 0$

$\therefore F_{BC} = 14.14$ kN

Joint C



$\Sigma F_x = 0$ (→ +ve)

$\Rightarrow -10 + F_{CE} + 14.14\cos 45^\circ = 0$

$\therefore F_{CE} = 0$

$\Sigma F_y = 0$ (↑ +ve)

$\Rightarrow 14.14\sin 45^\circ + F_{CD} - 10 = 0$

$\therefore F_{CD} = 0$

All other are Zero force member

2016/08

6/

500 w = 500 × 145 = 72500 psi

60 grade = 60,000 psi

Spacing for main bar: (12 mm ϕ)

for 60,000 psi, Spacing $= \left(\frac{8 \times 72500}{60000}\right)''$

" 72500 psi, " $= 9.67'' \approx 9.5''$.

Steel for distribution:

$A_s = \frac{0.0018 \times 60,000}{72,500} \times 12 \times 6$

$= 0.1072$ in²/ft

Spacing for distribution bar $= \frac{0.11 \times 12}{0.1072}$ [10 mm bar]

$= 12.3'' \approx 12''$ c/c

Spacing should not exceed,

for main bar = 3t = 3×6 = 18"

" distribution " = 5t = 5×6 = 30"

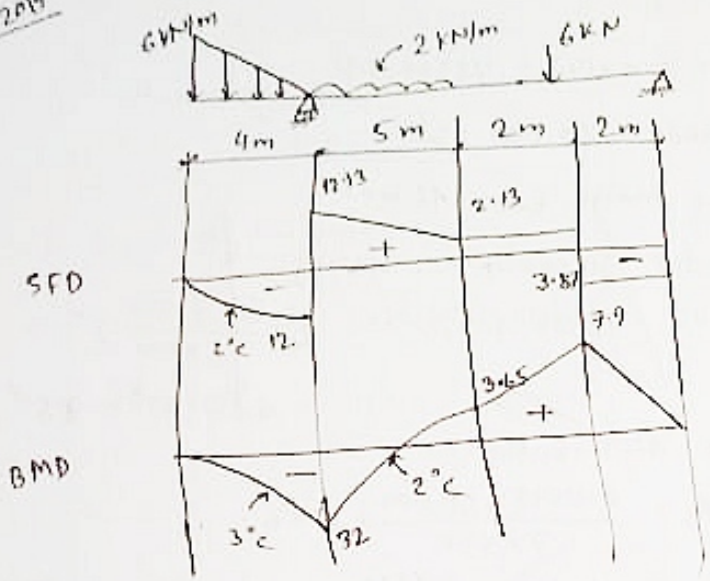
∴ 9.5" c/c for main bar and 12" c/c for distribution bar.

Note: f_y < 60 grade হলে, $A_{st} = 0.002bt$ [Distribution steel]

f_y = 60 " " , $A_{st} = 0.0018bt$

f_y > 60 " " , $A_{st} = \frac{0.0018 \times 60000}{f_y} bt$

LGED
AE 2019



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

$\Rightarrow \frac{1}{2} \times 6 \times 4 \left(9 + \frac{2}{3} \times 4\right) + 2 \times 5 \times 6.5 + 6 \times 2 = R_A \times 9$

$\therefore R_A = 24.13$ KN

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = \frac{1}{2} \times 6 \times 4 + 2 \times 5 + 6$

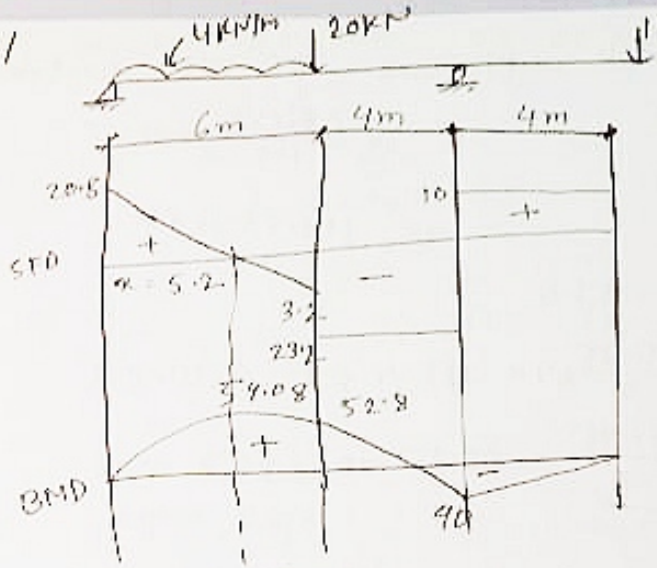
$\therefore R_B = 3.87$ KN.

LGED
SAE 2019

a/ Volume of earthwork $= 40 \times 10,000 \times 4$
$= 1.6 \times 10^6$ m^3

Required Volume of Sand: $(1.6 \times 10^6 + 0.15 \times 1.6 \times 10^6)$
$= 1.84 \times 10^6$ m^3.

b/



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

$\Rightarrow 4 \times 6 \times 3 + 20 \times 6 + 10 \times 14 = R_B \times 10$

$R_B = 33.2$ K

$\Sigma V = 0$ (↑ +ve)

$\Rightarrow R_A + R_B = 6 \times 4 + 20 + 10$

$\therefore R_A = 20.8$ K.

$\frac{x}{20.8} = \frac{6-x}{3.2}$

$\Rightarrow 3.2x = 124.8 - 20.8x$

$\therefore x = 5.2$

c/ Area of brick work $= 2(10 \times 10 + 12 \times 10) - 2(4 \times 5) - (3 \times 7)$
$= 379$ ft^2.

Volume of brick work $= \left(379 \times \frac{10}{12}\right)$ cft
$= 314.6$ cft
≈ 315 cft

We know, 1 cft brick work needs 12 Nos.

Total Bricks reqd $= (315 \times 12)$ Nos
$= 3780$ Nos.

We Know,

100 cft brick work need 45 cft mortar

∴ 315 cft " " " " $\left(\frac{45\times315}{100}\right)$ cft "

= 141.75 cft

Given ratio 1 : 4

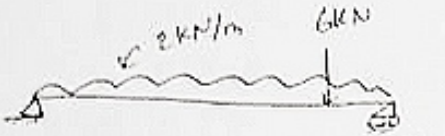
Sand reqd = $\frac{141.75}{5}\times4$ = 113.4 cft ≈ 114 cft

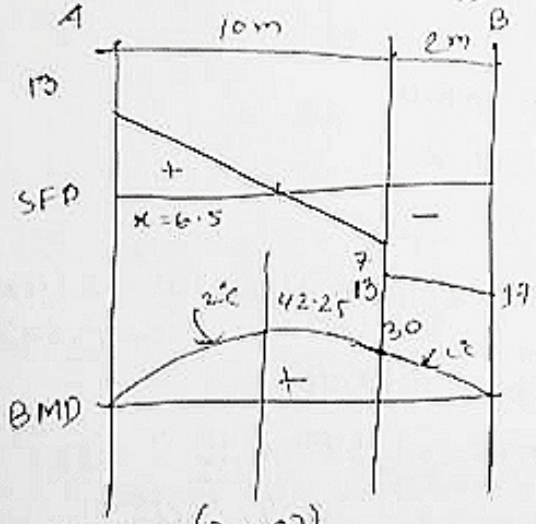
Cement " = $\frac{141.75}{5}$ = 28.35 cft = 22.7 bags

≈ 23 bags.

HED SAE 2020

2/





$\frac{x}{13} = \frac{10-x}{7}$

⇒ $7x = 130 - 13x$

∴ $x = 6.5$

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

⇒ $R_B \times 12 = 12\times12\times6 + 6\times10$

∴ R_B = 17 kN

$\Sigma M_V = 0$ (1 +ve) ⇒ $R_A + R_B$ = 24+6

∴ R_A = 13 kN

3/ Given R = 500 m, V = 100 km/hr = 27.78 ms^{-1}

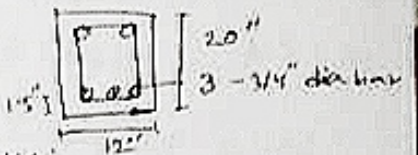
f = 0.11

So, $e+f = \frac{V^2}{gR}$

⇒ $e = \frac{(27.78)^2}{9.81\times500} - 0.11$ ∴ e = 0.086 m = 8.6 cm.

4/ Here, b = 12" f'_c = 3Ksi, f_y = 60Ksi

d = 20 − 1.5 = 18.5"



$A_S = \frac{\pi}{4}\times\left(\frac{3}{4}\right)^2\times3 = 1.33$ in^2

$f''_c = 0.45 f'_c$ ∴ f_c = 1.35 Ksi

$f_s = 0.4 f_y$ ∴ $f_s = 0.4\times60$ = 24 Ksi.

$n = 9.28 = \frac{29\times10^6}{57000\sqrt{f'_c}}$

We know, $\frac{bx^2}{2} = nA_s(d-x)$

⇒ $\frac{12\times x^2}{2} = 9.28\times1.33\,(18.5-x)$

∴ x = 5.23

$M_c = M_T = M$ = 100 K-ft = 1200 K-in.

$M_c = \frac{f_c}{2} bx\left(d - \frac{x}{3}\right)$

⇒ $1200 = \frac{f_c}{2}\times12\times5.23\left(18.5 - \frac{5.23}{3}\right)$

∴ f_c = 2.24 Ksi ~~(safe)~~ (safe)

∴ f'_c = 4.98 Ksi > 3 Ksi (Not Safe)

$M_T = A_s f_s \left(d - \frac{x}{3}\right)$

⇒ $1200 = 1.33\times f_s \left(\text{or } 18.5 - \frac{5.23}{3}\right)$

∴ f_s = 53.85 Ksi

$f_y = \frac{53.85}{0.4}$ = 134.6 Ksi > 60 Ksi. (Not Safe)

HED
AE 2020

3/ 4f) Chlorine reqd = dose × Quantity
= $(0.5 \times 10^{-6}$ kg/L) × $(4 \times 10^{6}$ Litres)
= 2 kg.

Bleaching powder reqd = $2 \times \frac{100}{30}$ = 6.67 kg.

2/ 3f) V = 30 mph = 13.41 m/s (Also consider A = 0.15)

Let, t = 2.5 Sec, A = 0.4, n = 5.1% = ±0.05

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

$= 13.41 \times 2.5 + \frac{(13.41)^2}{2 \times 9.8 (0.4 \pm 0.05)}$

∴ SSD = 53.9 m ≈ 54 m (upgrade, n → +ve)

SSD = 59.8 m ≈ 60 m (downgrade, n → −ve)

4/ 4f) SPT = Last two 6" penetration blow number of three consecutive 6" penetration
= 6 + 8 = 14.

6/ 3f) $BOD_5 = L_o(1 - e^{-kt})$

$\Rightarrow 150 = L_o(1 - e^{-0.23 \times 5})$

∴ L_o = 219.5 mg/L

Rate Constant at 15°C, $K_{T_1} = K_{T_2}(1.047)^{T_1 - T_2}$

$= 0.23(1.047)^{15-20}$

= 0.183.

$BOD_8 = L_o(1 - e^{-kt})$

$= 219.5(1 - e^{-0.183 \times 8})$ = 168.65 mg/L.

21) Volume = $5 ft \times 2.5 ft \times 5 in = \left(\frac{5}{3.28} \times \frac{2.5}{3.28} \times \frac{5}{12 \times 3.28}\right)$

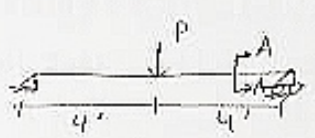
= 0.15 m^3.

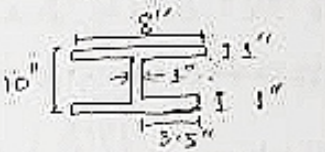
∴ Dry volume = (0.15×1.5) = 0.225 m^3.

∴ weight of block = 0.225 × 2130 = 479.25 kg.

Amount of cement = $\frac{479.25}{7}$ = 68.5 kg ≈ 69 kg.

2/





Given,
σ_{allow} = 9 ksi
τ_{allow} = 1.5 ksi
E = 29000 ksi

Deflection, $\Delta = \frac{PL^3}{48EI}$ ——— ①

Moment of Inertia, $I = \frac{8 \times 10^3}{12} - 2 \times \frac{3.5 \times 8^3}{12}$

= 368 in^4.

Maxm Moment = $\frac{PL}{4} = \frac{P \times 8 \times 12}{4}$ = 24P K-in

Shear = $P/2$ = 0.5P

Moment of area above or ~~below~~ bottom of neutral axis, Q = $\left(8 \times 5 \times \frac{5}{2} - 2 \times 3.5 \times 4 \times \frac{4}{2}\right)$ = 44 in^3

$\sigma_{allowable} = \frac{M_{max} \times c}{I}$

$\Rightarrow 9 = \frac{24P \times 5}{368}$

∴ P = 27.6 kip

$\tau_{max} = \frac{VQ}{Ib}$

$\Rightarrow 1.5 = \frac{0.5P \times 44}{368 \times 1}$

∴ P = 25.09 kip = 25.09 k

$\Delta_{max} = \frac{25.09 \times (8 \times 12)^3}{48 \times 29000 \times 368}$

= 0.043"

7/ Total load, $w = 3.47 \times 1.27 + 1.7 \times 2.2 = 3.47\ K$ ~~5.52 K~~ [Load factor 1.27 & 2.2]

USD method

Maxm bending moment, $M = \frac{wL^2}{8} = \frac{5.52 \times 15^2}{8}$ [1.4 DL + 1.7 LL]

$= 97.6\ K\text{-ft}$

$= 1171.2\ K\text{-in}$.

$= 1863\ K\text{-in}$

$\rho_{max} = 0.85\,\beta_1 \frac{f'_c}{f_y} \times \frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}$

$= 0.85 \times 0.85 \times \frac{4}{60} \times \frac{0.003}{0.003 + 0.005}$

$= 0.0181$,

[BNBC-2006 WSD/USD Both correct]

$M_u = \phi \rho f_y b d^2 \left[1 - 0.59 \rho \frac{f_y}{f'_c}\right]$ Assume, $b = 12''$

$\Rightarrow \frac{1863}{1171.2} = 0.9 \times 0.0181 \times 60 \times 12 \times d^2 \left[1 - 0.59 \times 0.0181 \times \frac{60}{3}\right]$

$\Rightarrow d^2 = 126.976$ $\therefore d = 11.26$ in ≈ 11.5 in.

$= 14.22 \approx 14.5$ in

Total thickness: $14.5 + 1.5$ [clear cover = 1.5"]

$= 16''$

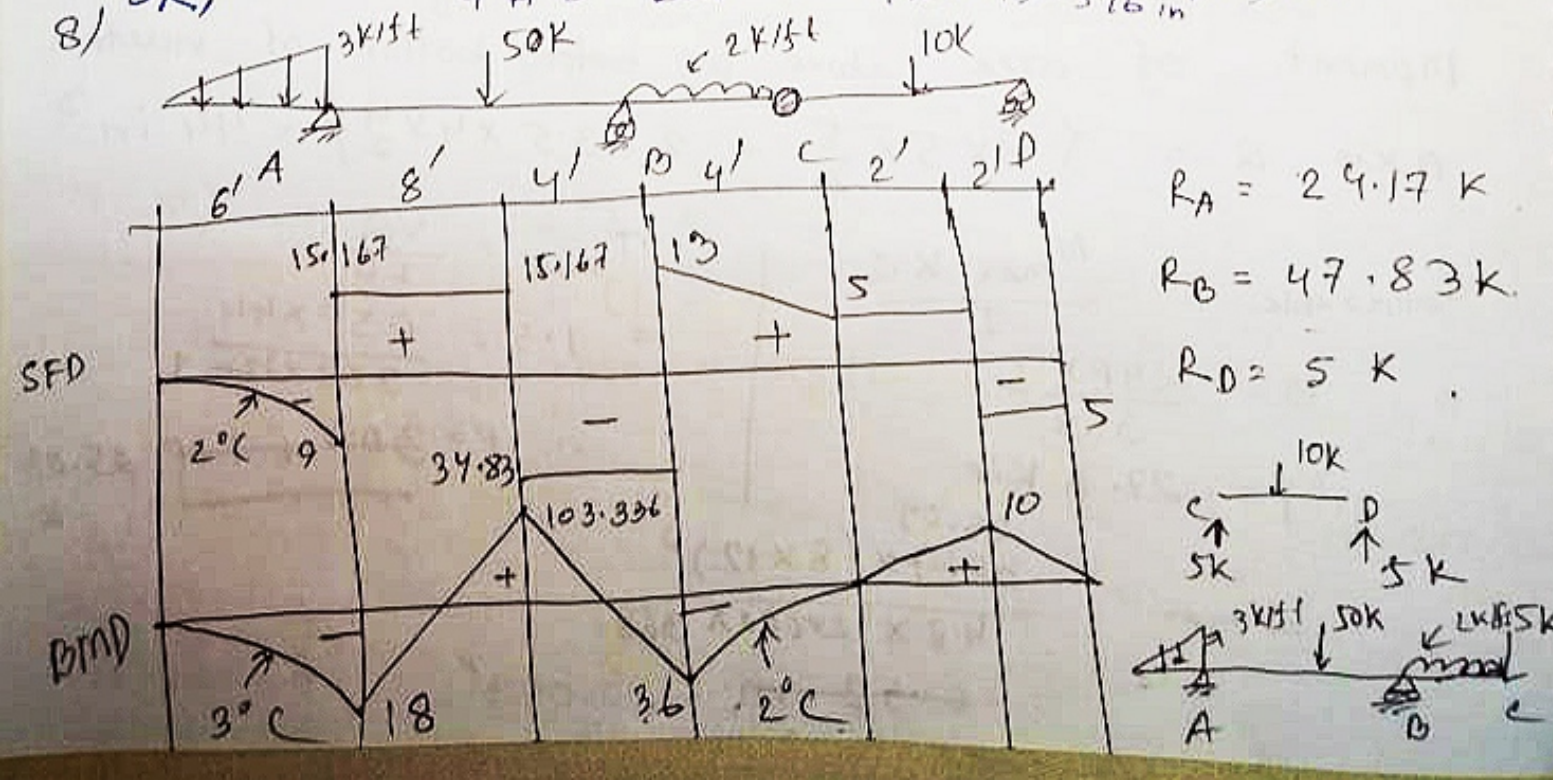
beam size $12'' \times 16''$

Steel area, $A_s = \rho b d = 0.0181 \times 12 \times 14.5 = 3.15\ in^2$ ~~2.48~~

Provide 8 #6 bar $= 8 \times 0.44 = 3.52\ in^2$ ~~2.48~~.

" 4 #8 bar $= 4 \times 0.79 = 3.16\ in^2$

8/ OR,



$R_A = 24.17\ K$

$R_B = 47.83\ K$

$R_D = 5\ K$.