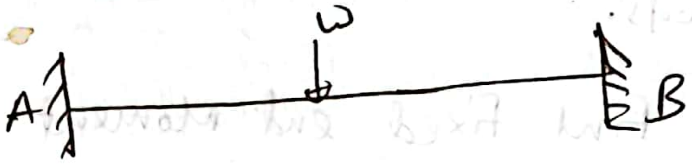
BCS

③ Slope deflection Method for indeterminate Structure :-



$$M_{AB} = M_{AB}^{F} + \frac{2EI}{L}\left(2\theta A + \theta B - \frac{3\delta}{L}\right)$$

use this for, L → R

$$M_{BA} = M_{BA}^{F} + \frac{2EI}{L}\left(2\theta B + \theta \cancel{A} - \frac{3\delta}{L}\right)$$

Here, M_{AB}^{F}, M_{BA}^{F} = Fixed end Moment

θ = ~~deflection~~ slope, for fixed end slope, $\theta = 0$

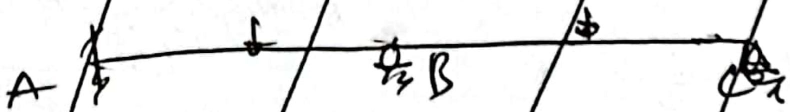
~~δ = If def~~

δ = deflection

Note: If deflection is given in question take δ or take $\delta = 0$ if not given.

settle

Note:- Same formula for all types of Beam.



$$M_{BC} = M_{BA}^{F} + \frac{M_{CB}^{F}}{2} + \frac{3EI}{L}\theta_B$$

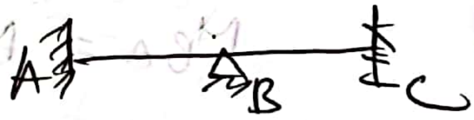
$M_{CB} = 0$

Steps for calculating SF & BM applying slope deflection Methods:

Step:1 - Find fixed end Moment

Step:2 Apply slope deflection equation for each span

Step:3 Apply condition for Equilibrium

$M_{BA} + M_{BC} = 0$ for 

$M_{AB} = 0 \mid M_{CB} = 0$ for, 

Step 4: Find final Moment

Step 5: - Find support reaction

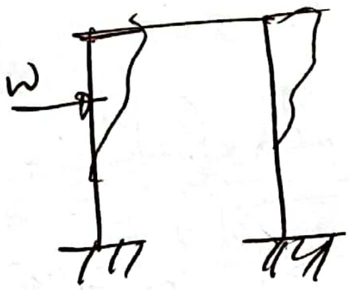
Step 6: Draw SFD & BMD

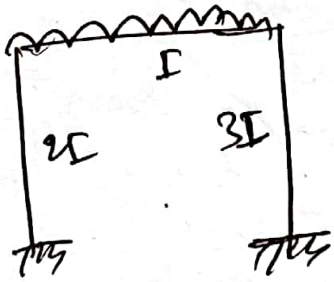
Difference between sway and non-sway frame

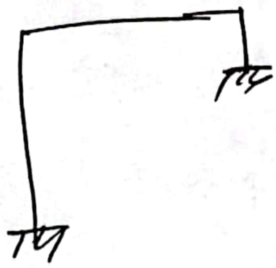
Sawy

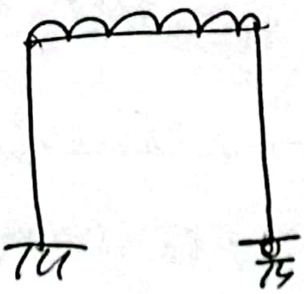
- One of these or more of these condⁿ will fail.

Ex:-

(1) 

(2) 

(3) 

(4) 

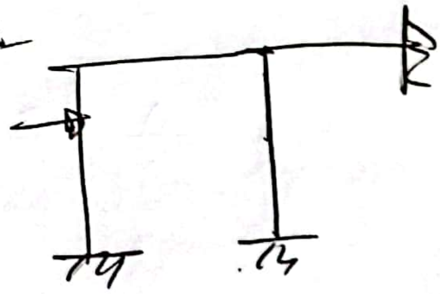
Non sway

~~Stisfy~~ Satisfy all these condⁿ:-

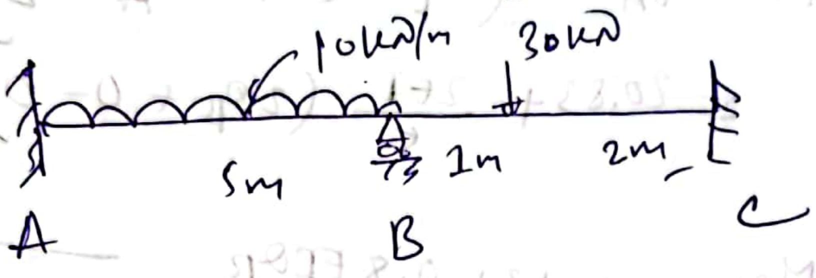
- check for symmetric loading
- check for symmetrical EI
- Check for verticle member length
- check for symetrical supports.

Non-sway ~~way~~ member when all are checked.

Ex:-



Q) Draw SFD & BMD using slope deflection Method.



Sol^n:-

Step 1:- FEM

$$M_{AB}^F = -\frac{wl^2}{12} = -\frac{10\times5^2}{12} = -20.83 \text{ kNm}$$

$$M_{BA}^F = +\frac{wl^2}{12} = 20.83 \text{ kNm}$$

$$M_{BC}^F = -\frac{wab^2}{L^2} = -\frac{30\times1\times2^2}{3^2} = -13.33 \text{ kNm}$$

$$M_{CB}^F = +\frac{wa^2b}{L^2} = \frac{30\times1^2\times2}{3^2} = +6.67 \text{ kNm}$$

Step 2:- Apply slope deflection equation for each span.

For span AB,

$$M_{AB} = M_{AB}^F + \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$$

$$= -20.83 + \frac{2EI}{5}\left(2\times0 + \theta_B - \frac{3\times0}{L}\right)$$

$$= -20.83 + \frac{2EI\theta_B}{5}$$

$$M_{AB} = -20.83 + 0.4EI\theta_B \quad \text{——— (1)}$$

$$M_{BA} = M_{BA}^F + \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\delta}{2}\right)$$

$$= 20.83 + \frac{2EI}{5}(2\theta_B + 0 - 0)$$

$$M_{BA} = 20.83 + 0.8\,EI\theta_B \quad \text{——— (II)}$$

<u>For Span BC</u>

$$M_{BC} = M_{BC}^F + \frac{2EI}{L}\left(2\theta_B + \theta_C - \frac{3\delta}{2}\right)$$

$$= -13.33 + \frac{2EI}{3}(2\theta_B + 0 - 0)$$

$$M_{BC} = -13.33 + 1.33\,EI\theta_B \quad \text{——— (III)}$$

$$M_{CB} = 6.67 + \frac{2EI}{3}\left(2\theta_C + \theta_B - \frac{3\delta}{2}\right)$$

$$= 6.67 + \frac{2EI}{3}(2\times 0 + \theta_B - 0)$$

$$M_{CB} = 6.67 + 0.67\,EI\theta_B \quad \text{——— (IV)}$$

<u>Step 3</u> Apply condⁿ for equilibirium

$$M_{BA} + M_{BC} = 0$$

$$\Rightarrow 20.83 + 0.8\,EI\theta_B - 13.33 + 1.33\,EI\theta_B = 0$$

$$\Rightarrow EI\theta_B = -3.52$$

$$\therefore \theta_B = -\frac{3.52}{EI}$$

Step 4:-

From (I), (II), (III), (IV) using $EI\theta_B$ values,

$$M_{AB} = -20.83 + 0.4 \times (-3.51)$$

$$= -22.234 \text{ kNm} = 22.234 \text{ kNm}$$

$$M_{BA} = 20.83 + 0.8(-3.51)$$

$$= 18.022 \text{ kNm}$$

$$M_{BC} = -13.33 + 1.33(-3.51)$$

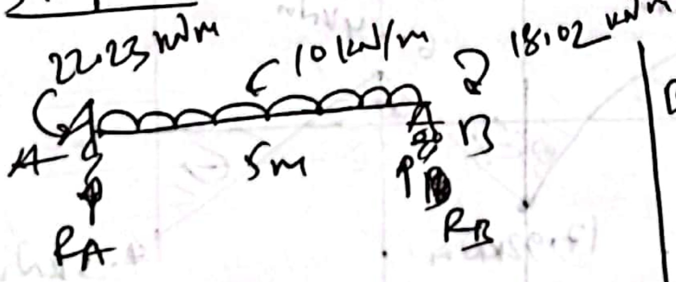
$$= -17.998 \text{ kNm}$$

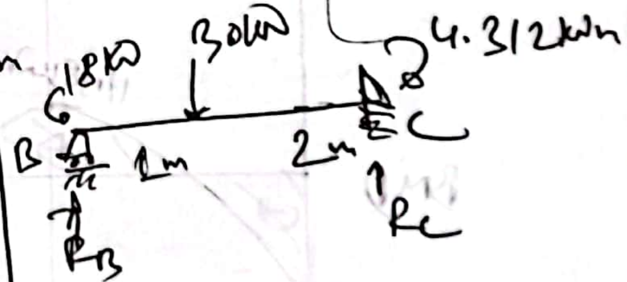
$$= 17.998 \text{ kNm} \approx 18 \text{ kNm}$$

$$M_{CB} = 6.67 + 0.67(-3.52)$$

$$= 4.312 \text{ kNm}$$

Step:5 find reaction





$\Sigma M_A = 0$

$R_B \times 5 + 22.23 = 50 \times 2.5 + 18.02$

$\therefore R_B = 24.15 \text{ kN}$

$\Sigma F_y = 0$

$R_A = 25.85 \text{ kN}$

$\Sigma M_B = 0$

$R_C \times 3 + 18 = 4.312 + 30 \times 1$

$R_C = 5.44 \text{ kN}$

$\Sigma F_y = 0$

$R_B = 24.56 \text{ kN}$

Final Reaction

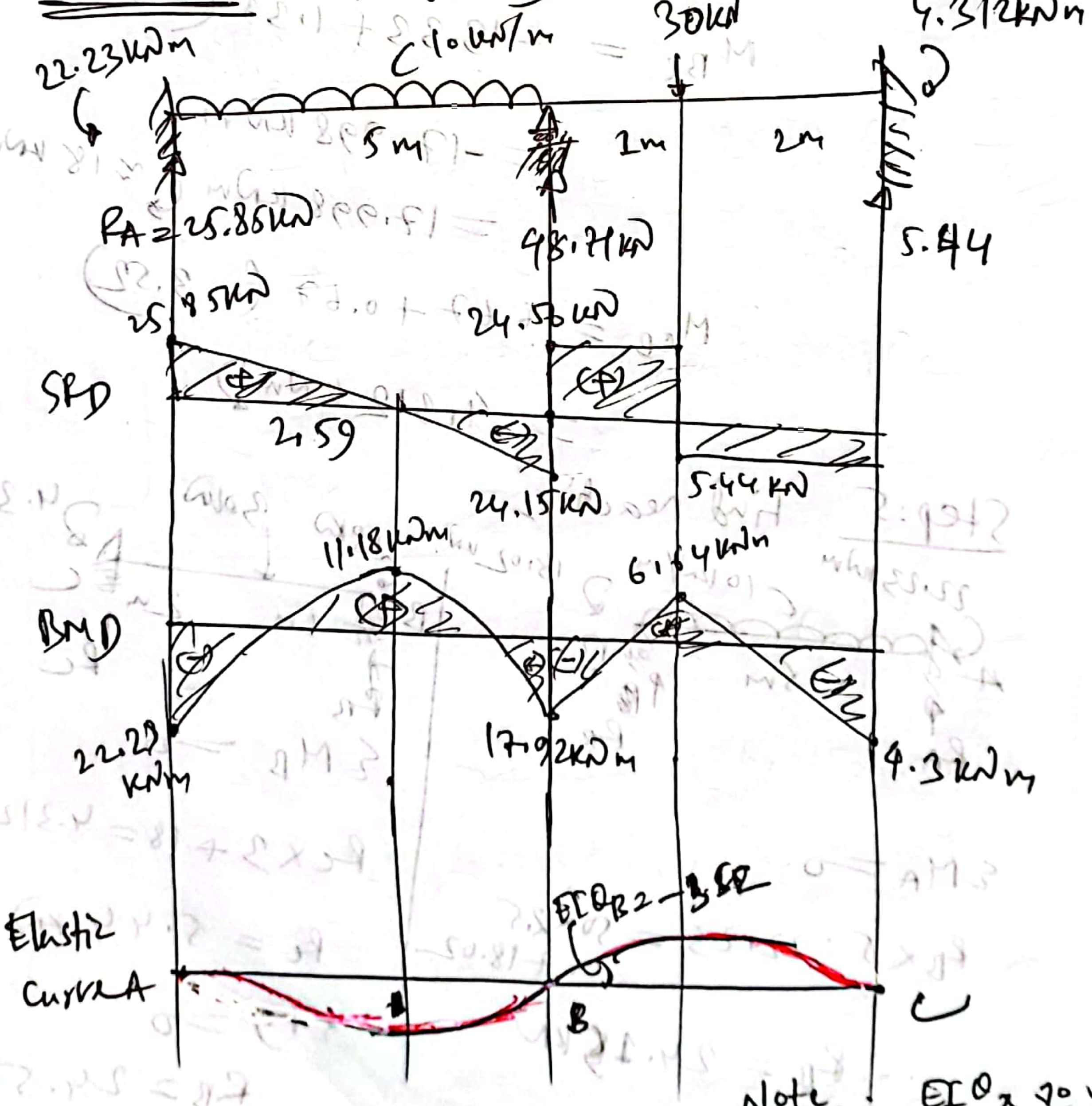
$R_A = 25.85$ kN

$R_B = (24.15 + 24.56)$ kN

$= 48.71$ kN

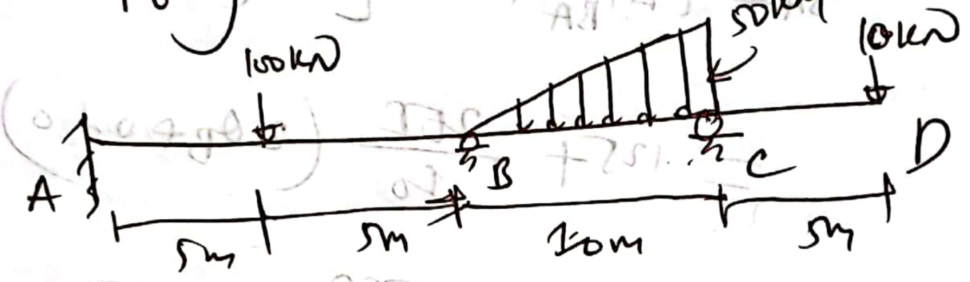
$R_C = 5.44$ kN

Step:6 SFD & BMD



Note: $EI\theta_x$ এর value + হলে নিচে এবং (−) হলে উপরে deflect

Q) Draw shear force and Bending Moment Diagram of the following continuous beam.



Sol^n:—

Step:1 FEM

$$FEM_{AB} = -\frac{wl}{8} = -\frac{100\times10}{8} = -125 kNm$$

$$FEM_{BA} = \frac{wl}{8} = 125 kNm$$

$$FEM_{BC} = -\frac{wl^2}{30} = -\frac{50\times10^2}{30} = -166.67 kNm$$

$$FEM_{CB} = +\frac{wl^2}{20} = \frac{50\times10^2}{20} = 250 kNm$$

$$FEM_{CD} = -50 kNm$$

$$FEM_{DC} = 0$$

Step:2 Apply slope deflection equation for each span

For span AB

$$M_{AB} = FEM_{AB} + \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$$

$$= -125 + \frac{2EI}{10}\left(2\times0 + \theta_B - 0\right)$$

$$M_{AB} = -125 + 0.2EI\theta_B \quad \text{—— (1)}$$

For Span BA,

$$M_{BA} = FEM_{BA} + \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\delta}{L}\right)$$

$$= 125 + \frac{2EI}{10}\left(2\theta_B + 0 - 0\right)$$

$$M_{BA} = 125 + 0.4\,EI\theta_B \longrightarrow (i)$$

For span BC

$$M_{BC} = FEM_{BC} + \frac{2EI}{L}\left(2\theta_B + \theta_C - \frac{3\delta}{L}\right)$$

$$= -166.67 + \frac{2EI}{10}\left(2\theta_B + \theta_C - 0\right)$$

$$M_{BC} = -166.67 + 0.4\,EI\theta_B + 0.2\theta_C EI$$

$$\longrightarrow (ii)$$

For span CB

$$M_{CB} = FEM_{CB} + \frac{2EI}{L}\left(2\theta_C + \theta_B - \frac{3\delta}{L}\right)$$

$$= 250 + \frac{4EI}{10}\left(2\theta_C + \theta_B - 0\right)$$

$$M_{CB} = 250 + 0.4\,EI\theta_C + 0.2\,EI\theta_B$$

$$\longrightarrow (iii)$$

~~for span~~

Step: 7 Applying equilibrium cond^n

$$M_{BA} + M_{BC} = 0$$

$$125 + 0.4EI\theta_B - 166.67 + 0.4EI\theta_B + 0.2\theta_C EI = 0$$

$$\Rightarrow 0.8EI\theta_B + 0.2EI\theta_C = 41.67$$

$$\therefore 0.8EI\theta_B + 0.2EI\theta_C = 41.67 \quad \text{--- (v)}$$

and, $M_{CB} - 10 \times 5 = 0$

$$\Rightarrow 250 + 0.4EI\theta_C + 0.2EI\theta_B - 50 = 0$$

$$\therefore 0.2EI\theta_B + 0.4EI\theta_C = -200 \quad \text{--- (vi)}$$

Solving (v) & (vi) we get,

$$EI\theta_B = 202.39$$

$$EI\theta_C = -601.19$$

from (i), (ii), (iii), (iv) we get

$$M_{AB} = -125 + 0.2 \times 202.39$$
$$= -84.522 \text{ KNm}$$

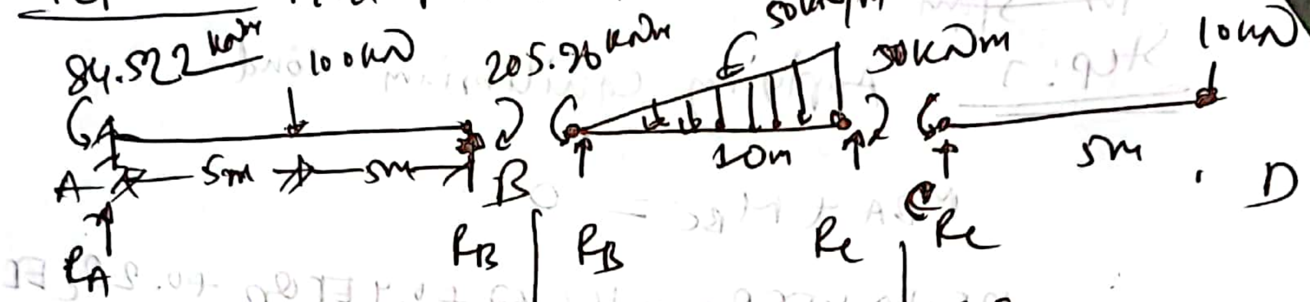
$$M_{BA} = 205.956 \text{ KNm}$$

$$M_{BC} = -205.95 \text{ KNm}$$

$$M_{CB} = 50 \text{ KNm}$$

$$M_{CD} = -50 \text{ KNm}$$

Step 5 : find Reaction



$\Sigma M_A = 0$

$R_B \times 10 + 84.52 = 500 + 205.96$

$\therefore R_B = 62.15$

$\Sigma F_y = 0$

$R_A = 37.85$ kN

$\Sigma M_B = 0$

$R_C \times 10 + 205.96 = 50 + 5 \times 50 \times \frac{2}{3} \times 10$

$\therefore R_C = 151.1$ kN

$\Sigma F_y = 0$

$R_B = 98.9$ kN

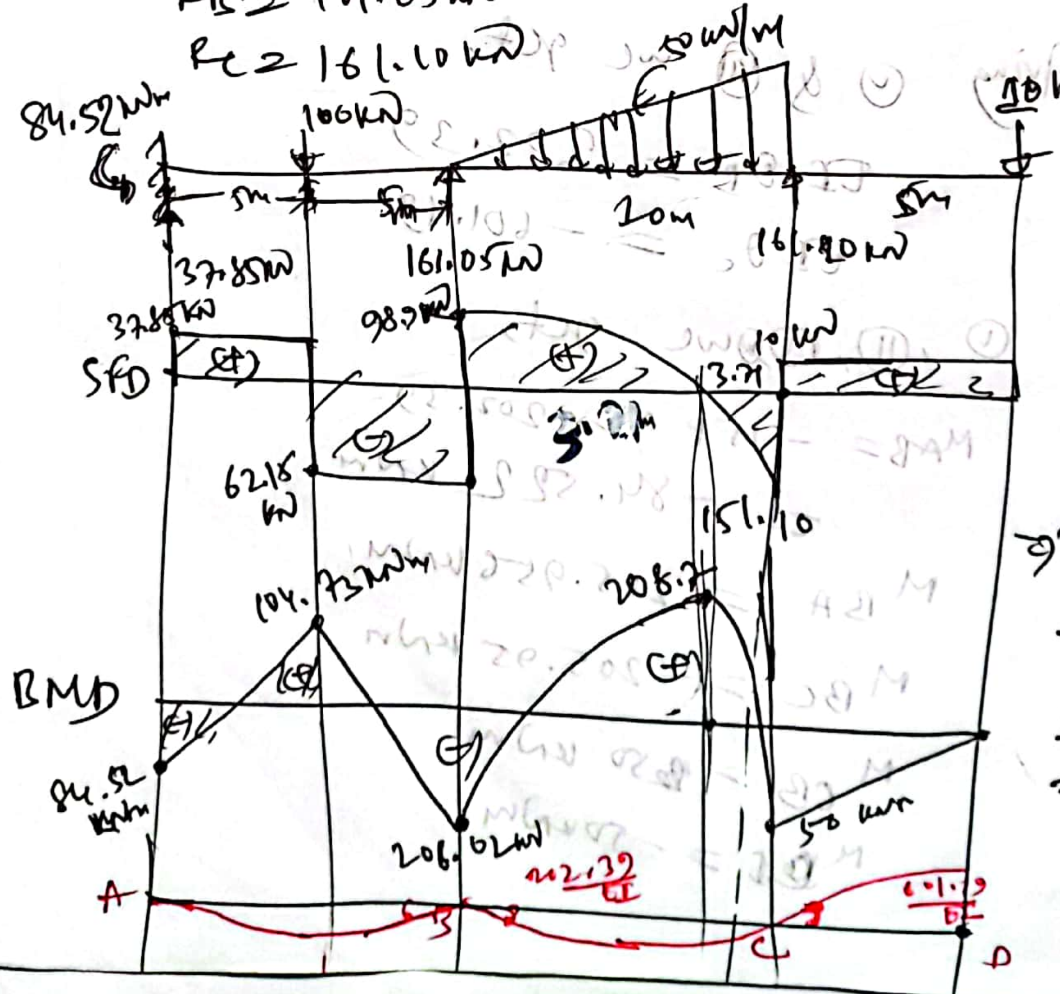
$\Sigma F_y = 0$

$R_C = 10$ kN

$\therefore R_A = 37.85$ kN

$R_B = 161.05$ kN

$R_C = 161.10$ kN



$\frac{x}{5} = \frac{10}{50}$

$y = 2.5$ m (?)

$161.10 = 10 + \frac{1}{2} \times x (50 + 50 - y)$

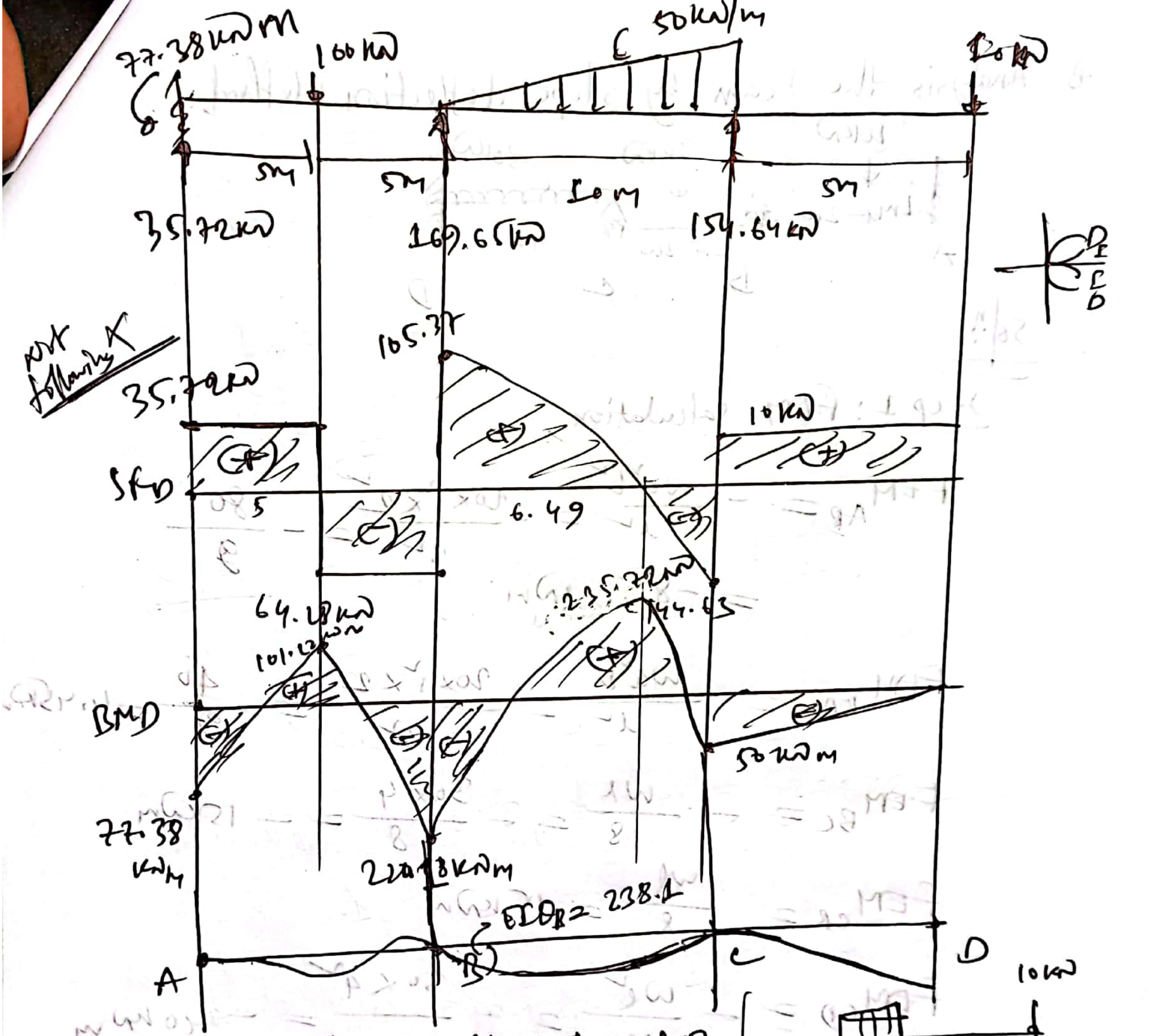
$\Rightarrow 302.2 = 100x - 5x^2$

$\therefore x = 3.71$ m

$\frac{2}{3}$ bh

$= \frac{2}{3} \times 6.29 \times 98.9$

$= 414.72$



$M_x = 154.64 \times 3.51 - 10 \times 8.51$

$- 3.51 \times (50 - 5 \times 3.51) \times \frac{3.51}{2} - \frac{1}{2} \times 3.51 \times 5 \times 3.51 \times \frac{2}{3} \times 3.51$

$= 542 - 85.1 - 199.82 - 72.09$

$= 185.73$ kNm

10 kN

154.64

$\frac{x}{y} = \frac{10}{50}$

$\therefore y = 5x$

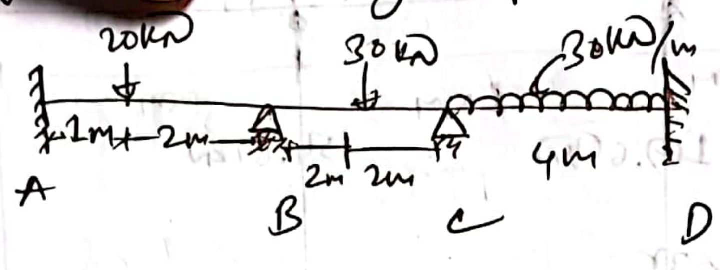
$\Rightarrow 154.64 = 10 + \frac{1}{2} \times x(50 + 50 - 5x)$

$\Rightarrow 144.64 = \frac{1}{2}x(100 - 5x)$

$\Rightarrow 289.28 = 100x - 5x^2$

$\therefore x = 3.51$ m

Ⓑ Analysis ... beam by slope-deflection Method



Sol^n:-

Step 1: FEM calculation,

$$FEM_{AB} = -\frac{Wab^2}{l^2} = -\frac{20\times1\times2^2}{3^2} = -\frac{80}{9}$$

$$= -8.89\ kNm$$

$$FEM_{BA} = \frac{Wa^2b}{l^2} = \frac{20\times1^2\times2}{3^2} = \frac{40}{9} = 4.45kN.$$

$$FEM_{BC} = -\frac{Wl}{8} = -\frac{30\times4}{8} = -15kNm$$

$$FEM_{CB} = \frac{wl}{8} = 15kNm$$

$$FEM_{CD} = -\frac{Wl^2}{12} = -\frac{30\times4^2}{12} = -40kNm$$

$$FEM_{DC} = 40kNm$$

Step:2 Applying ~~Equilibrium Condition~~ slope deflection equation,

$$M_{AB} = FEM_{AB} + \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$$

$$= -8.89 + \frac{2EI}{3}(0 + \theta_B - 0)$$

$$= -8.89 + 0.67EI\theta_B$$

$$M_{BA} = FEM_{BA} + \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\delta}{L}\right)$$

$$= 9.45 + \frac{4EI}{3}\theta_B$$

$$= 9.45 + 1.33\,\theta_B$$

$$M_{BC} = FEM_{BC} + \frac{2EI}{L}\left(2\theta_B + \theta_A\right)$$

$$= -15 + EI\theta_B + \frac{1}{2}EI\theta_C$$

$$M_{CB} = FEM_{CB} + \frac{2EI}{L}\left(2\theta_C + \theta_B\right)$$

$$= 15 + EI\theta_C + \frac{1}{2}EI\theta_B$$

$$M_{CD} = FEM_{CD} + \frac{2EI}{L}\left(2\theta_C + \theta_D\right)$$

$$= -40 + EI\theta_C$$

$$M_{DC} = 40 + \frac{1}{2}EI\theta_C$$

Step:3 using equation of equilibrium Condition

$$M_{BA} + M_{BC} = 0$$

$$9.45 + 1.33\theta_B + -15 + EI\theta_B + \frac{1}{2}EI\theta_C = 0$$

$$-10.55 + 2.33\theta_B + 0.5EI\theta_C = 0 \quad \text{——} \quad ①$$

CamScanner

$M_{CB} + M_{CD} = 0$

$\therefore 15 + EI\theta_C + 0.5\,EI\theta_B - 40 + EI\theta_C = 0$

$-25 + 0.5EI\theta_B + 2EI\theta_C = 0$ ——— (ii)

Solving Equation (i) and (ii) we get,

$EI\theta_B = 1.95$

$EI\theta_C = 12.01$

Using these value we get,

$M_{AB} = -8.89 + 0.67 \times 1.95$

$= -7.58\ kNm = 7.58\ kNm$

$M_{BA} = 7.04\ kNm$

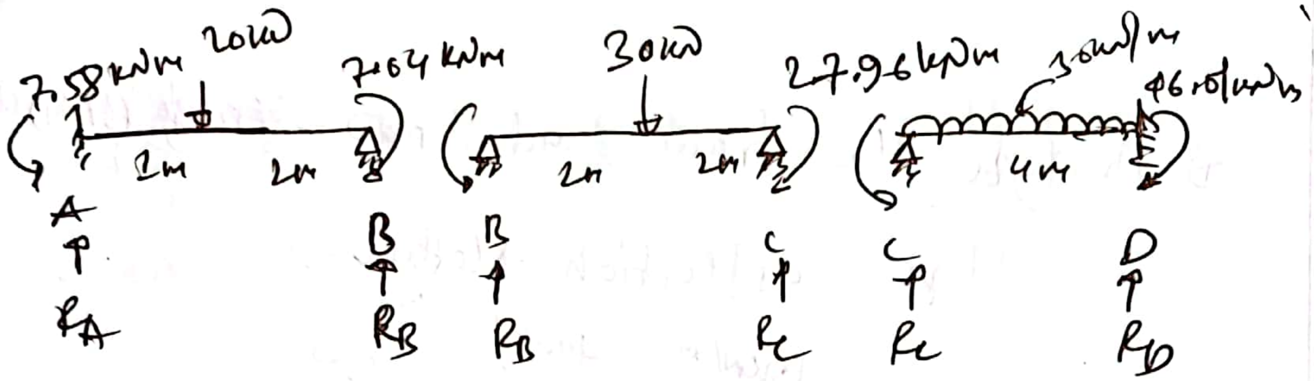
$M_{BC} = -7.045\ kNm = 7.04\ kN$

$M_{CB} = 27.96\ kNm$

$M_{CD} = -27.99\ kNm$

$M_{DC} = 8.01\ kNm$

Step: 4 Final Reactions



$\Sigma M_A = 0$

$R_B \times 3 + 7.58 = 20 \times 1 + 7.04$

$\therefore R_B = 6.49$ kN

$\Sigma F_y = 0$

$R_A = 13.51$ kN

$\Sigma M_B = 0$

$R_C \times 4 + 7.04 = 30 \times 2 + 27.96$

$\therefore R_C = 20.23$ kN

$\Sigma F_y = 0$

$R_B = 9.77$ kN

$\Sigma M_C = 0$

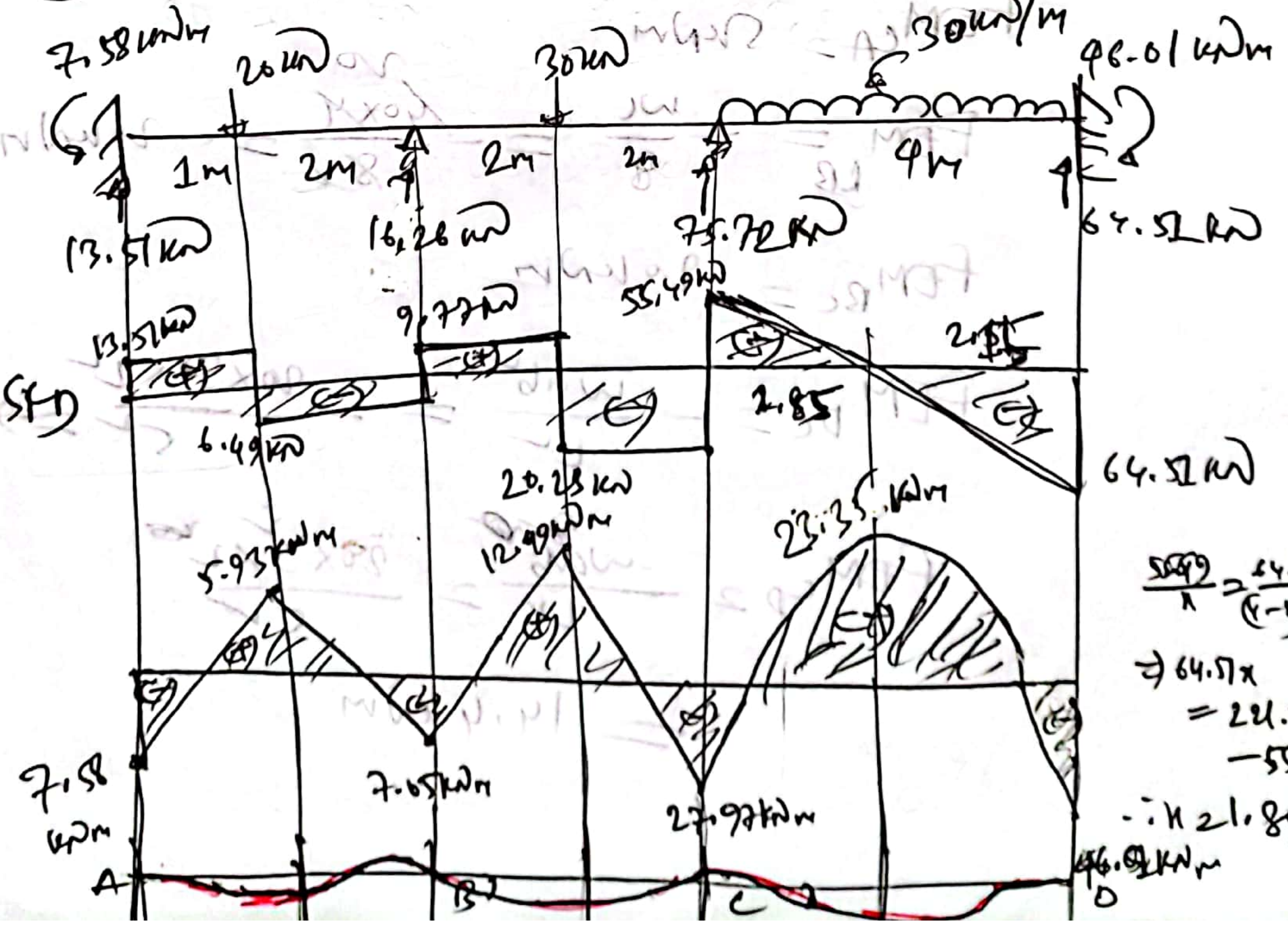
$R_D \times 4 + 27.96 = 46.01 + 30 \times 4 \times 2$

$\therefore R_D = 64.51$ kN

$\Sigma F_y = 0$

$R_C = 55.49$ kN

Step:5 Draw SFD & BMD

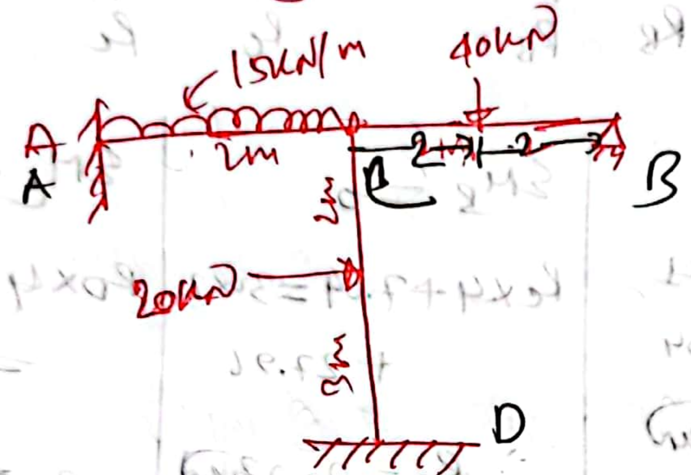


$\frac{55.49}{x} = \frac{64.51}{(4-x)}$

$\Rightarrow 64.51x = 221.96 - 55.49x$

$\therefore x = 1.85$

Q) Analyze the frame and draw ~~SFD &~~ BMD by Slope deflection Method



Solution:- Step 1:- FEM

$$FEM_{AC} = -\frac{wl^2}{12} = -\frac{15\times 2^2}{12} = -5\,kNm$$

$$FEM_{CA} = 5\,kNm$$

$$FEM_{CB} = -\frac{wl}{8} = -\frac{40\times 4}{8} = -20\,kNm$$

$$FEM_{BC} = 20\,kNm$$

$$FEM_{DC} = -\frac{wab^2}{L^2} = -\frac{20\times 3\times 2^2}{5^2} = -9.6\,kN$$

$$FEM_{CD} = \frac{wa^2b}{L^2} = \frac{20\times 3^2\times 2}{5^2}$$

$$= 14.4\,kNm$$

Step 2: Applying slope deflection equation

$$M_{AC} = FEM_{AC} + \frac{2EI}{L}(2\theta_A + \theta_C)$$

$$= -5 + \frac{2 \times E \times I}{\cancel{2}}(0 + \theta_C)$$

$$\therefore M_{AC} = -5 + EI\theta_C$$

$$M_{CA} = FEM_{CA} + \frac{2EI}{\cancel{2}}(2\theta_C + 0)$$

$$\therefore M_{CA} = 5 + 2EI\theta_C$$

$$M_{CB} = -20 + \frac{\cancel{2}EI}{\cancel{4}_2} \times (2\theta_C + \theta_B)$$

$$\therefore M_{CB} = -20 + EI\theta_C + 0.5EI\theta_B$$

$$\therefore M_{BC} = 20 + 0.5EI\theta_C + EI\theta_B$$

$$M_{CD} = 14.4 + \frac{2EI}{5}(2\theta_C + \theta_D)$$

$$\Rightarrow M_{CD} = 14.4 + \frac{4}{5}EI\theta_C$$

$$\therefore M_{CD} = 14.4 + 0.8EI\theta_C$$

$$M_{DC} = -9.6 + \frac{2EI}{5}(2\theta_D + \theta_C)$$

$$\therefore M_{DC} = -9.6 + 0.4EI\theta_C$$

Step 3: Applying equation of equilibrium Cond^n

$$M_{CA} + M_{CB} + M_{CD} = 0$$

$$M_{BC} = 0$$

$$\therefore M_{CA} + M_{CB} + M_{CD} = 0$$

$$54.2EI\theta_B - 20 + EI\theta_C + 0.5EI\theta_B + 14.4 + 0.8EI\theta_C = 0$$

$$\therefore 0.5EI\theta_B + 3.8EI\theta_C = 0.6$$

Again,

$$M_{BC} = 0$$

$$EI\theta_B + 0.5EI\theta_C = -20$$

Solving these equations

$$EI\theta_B = -\cancel{81}.49$$

$$EI\theta_C = 02.99$$

Step 4: find Moment,

$$M_{AC} = -2.02 \text{ kNm}$$

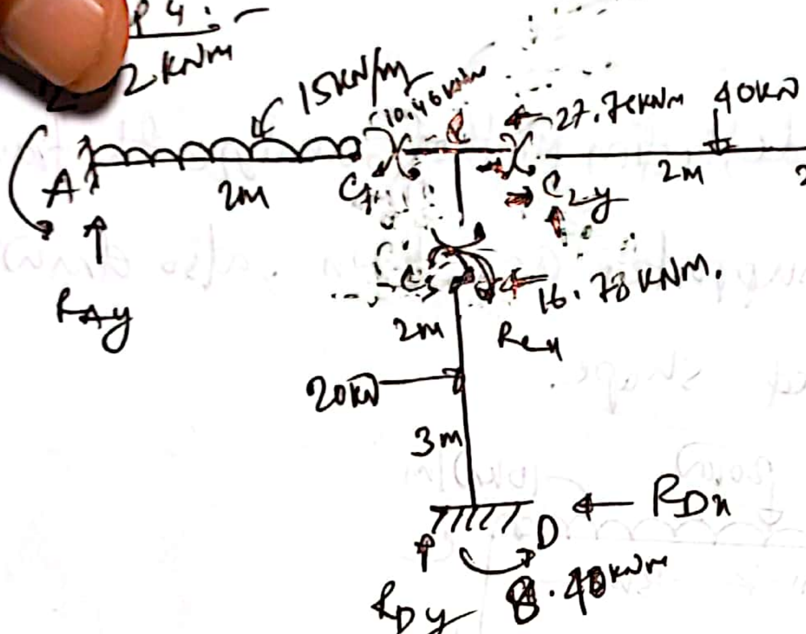
$$M_{CA} = 10.46 \text{ kNm}$$

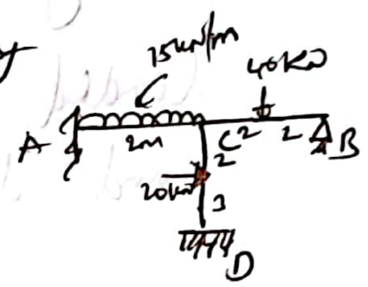
$$M_{CB} = -27.76 \text{ kNm}$$

$$M_{BC} = 0$$

$$M_{CD} = 16.78 \text{ kNm}$$

$$M_{DC} = -8.4 \text{ kNm}$$





$\Sigma M_{C_1} = 0$

$R_{Ay} \times 2 = 2.2 - 10.46 + 30 \times 1$

$R_{Ay} = 10.78$ kN

$\Sigma F_y = 0$

$R_{My} = 30 - 10.78$

$= 19.22$ kN

$\Sigma M_B = 0$

$R_{C_2y} \times 4 = 27.76 + 40 \times 2$

$\therefore R_{C_2y} = 26.94$ kN

$R_{By} = 13.06$ kN

$R_C = 46.16 \uparrow$

$R_{Dy} = R_{cy} + R_{cy}'$

$= 30$ kN

$\Sigma M_{C_3} = 0$

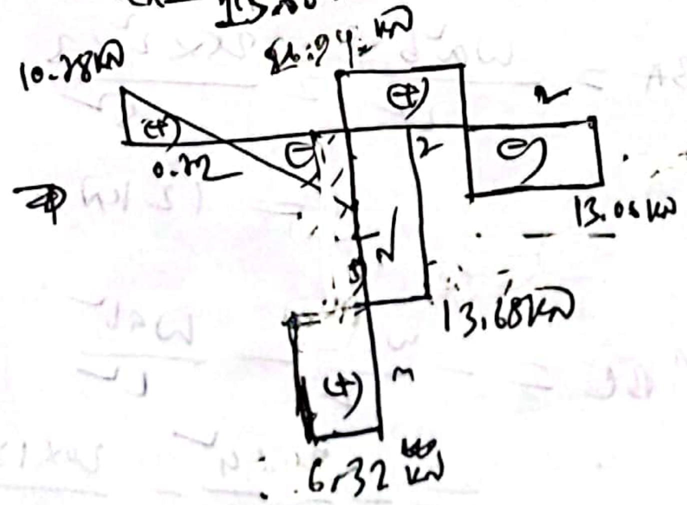
$R_{Dx} \times 5 = 8.40 + 20 \times 2 - 16.78$

$\therefore R_{Dx} = 6.32$ kN $\leftarrow$

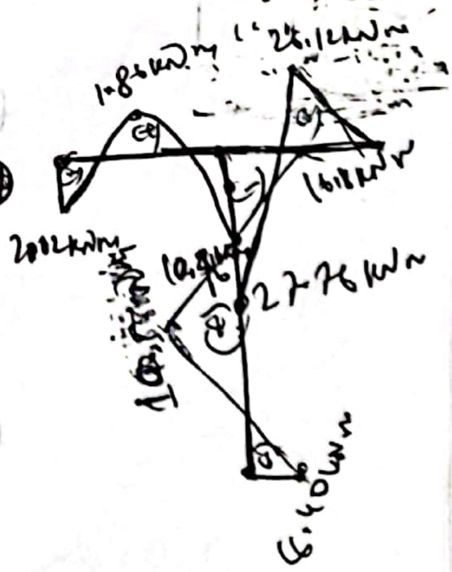
$R_{cx} = 13.68$ kN $\leftarrow$

R_C

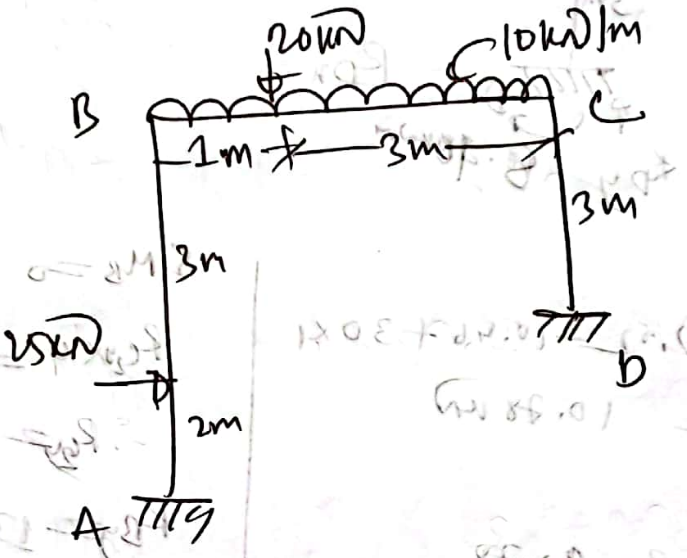
SFD



BMD



8) Using slope deflection Method, analyze the frame loaded and supported as shown. also draw BMD and deflected shape.



~~Step:~~ Sol^n:- Step 1 FEM

$$FEM_{AB} = -\frac{wab^2}{L^2} = -\frac{25\times2\times3^2}{5^2}$$

$$= -18kN\,m$$

$$FEM_{BA} = \frac{wa^2b}{L^2} = \frac{25\times2^2\times3}{5^2}$$

$$= 12\,kN\,m$$

$$FEM_{BC} = -\frac{wL^2}{12} - \frac{wab^2}{L^2}$$

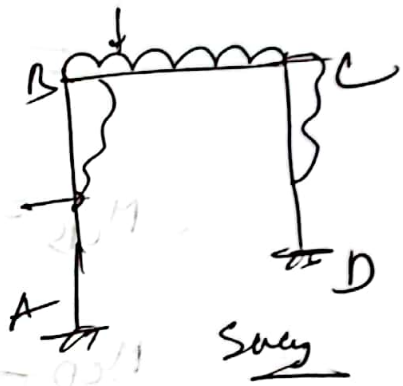
$$= -\frac{10\times4^2}{12} - \frac{20\times1\times3^2}{4^2}$$

$$= -13.33 - 11.25 = -24.58\ kNm$$

$$FEM_{CB} = \frac{wl^2}{12} + \frac{wa^2b}{l^2}$$

$$= 13.33 + \frac{20 \times 1^2 \times 3}{9^2}$$

$$= 17.08 \text{ KNm}$$



$$FEM_{CD} = 0$$

$$FEM_{DC} = 0$$

Step: 2 use slope deflection equation

$$M_{AB} = FEM_{AB} + \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$$

$$= -18 + \frac{2EI}{5}\left(0 + \theta_B + \frac{3\delta}{5}\right)$$

$$M_{AB} = -18 + 0.4\theta_B EI + 0.248 EI$$

$$M_{BA} = 12 + \frac{2EI}{5}\left(2\theta_B + 0 - \frac{3\delta}{5}\right)$$

$$M_{BA} = 12 + 0.8\theta_B EI - 0.24 EI\delta$$

$$M_{BC} = -24.58 + \frac{2EI}{L}\left(2\theta_B + \theta_C - \frac{3\delta}{L}\right)$$

$$= -24.58 + \frac{\cancel{2}EI}{\cancel{4}\,2}\left(2\theta_B + \theta_C - 0\right)$$

$$= -24.58 + \theta_B EI + 0.5\theta_C EI$$

$$M_{CB} = 17.08 + \frac{2EI}{L}\left(2\theta_C + \theta_B - 0\right)$$

$$= 17.08 + \frac{\cancel{2}EI}{\cancel{4}_2}\left(2\theta_C + \theta_B\right)$$

$$M_{CB} = 17.08 + \theta_C EI + 0.5\theta_B EI$$

$$M_{CD} = 0 + \frac{2EI}{3}\left(2\theta_C + \theta_D - \frac{\cancel{3}\delta}{\cancel{3}}\right)$$

$$M_{CD} = 1.33\,\theta_C EI \cancel{+ 0.67\theta_D EI} - 0.67\delta EI$$

$$M_{DC} = \frac{2EI}{3}\left(2\theta_D + \theta_C - \frac{\cancel{3}\delta}{\cancel{3}}\right)$$

$$M_{DC} = [illegible]\,\theta_C EI + \cancel{1.33\,\theta_D EI} - 0.67\delta EI$$

Step: 3 Using Equilibrium Equation:–

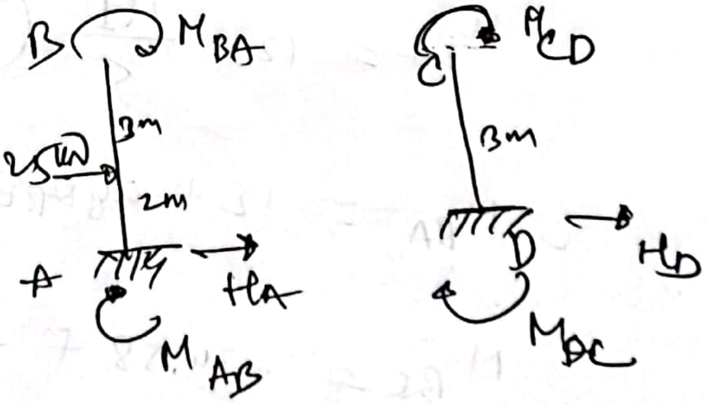
Calculate Horizontal Equilibrium

for member BA,

$\Sigma M_B = 0$ ↻+

$$M_{AB} + M_{BA} = 25 \times 3 + H_A \times 5$$

$$H_A = \frac{M_{AB} + M_{BA} - 75}{5}$$



Notes– Moment & force all in positive direction

For Moment CD

$\Sigma M_C = 0$ 2+

$M_{DC} + M_{CD} = H_D \times 3$

$$H_D = \frac{M_{DC}+M_{CD}}{3}$$

$\Sigma f_x = 0 \rightarrow +$

$H_A + H_D + 25 = 0$

$$\Rightarrow \frac{M_{AB}+M_{BA}-75}{5} + \frac{M_{DC}+M_{CD}}{3} + 25 = 0$$

$$\Rightarrow \frac{-18+0.4\theta_B EI - 0.24\delta EI\delta + 12 + 0.8\theta_B EI - 0.24EI\delta - 75}{5}$$

$$+ \frac{\theta_c EI - 0.678 EI + 1.33\theta_c EI - 0.678 EI}{3} = -25$$

$$\Rightarrow \frac{1.2EI\theta_B - 0.48EI\delta - 81}{5} + \frac{2.\theta_c EI - 1.36EI\delta}{3} = -25$$

$$\Rightarrow \frac{3.6EI\theta_B - 1.44EI\delta - 243 + 10\theta_c EI - 6.8EI\delta}{15} = -25$$

$\Rightarrow 3.6EI\theta_B + 10EI\theta_c - 8.24EI\delta = 243 - 375$

$\therefore 3.6EI\theta_B + 10EI\theta_c - 8.19EI\delta = -132$ — (1)

$\rightarrow M_{BA} + M_{BC} = 0$

$12 + 0.8\theta_B EI - 0.24 EI\delta + \theta_B EI + 0.5\theta_C EI$

$- 24.58 = 0$

$\therefore 1.8 EI\theta_B + 0.5 EI\theta_C - 0.24 EI\delta = 12.58$ — (ii)

$\therefore M_{CB} + M_{CD} = 0$

$17.08 + \theta_C EI + 0.5 EI\theta_B + 1.33\theta_C EI$

$- 0.678 EI = 0$

$\therefore 2.33 EI\theta_C + 0.5 EI\theta_B - 0.67 EI\delta = -17.08$ — (iii)

Solving (i), (ii), (iii) we get

$EI\theta_B = 10.93$

$EI\theta_C = 5.82$

$EI\delta = 14.02$

Step: 4

$M_{AB} = -17.24$ kNm

$M_{BA} = 16.44$ kN.m

$M_{BC} = -16.44$ kNm

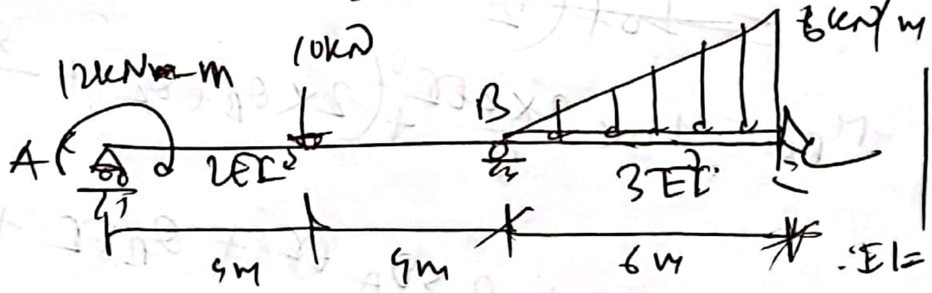
$M_{CB} = 16.75$ kNm

$M_{CD} = -16.74$ kNm

$M_{DC} = -13.05$ kNm

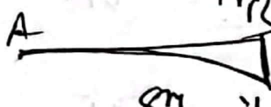
40th Bey

① Draw the quantitative shear and Bending moment diagram and qualitative deflected curve for the beam shown in Fig Q1. Support 'B' settles 10mm and EI constant. $E = 200$ GPa, $I = 200 \times 10^6$ mm^4.



$E = 200 \times 1000$ N/mm^2
$= 200$ kN/mm^2
$I = 200 \times 10^6$
$\therefore EI = 200 \times 200 \times 10^6$ kN/mm^2

if right settles (−)



A

8m

10mm

if left side settle (+)

Sol^n:—

$\therefore EI = 200$ kNm^2

Step 1: fix end Moment

$FEM_{AB} = -\frac{Wl}{8}$

$FEM_{BA} = 10$kNm

$FEM_{BC} = -\frac{Wl^2}{30}$

$FEM_{CB} = +\frac{Wl^2}{20}$

Step:2

$M_{AB} = FEM_{AB} + \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$

$= -10 + \frac{2 \times 2EI}{8}\left(2\theta_A + \theta_B + \frac{3 \times 0.01}{8}\right)$

$= -10 + \left(\frac{EI}{2} \times 2\theta_A + 0.5EI\theta_B + 1.875 \times 10^{-3} EI\right)$

$\delta_2 - 10$mm
$= 0.01$m
(as settle down)
$I = 2EI$

$\therefore M_{AB} = \cancel{-10} + EI\theta_A + 0.5EI\theta_B + 0.375$ [using $EI = 2000\ kNm^2$] — (i)

$\therefore M_{BA} = 10 + \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\delta}{L}\right)$

$\cancel{= 10 + (2}$

$M_{BA} = 10 \times \frac{2 \times 2EI}{8}\left(2 \times \theta_B + \theta_A + \frac{3 \times 0.01}{8}\right)$

$\therefore M_{BA} = 10 + 0.5\theta_A EI + \theta_B EI + 0.375$ — (ii)

$M_{BC} = -7.2 + \frac{2 \times 3EI}{6}\left\{2\theta_B + \theta_C - \frac{3 \times (-0.01)}{6}\right\}$

$M_{BC} = -7.2 + 2EI\theta_B + EI\theta_C - 0.02 \times EI$
$= -7.2 + 2EI\theta_B - 4$ — (iii)

$M_{CB} = 10.8 + \frac{2 \times 3EI}{6}\left\{2\theta_C + \theta_B - 0.02\right\}$

$M_{CB} = 10.8 + EI\theta_B + 2EI\theta_C - 0.02EI$
$= 10.8 + EI\theta_B - 4$ — (iv)

<u>Step 3</u> Equilibirium equation,

$M_{BA} + M_{BC} = 0$ and $M_{AB} = 0$

$10 + 0.5EI\theta_A + \theta_B EI + 1.875 \times 10^{-3} EI - 7.2 + 2EI\theta_B + 0.02EI = 0$

from (i)

$M_{AB} = 0$

$\Rightarrow -10 + EI\theta_A + 0.5\,EI\theta_B + 0.375 = 0$

$\therefore EI\theta_A + 0.5\,EI\theta_B = 9.625$ ——— (v)

$M_{BA} + M_{BC} = 0$

$10 + 0.5\,EI\theta_A + EI\theta_B + 0.375 - 7.2 + 2EI\theta_B - 4 = 0$

$\therefore 0.5\,EI\theta_A + 3EI\theta_B = 0.825$ ——— (vi)

Equating (v) & (vi) we get

$EI\theta_A = 10.35 \quad \therefore \theta_A = \frac{10.35}{200} = 0.05175\,m = 5.175\,cm = 51.75\,mm$

$EI\theta_B = -1.45, \quad \theta_B = \frac{-1.45}{200} = 7.25\,mm$

Using these value we get,

$M_{AB} = 10.35 - 0.5(1.45) - 9.625 = 0$

$M_{AB} = 12\,kNm$ (given)

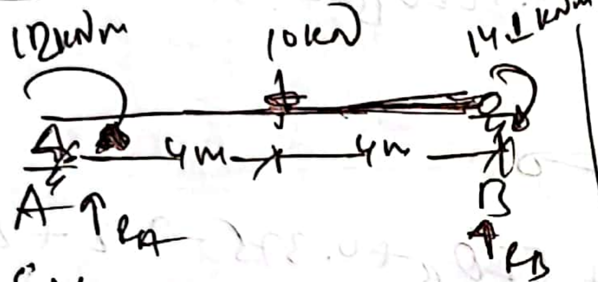
$M_{BA} = 10.375 + 0.5 \times 10.35 - 1.45$
$= 14.1\,kNm$

$M_{BC} = -11.2 + 2 \times (-1.45) = 14.1\,kN$

$M_{CB} = 6.8 - 1.45$

$= 5.35\ kNm$ ↻

Step: 4 find the reactions.



$\Sigma M_A = 0$

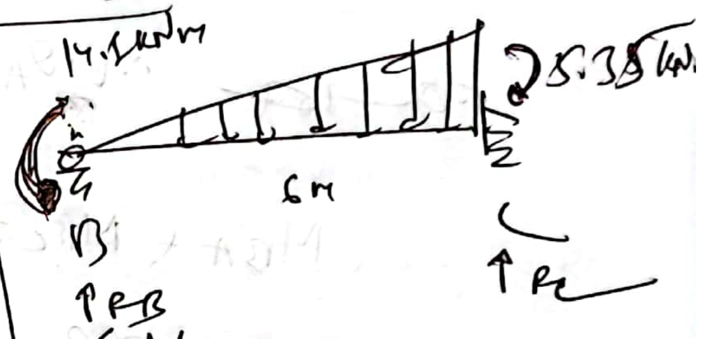
$R_B \times 8 = 10 \times 4 + 14.1 + 12$

$\therefore R_{B_1} = 8.26\ kN \uparrow$

$\Sigma f_y = 0$

$R_A = 10 - 8.26$

$= 1.74\ kN \uparrow$



$\Sigma M_B = 0$

$R_C \times 6 + 14.1 = 5.35 + \frac{1}{2} \times 6 \times 6 \times \frac{2}{3} \times 6$

$\therefore R_C = 10.54\ kN \uparrow$

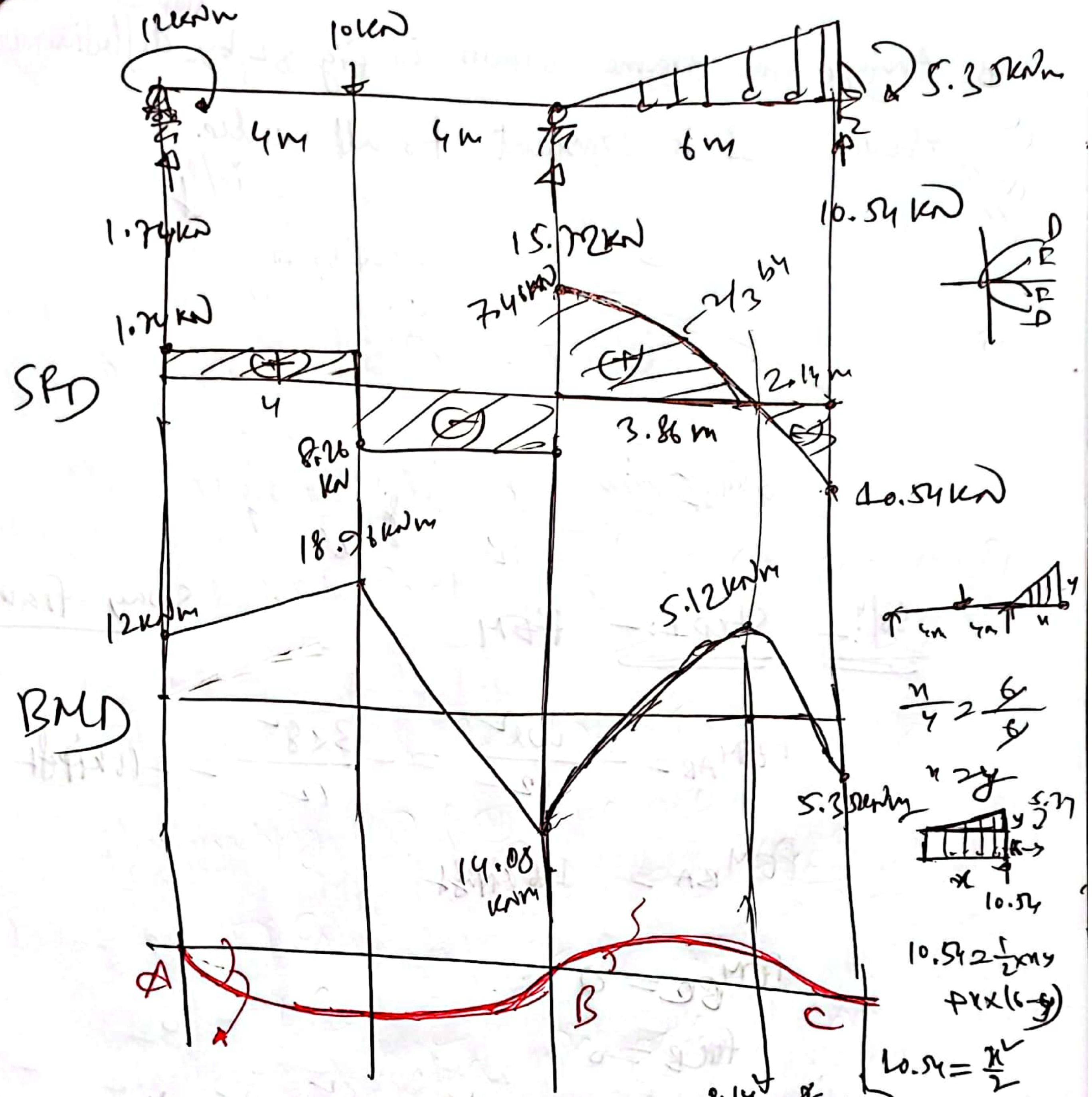
$\Sigma f_y = 0$

$R_{B_2} = 7.46\ kN \uparrow$

$\therefore R_A = 1.74\ kN \uparrow$

$R_B = 8.26 + 7.46 = 15.72\ kN \uparrow$

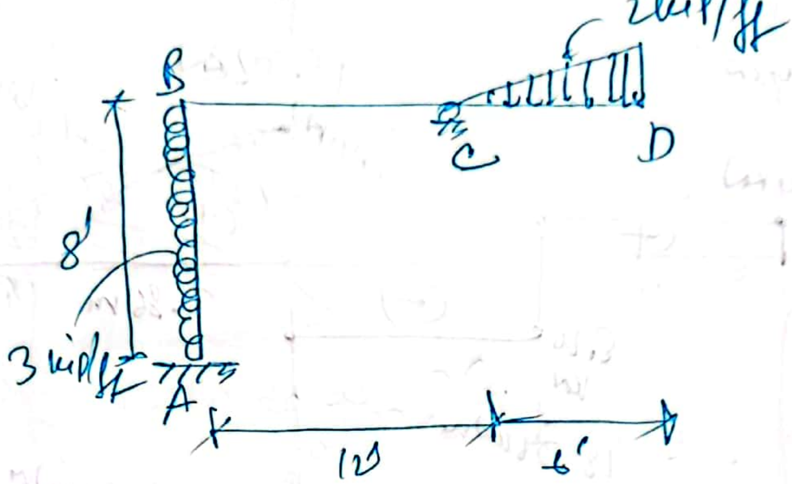
$R_C = 10.54\ kN \uparrow$



12kNm
10kN
5.35kNm
4m
4m
6m
1.74kN
15.72kN
10.54kN
SFD
1.74kN
7.46kN
2.14m
4
8.26 kN
3.86m
10.54kN
18.96kNm
5.12kNm
12kNm
BMD
5.35kNm
14.08 kNm
A
B
C

B Analyze the frame shown in Fig 8.2 by slope deflection method. Assume EI is constant for all member.

3cs
4°//



Solⁿ:- Step 1:- FEM

Sway frame

$$FEM_{AB} = -\frac{wl^2}{12} = -\frac{3\times8^2}{12} = -16 \text{ kip ft}$$

$$FEM_{BA} = 16 \text{ kip ft}$$

$$FEM_{BC} = 0$$

$$FEM_{CB} = 0$$

$$FEM_{CD} = -\frac{1}{2}\times 6 \times 2 \times \frac{2}{3}\times 6 = -24 \text{ kip ft}$$

$$FEM_{DC} = 0$$

Step : 2

$$M_{AB} = FEM_{AB} + \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$$

$$= -16 + \frac{2EI}{8}\left(2\times0 + \theta_B - \frac{3\delta}{8}\right)$$

$$= -16 + 0.25 EI\theta_B - 0.09375 EI$$

$$M_{BA} = FEM_{BA} + \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\delta}{L}\right)$$

$$= 16 + \frac{2EI}{8}\left(2\theta_B + 0 - \frac{3\delta}{8}\right)$$

$$= 16 + 0.5EI\theta_B - 0.094\,EI\delta$$

$$M_{BC} = FEM_{BA} + \frac{2EI}{L}\left(2\theta_B + \theta_C - 0\right)$$

$$= 0 + \frac{2EI}{12}\left(2 \times \theta_B + \theta_C\right)$$

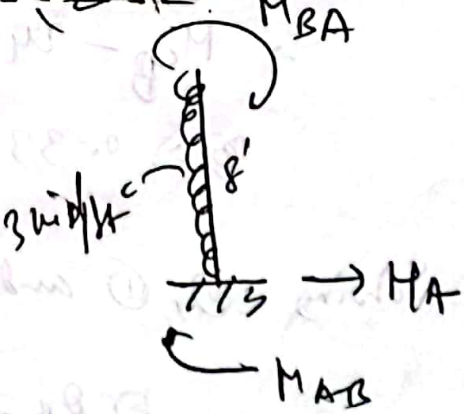
$$M_{BC} = 0.33EI\theta_B + 0.167EI\theta_C$$

$$M_{CB} = FEM_{CB} + \frac{2EI}{12}\left(2\theta_C + \theta_B - 0\right)$$

$$M_{CB} = 0 + 0.33EI\theta_C + 0.167EI\theta_B$$

Step 3 Using Equilibirum Equation

for member AB,



$\Sigma M_B = 0$ ↻+

$$M_{AB} + M_{BA} = H_A \times 8 + 24 \times 4$$

or, $8H_A = M_{AB} + M_{BA} - 96$

$$\therefore H_A = \frac{M_{AB} + M_{BA} - 96}{8}$$

$\Sigma f_x = 0$

$H_A + 24 = 0$

or, $\frac{M_{AB} + M_{BA} - 96}{8} = -24$

or, $M_{AB} + M_{BA} = -24 \times 8 + 96$

or, $M_{AB} + M_{BA} = -96$

or, $\cancel{-16} + 0.25 EI\theta_B - 0.0948 EI\delta \cancel{+16} + 0.5 EI\theta_B - 0.094 EI\delta = -96$

$\therefore 0.75 EI\theta_B - 0.1888 EI\delta = -96$ —— (i)

Again

$M_{BA} + M_{BC} = 0$

or, $16 + 0.5 EI\theta_B - 0.094 EI\delta + 0.33 EI\theta_B + 0.167 EI\theta_C = 0$

or, $\therefore 0.83 EI\theta_B + 0.167 EI\theta_C - 0.094 EI\delta = -16$ —— (ii)

$\rightarrow M_{CB} - 24 = 0$

$\therefore 0.33 EI\theta_C + 0.167 EI\theta_B = 24$ —— (iii)

Solving (i), (ii) and (iii) we get

$EI\theta_B = 53.59$
$EI\theta_C = 45.61$
$EI\delta = 724.43$

CamScanner

Using these value

$$M_{AB} = -16 + 0.25 \times 53.59 - 0.094 \times 724.43$$

$$= -70.699 \text{ kipft}$$

$$M_{BA} = 16 + 0.5 \times 53.59 - 0.094 \times 724.43$$

$$= -25.3 \text{ kipft}$$

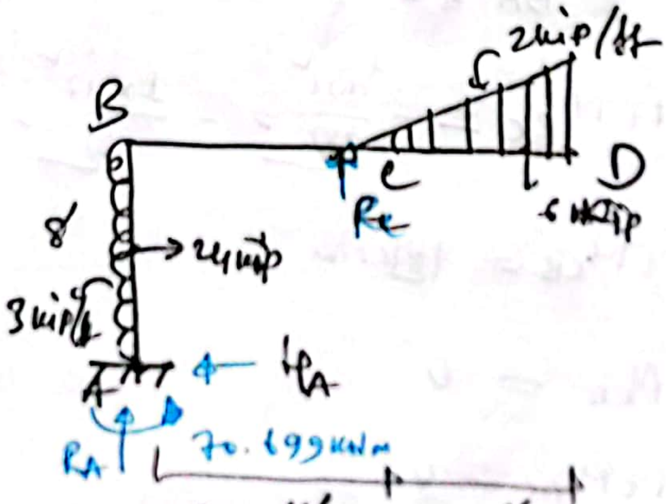
$$M_{BC} = 0.33 \times 53.59 + 0.167 \times 45.61$$

$$= 25.3 \text{ kipft}$$

$$M_{CB} = 0.33 \times 45.61 + 0.167 \times 53.59$$

$$= 24 \text{ kipft}$$

Step 4:- Find reactions



$\Sigma f_x = 0$

$H_A = 24 \text{ kN}$

$\Sigma M_A = 0$

$R_C \times 12 + 70.699 = 6 \times (\frac{2}{3} \times \ldots + 12)$

$R_C = 2.11 \text{ kip}$

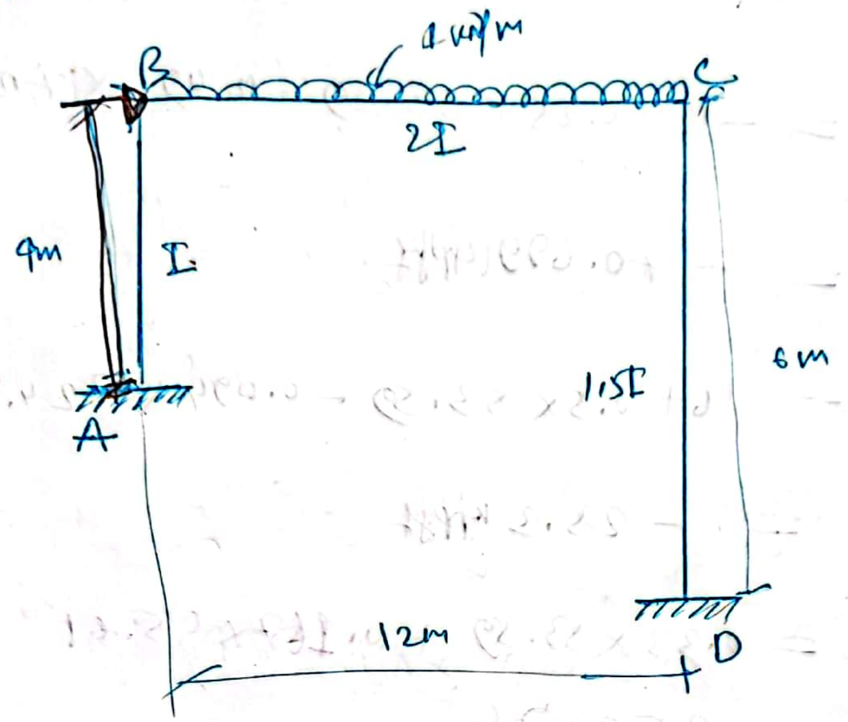
$\Sigma f_y = 0$

$R_A + R_C = 6$

$R_A = 6 - 2.11$

$= 3.89 \text{ kip}$

Analyze the frame shown in the following fig:



38th
& 37th
BCS

30th
BCS

Sol:- Step 1 FEM

$FEM_{AB} = 0$

$FEM_{BA} = 0$

$FEM_{BC} = -\frac{wl^2}{12} = -\frac{1 \times 12^2}{12} = -12 \text{ kNm}$

$FEM_{CB} = 12 \text{ kNm}$

$FEM_{CD} = 0$

$FEM_{DC} = 0$

Step:2

$M_{AB} = 0 + \frac{2EI}{4}\left(2\theta_A + \theta_B - \frac{3\delta}{L}\right)$

$= \frac{EI}{2}\left(0 + \theta_B - \frac{3\delta}{4}\right)$

$$M_{AB} = 0.5 EI\theta_B - 0.375 EI\delta$$

$$M_{BA} = 0 + \frac{2EI}{4}\left(2\theta_B + 0 - \frac{3\delta}{4}\right)$$

$$M_{BA} = EI\,\theta_B - 0.375 EI\delta$$

$$M_{BC} = -18 + \frac{2\times 2EI}{12}\left(2\theta_B + \theta_C - \frac{3\delta}{L}\right)$$

$$= -18 + 0.67 EI\theta_B + 0.33 EI\theta_C - 0$$

$$\therefore M_{BC} = -18 + 0.67 EI\theta_B + 0.33 EI\theta_C$$

$$M_{CB} = 18 + \frac{2\times 2EI}{12}\left(2\theta_C + \theta_B\right)$$

$$M_{CB} = 18 + 0.33 EI\theta_B + 0.67 EI\theta_C$$

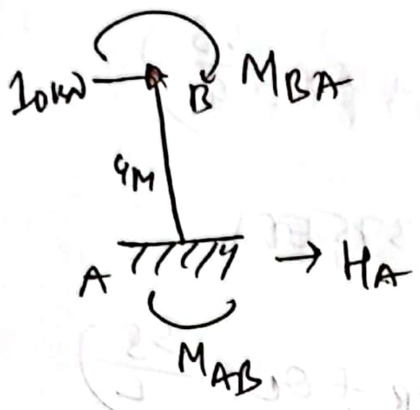
$$M_{CD} = 0 + \frac{1.5\times 2EI}{6}\left(2\theta_C + \theta_D - \frac{3\delta}{\cancel{6}\,2}\right)$$

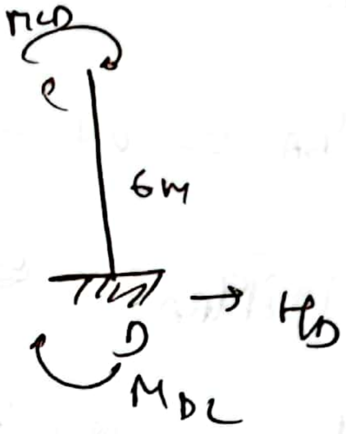
$$M_{CD} = EI\theta_C - 0.25 EI\delta$$

$$M_{DC} = 0 + \frac{1.5\times 2EI}{6}\left(0 + \theta_C - \frac{3\delta}{6}\right)$$

$$M_{DC} = 0.5 EI\theta_C - 0.25 EI\delta$$

Step 3 Using Equilibirum equation





$\Sigma M_B = 0 \circlearrowright +$

$M_{AB} + M_{BA} = H_A \times 4$

$H_A = \dfrac{M_{AB} + M_{BA}}{4}$

$\Sigma M_C = 0 \circlearrowright +$

$M_{CD} + M_{DC} = H_{\cancel{A}} \times 6$

$H_D = \dfrac{M_{CD} + M_{DC}}{6}$

$\Sigma F_x = 0$

$H_A + H_D + 10 = 0$

or, $\dfrac{M_{AB} + M_{BA}}{4} + \dfrac{M_{CD} + M_{DC}}{6} = -10$

or, $\dfrac{3M_{AB} + 3M_{BA} + 2M_{CD} + 2M_{DC}}{12} = -10$

or, $3M_{AB} + 3M_{BA} + 2M_{CD} + 2M_{DC} = -120$

or, $3(0.5EI\theta_B - 0.375EI\delta) + 3(EI\theta_B - 0.375EI\delta)$
$+ 2(EI\theta_C - 0.25EI\delta) + 2(0.5EI\theta_C - 0.25EI\delta)$
$= -120$

or, $1.5\,EI\theta_B - 1.125\,EI\delta + 3\,EI\theta_B - 1.125\,EI\delta + 2\,EI\theta_C - 0.5\,EI\delta + EI\theta_C - 0.5\,EI\delta = -120$

or, $4.5\,EI\theta_B + 3\,EI\theta_C - 3.25\,EI\delta = -120$ —— (i)

$M_{BA} + M_{BC} = 0$

$2\,EI\theta_B - 0.375\,EI\delta + 0.67\,EI\theta_B + 0.33\,EI\theta_C - 18 = 0$

$1.67\,EI\theta_B + 0.33\,EI\theta_C - 0.375\,EI\delta = 18$ —— (ii)

$M_{CB} + M_{CD} = 0$

$18 + 0.33\,EI\theta_B + 0.67\,EI\theta_C + EI\theta_C - 0.25\,EI\delta = 0$

$0.33\,EI\theta_B + 1.67\,EI\theta_C - 0.25\,EI\delta = -18$ —— (iii)

using (i), (ii), (iii) we get,

$EI\theta_B = 22.44$

$EI\theta_C = -1.67$

$EI\delta = 66.45$

Using these value,

$M_{AB} = 0.5 \times 22.99 - 0.375 \times 68.95$

$= \cancel{-12.38\ KNm}\ \ \cancel{-14.95\ KNm}$

$= -13.69\ KNm$

$$M_{BA} = 22.44 - 0.375 \times 66.95$$

$$= -2.95 \text{ kNm}$$

$$M_{BC} = -12 + 0.67 \times 22.44 + 0.33 \times (-1.77)$$

$$\cancel{= -1.42 \text{ kNm}}$$

$$= 2.48 \text{ kNm}$$

$$M_{CB} = 12 + 0.33 \times 22.44 + 0.67 \times (-1.77)$$

$$\cancel{= 23.23 \text{ kNm}} = 20.53 \text{ kNm}$$

$$M_{CD} = -1.77 - 0.25 \times 66.95$$

$$= \cancel{-23.23 \text{ kNm}} - 18.28 \text{ kNm}$$

$$M_{DC} = 0.5 \times (-1.77) - 0.25 \times 66.95$$

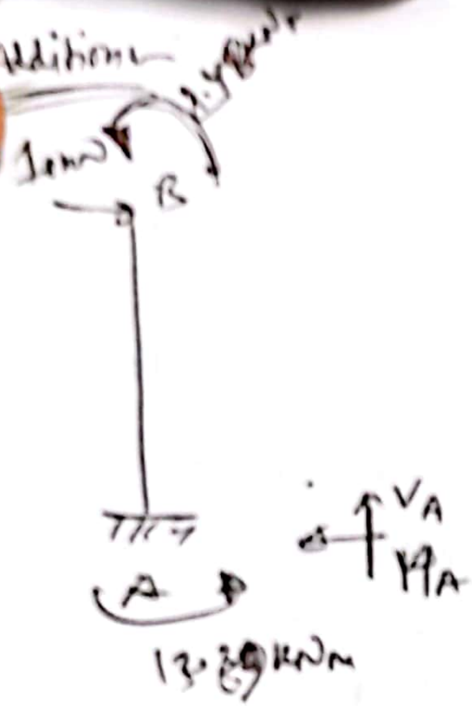
$$\cancel{= -20.34 \text{ kNm}}$$

$$= -17.45 \text{ kNm}$$

~~Step 14~~ Find Reactions

Analyze CONTD. Dummy done,

Additional

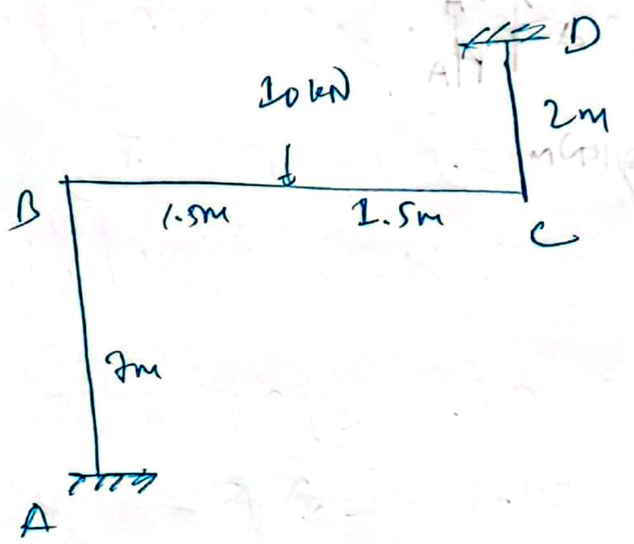


$\Sigma M_B = 0$

$H_A \times 4 = M_{AB} + M_{BA}$

$H_A = \dfrac{M_{AB} + M_{BA}}{4}$

Q) Determine the joint moment of the frame given in the following fig. Assume all member to have identical cross-section. Hence draw the bending moment diagram (BMD).



37th BCS

Solution:— Step: 1

$FEM_{AB} = 0$

$FEM_{BA} = 0$

$FEM_{BC} = -\frac{Wl}{8} = -\frac{10 \times 3}{8} = -3.75 \text{ kNm}$

$FEM_{CB} = 3.75 \text{ KNm.}$

$FEM_{CD} = 0$

$FEM_{DC} = 0$

CamScanner

Step:2

$$M_{AB} = 0 + \frac{2EI}{L}(0+\theta_B)$$

$$= 0.29 EI\theta_B$$

$$M_{BA} = 0 + \frac{2EI}{7} \times 2\theta_B$$

$$= 0.57 EI\theta_B$$

$$M_{BC} = -3.75 + \frac{2EI}{3}(2\theta_B + \theta_C)$$

$$M_{BC} = -3.75 + 1.3 EI\theta_B + 0.67 EI\theta_C$$

$$M_{CB} = 3.75 + \frac{2EI}{3}(2\theta_C + \theta_B)$$

$$M_{CB} = 3.75 + 0.67 EI\theta_B + 1.3 EI\theta_C$$

$$M_{CD} = 0 + \frac{\cancel{2}EI}{\cancel{2}}(2\theta_C)$$

$$= 2EI\theta_C$$

$$M_{DC} = \cancel{0.8} EI\theta_C$$

Step:3 Applying Equilibirum Equation,

$$M_{BA} + M_{BC} = 0$$

$$\therefore 0.57EI\theta_B - 3.75 + 1.3EI\theta_B + 0.67EI\theta_C = 0$$

$$1.87EI\theta_B + 0.67EI\theta_C = 3.75 \quad \text{--- (i)}$$

$$M_{CB} + M_{CD} = 0$$

$$3.75 + 0.67EI\theta_B + 1.3EI\theta_C + 2EI\theta_C = 0$$

$$\therefore 0.67EI\theta_B + 3.3EI\theta_C = -3.75 \quad \text{--- (ii)}$$

Calculating equation (i) and (ii) we get

$$EI\theta_B = 2.80$$

$$EI\theta_C = -1.47$$

$$\therefore M_{AB} = \cancel{0.8381}\ 0.754$$

$$M_{BA} = \cancel{1.65}\ 1.482$$

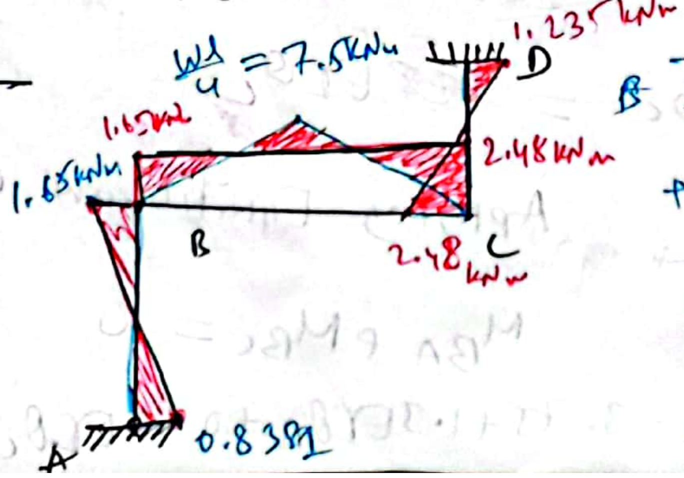
$$M_{BC} = \cancel{-1.65}\ -1.48$$

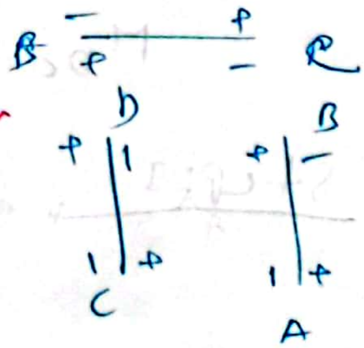
$$M_{CB} = \cancel{2.48}\ 3.321$$

$$M_{CD} = \cancel{-2.47}\ -3.34$$

$$M_{DC} = \cancel{-1.235}\ -1.67$$

BMD





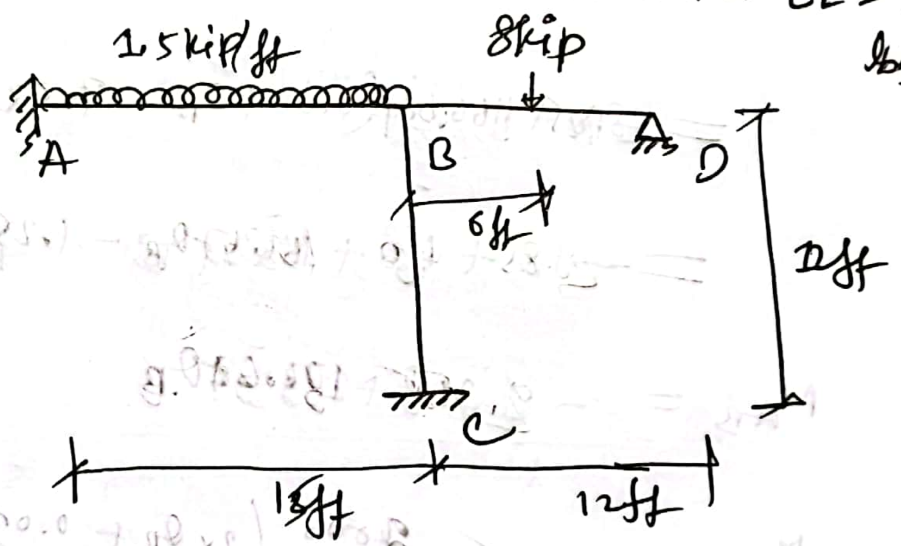
□ Analyze the frame shown in fig I using slope deflection Method. Draw shear force and Bending Moment diagram. Given $\theta_A = 0.003$ rad clockwise

36 ft

$\Delta C = 0.02$ ft upward, $\delta C = 0.03$ ft left, $\delta A = 0.01$ ft

BY

down and $\Delta D = 0.01$ ft down. Assume $EI = 1000$ lb ft²



Solution:- Step: 1

Here

$\Delta A = 0.01$ ft ↓

$\Delta C = \Delta B = 0.02$ ft ↑

$\Delta D = 0.01$ ft

$\delta C = 0.03$ ft ←

$$FEM_{AB} = -\frac{wl^2}{12} = -\frac{1.5 \times 15^2}{12} = -28.125 \text{ kip ft}$$

$$FEM_{BA} = 28.125 \text{ kip ft}$$

$$FEM_{BD} = -\frac{wl}{8} = -\frac{8 \times 12}{8} = -12 \text{ kip ft}$$

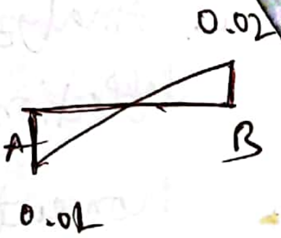
$$FEM_{DB} = 12 \text{ kip ft}$$

$$FEM_{BC} = 0$$

$$FEM_{CB} = 0$$

Step 2

$$M_{AB} = -28.125 + \frac{2EI}{15}\left(2\theta_A + \theta_B - \frac{3\delta}{15}\right)$$



$$= -28.125 + \frac{2000}{15}\left(2\times 0.03 + \theta_B - \frac{3(0.01+0.02)}{15}\right)$$

If left settle (+)
Right up (+)

$$= -28.125 + 133.34(0.06 + \theta_B - 0.006)$$

$$= -28.125 + 8 + 133.34\theta_B - 0.8$$

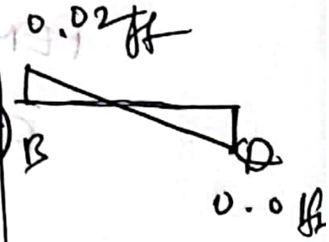
$$M_{AB} = -20.925 + 133.34\theta_B$$

$$M_{BA} = 28.125 + \frac{2000}{15}\left(2\times\theta_B + 0.03 - \frac{3\times 0.03}{15}\right)$$

$$= 28.125 + 266.67\theta_B + 4 - 0.8$$

$$M_{BA} = 31.325 + 266.67\theta_B$$

$$M_{BD} = -12 + \frac{1000}{6}\left(2\theta_B + \theta_D + \frac{3\times 0.03}{12}\right)$$



$$= -12 + 333.3\theta_B + 166.67\theta_D + 1.25$$

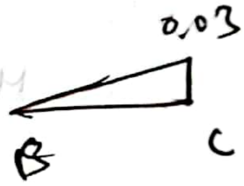
$$M_{BD} = -10.75 + 333.3\theta_B + 166.67\theta_D$$

$$M_{DB} = 12 + \frac{1000}{8}\left(2\theta_D + \theta_B + \frac{3\times 0.03}{12}\right)$$

$$= 12 + 166.67\theta_B + 333.33\theta_D + 1.25$$

$$M_{DB} = 13.25 + 166.67\theta_B + 333.33\theta_D$$

$$M_{BC} = 0 + \frac{2\times 1000}{6}\left(2\theta_B + 0 - \frac{3\times 0.03}{12}\right)$$



$$M_{BC} = 333.3\theta_B - 1.25$$

$$M_{CB} = 0 + \frac{1000}{6}\left(\theta_B - \frac{3\times 0.03}{12}\right)$$

$$M_{CB} = 166.67\theta_B - 1.25$$

Step 3

$$M_{BA} + M_{BC} + M_{BD} = 0$$

$$-40.75 + 333.3\theta_B + 166.67\theta_D + 333.3\theta_B - 1.25$$

$$+ 31.325 + 266.67\theta_B = 0$$

$$\therefore 933.33\theta_B + 166.67\theta_D = 19.325$$

$$M_{DB} = 0$$

$$166.67\theta_B + 333.33\theta_D = -13.25$$

$$\therefore \theta_B = -0.0149$$

$$\theta_D = -0.033 \text{ rad}$$

$M_{AB} = -22.91$ kipft

$M_{BA} = 27.35$ kipft

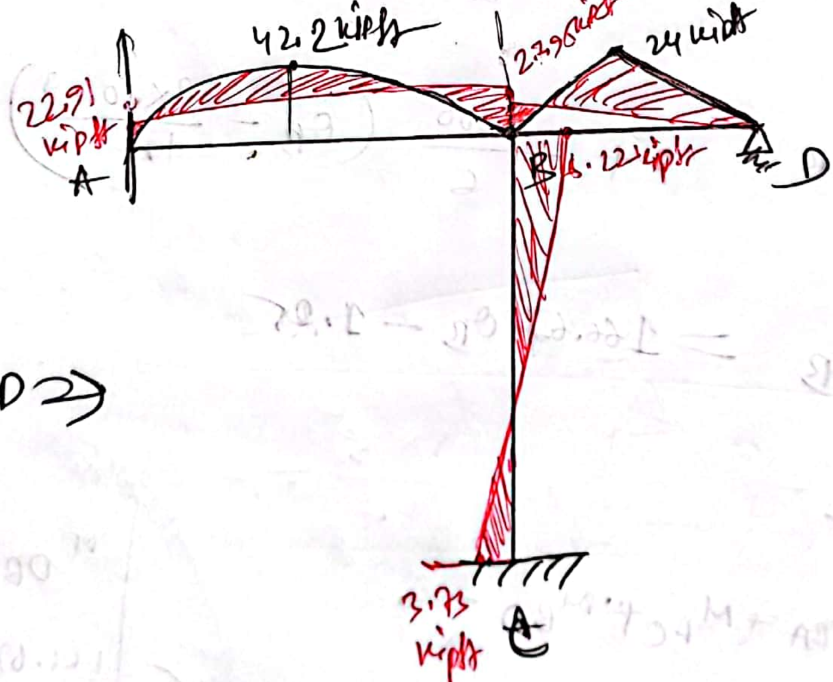
$M_{BD} = -21.1$ kipft

$M_{DB} = 0$

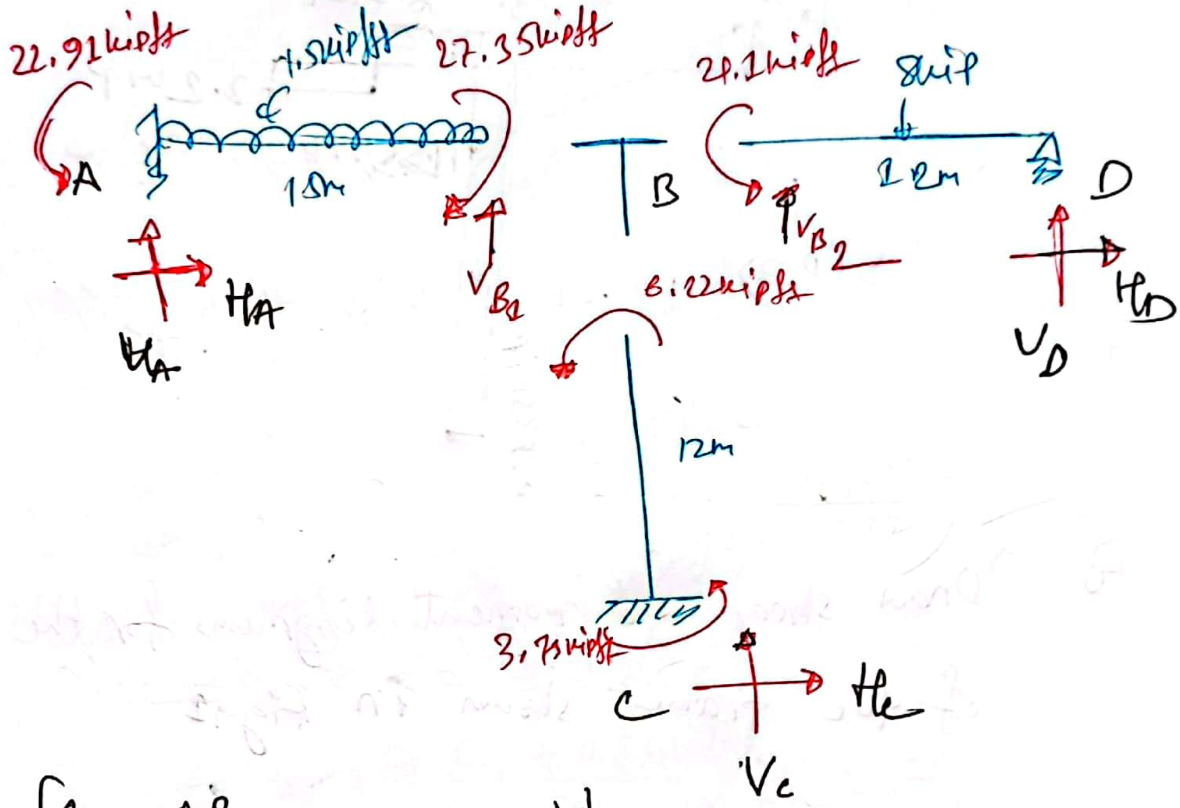
$M_{BC} = -6.22$ kipft

$M_{CB} = -3.73$ kipft.

Net BMD ⇒



Step : 4 find reaction



from AB

$$\Sigma F_x = 0$$

$$H_A = 0$$

$$\Sigma M_B = 0$$

$$15 \times V_A + 27.35 = 22.91 + 15 \times 1.5 \times 7.5$$

$$V_A = \frac{164.31 \text{ kip}}{15} = 10.954 \text{ kip}$$

$$\Sigma F_y = 0$$

$$10.954 + V_{B1} = 22.5$$

$$V_{B1} = 11.6 \text{ kip}$$

from BD

$$\Sigma F_x = 0$$

$$H_D = 0$$

$$\Sigma M_B = 0$$

$$12 \times V_D + 21.1 = 8 \times 6$$

$$12 V_D = 26.9$$

$$V_D = 2.24 \text{ kip}$$

$$\Sigma F_y = 0$$

$$V_{B2} + V_D = 8$$

$$V_{B2} = 8 - 2.24 = 5.76 \text{ kip}$$

from CB

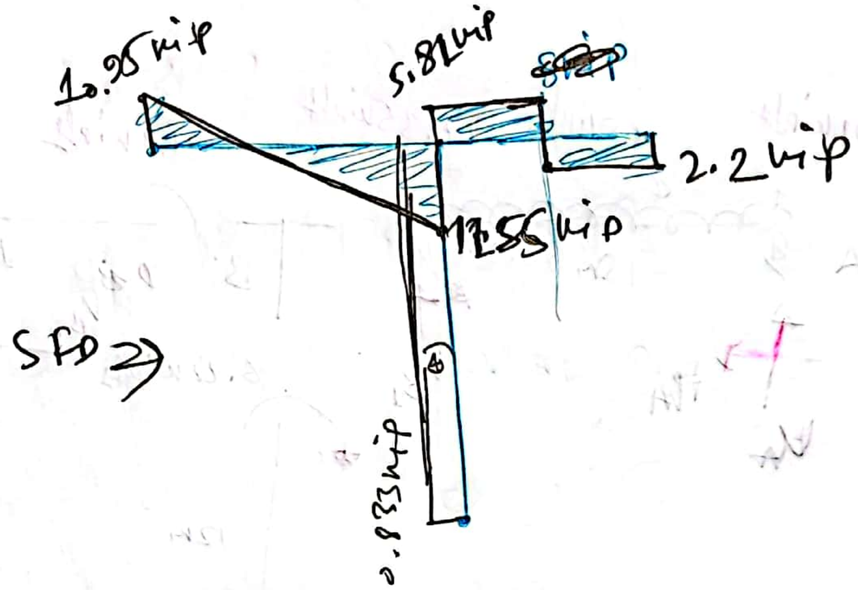
$$\Sigma F_y = 0$$

$$V_C = 11.6 + 5.76 = 17.36 \text{ kip}$$

$$\Sigma M_B = 0$$

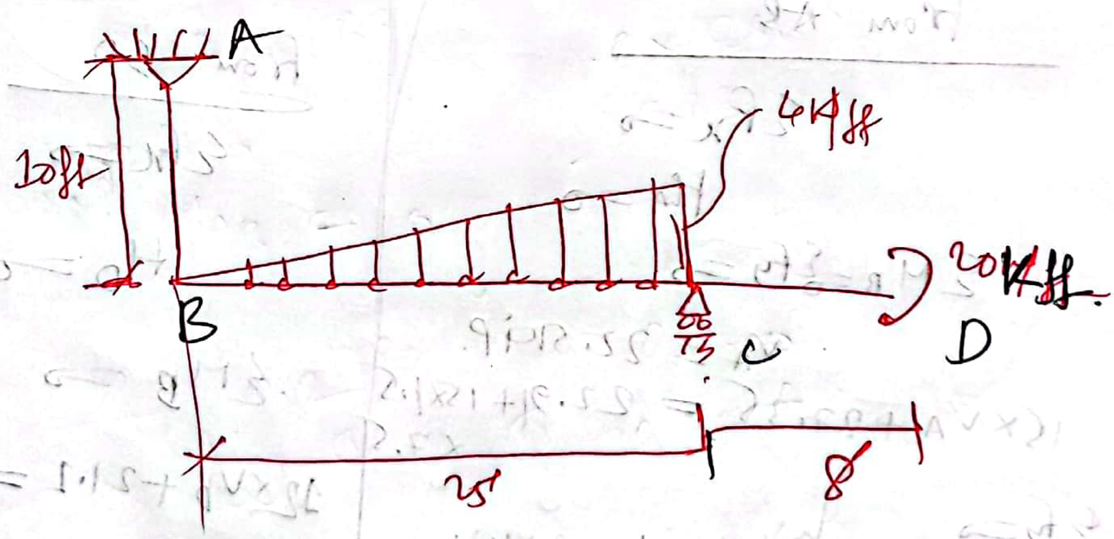
$$H_C \times 12 + 3.75 + 6.22 = 0$$

$$H_C = -0.833 \text{ kip}$$



P8

Draw shear and moment diagrams for the members of the frame shown in Fig. 12



Sol^n: Step 1:

$FEM_{AB} = 0$

$FEM_{BA} = 0$

$FEM_{BC} = -\frac{wl^2}{30} = -\frac{4\times25^2}{30}$

$= -83.33$ k-ft

$FEM_{CB} = +\frac{wl^2}{20} = \frac{4\times25^2}{20}$

$= 125$ k-ft.

~~Date: /~~

Step: 2

$$M_{AB} = 0 + \frac{2EI}{10}(2\theta_A + \theta_B)$$

$$M_{AB} = 0.2EI\theta_B + 0.4EI\theta_A$$

$$M_{BA} = \frac{2EI}{10}(2\theta_B + \theta_A)$$

$$= 0.4EI\theta_B + 0.2EI\theta_A$$

$$M_{BC} = -83.33 + \frac{2EI}{25}(2\theta_B + \theta_C)$$

$$M_{BC} = -83.33 + 0.16\theta_B EI + 0.08\theta_C EI$$

$$M_{CB} = 125 + \frac{2EI}{25}(2\theta_C + \theta_B)$$

$$= 125 + 0.08EI\theta_B + 0.16EI\theta_C$$

~~$M_{CD} =$~~

Step: 3

$$M_{BA} + M_{BC} = 0$$

$$\text{or, } 0.4EI\theta_B + 0.2EI\theta_A - 83.33 + 0.16EI\theta_B + 0.08EI\theta_C = 0$$

$$0.2EI\theta_A + 0.56EI\theta_B + 0.08EI\theta_C = 83.3 \quad (1)$$

$M_{CB} - 20 = 0$

$125 + 0.08 EI\theta_B + 0.16 EI\theta_C - 20 = 0$

$\therefore 0.08 EI\theta_B + 0.16 EI\theta_C = -105$ —— (ii)

Solving equation (i) and (ii)

$\cancel{EI\theta_B = 261.15}$

$\cancel{EI\theta_C = -786.82}$

~~Step 4:~~ $\cancel{M_{AB} = 0.2 \times 261.15}$

$\cancel{= 52.23}$

and $M_{AB} = 0$

$0.2 EI\theta_B + 0.4 EI\theta_A = 0$ —— (iii)

Solving (i), (ii), (iii) we get,

$EI\theta_A = -161.67$

$EI\theta_B = 323.33$

$EI\theta_C = -817.92$

~~$M_{AB} = 0.4(-130.58) + 0.2 \times 261.15$~~

Step: 4

$M_{AB} = 0$

$M_{BA} = 0.4 \times 323.33 + 0.2(-161.37)$

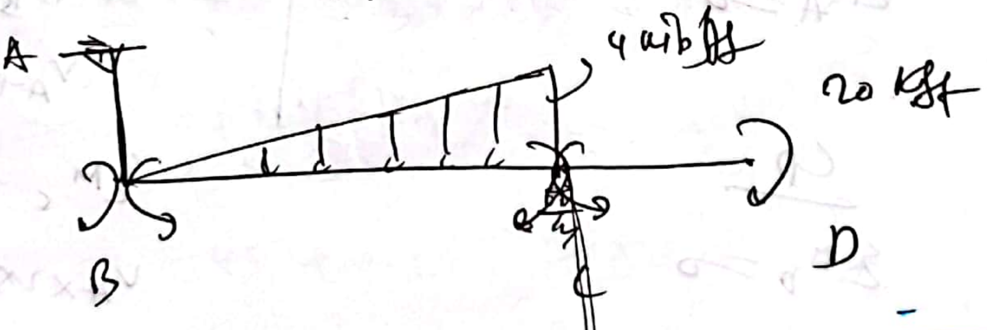
$= 97$ kip.ft.

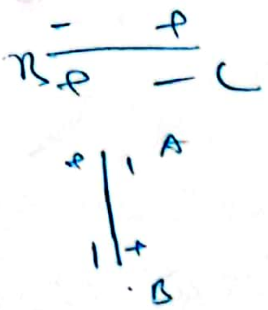
$M_{BC} = -83.3 + 0.16 \times 323.35 - 0.08(817.92)$

$= -97$ kip.ft

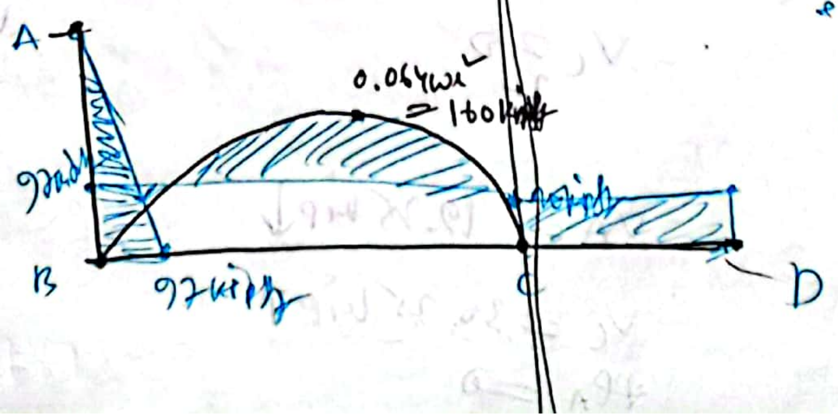
$M_{CB} = 125 + 0.08(323.33) + 0.16(-817.92)$

$= 20$ kip.ft

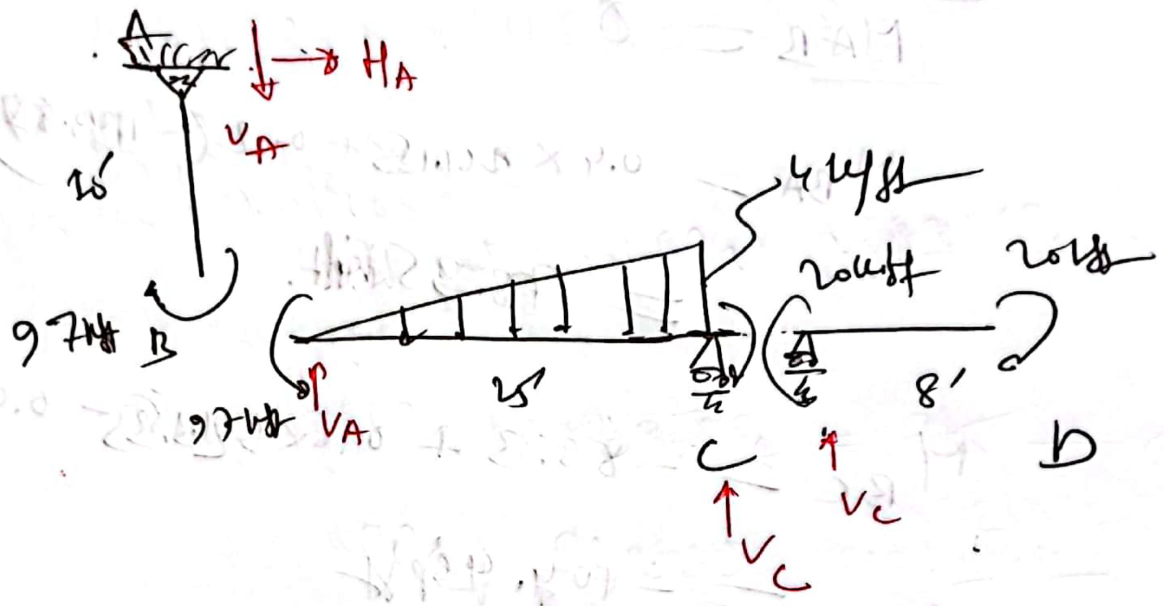




Nu BMD ⇒



Step 5   Find reaction



AB

$\Sigma F_x = 0$

$H_A = 0$

CD

$\Sigma M_D = 0$

$V_C \times 8 + 20 = 20$

$\therefore V_C = 0$

$\therefore V_A = 19.75$ kip ↓

$V_C = 30.25$ kip ↑

$H_A = 0$

BC

$\Sigma F_y = 0$

$V_A + V_B = \frac{1}{2} \times 25 \times 4$

$\therefore V_A + V_{C_1} = 50$

$\Sigma M_C = 0$

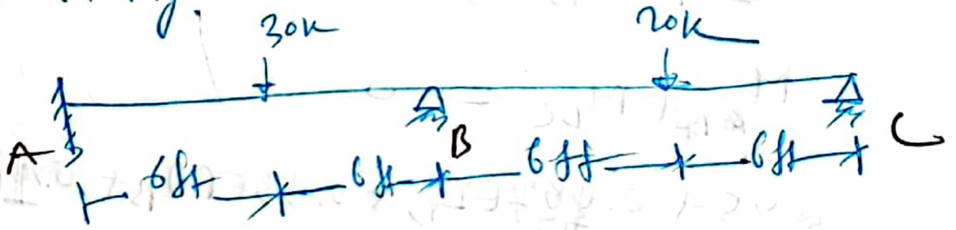
$V_A \times 25 + 20 = 50 \times \frac{1}{3} \times 25 + 97$

$\therefore V_A = 19.75$ kip ↑

$V_B = 30.25$ kip

1) Determine all reaction components and draw shear force and bending moment diagrams for the beam shown in fig.

2016 BCE



Solution:—

$$FEM_{AB} = -\frac{wl}{8} = -\frac{30\times 12}{8} = -45\text{kft}$$

$$FEM_{BA} = 45\text{kft}$$

$$FEM_{BC} = -\frac{20\times 12}{8} = -30\text{kft}$$

$$FEM_{CB} = 30\text{kft}$$

$$M_{AB} = -45 + \frac{2EI}{12}(\theta_B)$$

$$= -45 + 0.167 EI\theta_B$$

$$M_{BA} = 45 + \frac{2EI}{12}\times 2\theta_B$$

$$= 45 + 0.33 EI\theta_B$$

$$M_{BC} = -30 + \frac{2EI}{12}(2\theta_B + \theta_C)$$

$$= -30 + 0.33EI\theta_B + 0.167 EI\theta_C$$

$$M_{CB} = 30 + 0.167EI\theta_B + 0.33 EI\theta_C$$

$M_{CB} = 0$

$0.167 EI\theta_B + 0.33 EI\theta_C = -30$ —— ①

$M_{BA} + M_{BC} = 0$

$45 + 0.66 EI\theta_B + 0.33 EI\theta_B + 0.167 EI\theta_C - 30 = 0$

$\Rightarrow 0.66 EI\theta_B + 0.167 EI\theta_C = -15$ —— ④

$EI\theta_B = 0.32$ kft

$EI\theta_C = -91.1$ kft

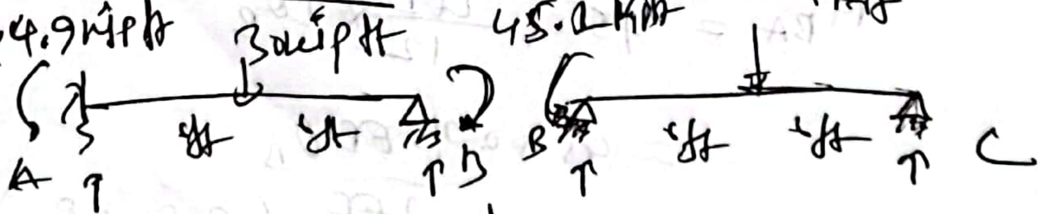
$M_{AB} = 44.9$ kft

$M_{BA} = 45.1$ kft

$M_{BC} = -45.1$ kft

$M_{CB} = 0$

Find Reactions:—



$\Sigma M_A = 0$

$12 \times R_{B_1} + 44.9 = 30 \times 6 + 45.1$

$R_{B_1} = 15.02$ kip

$R_A = 14.98$ kip

$\Sigma M_B = 0$

$R_C \times 12 + 45.1 = 20 \times 6$

$\therefore R_C = 6.24$ kip

$R_{B_2} = 13.76$ kip

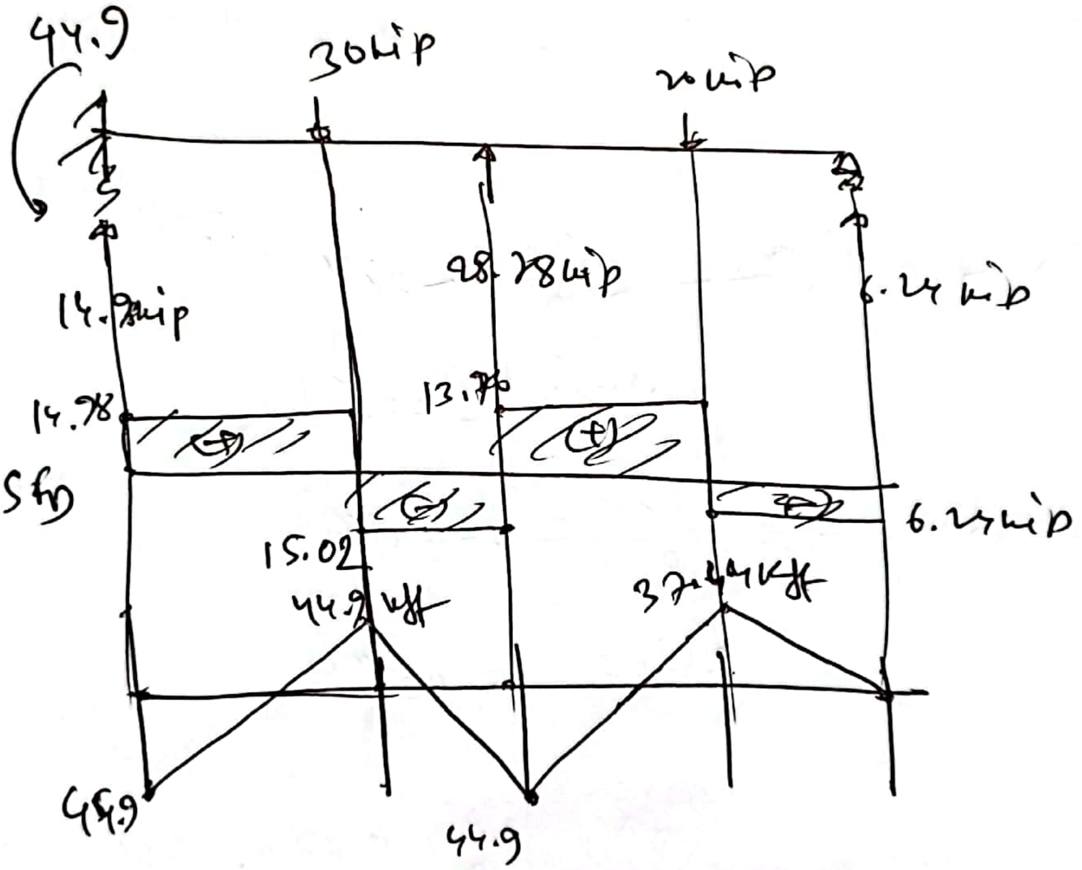
CamScanner

$\therefore R_A = 14.98\,kip$

$R_B = (15.02 + 13.76)\,kip$

$= 28.78\,kip$

$R_C = 6.14\,kip$



Note:- 44.98 ≈ 45

15.98 ≈ 15

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