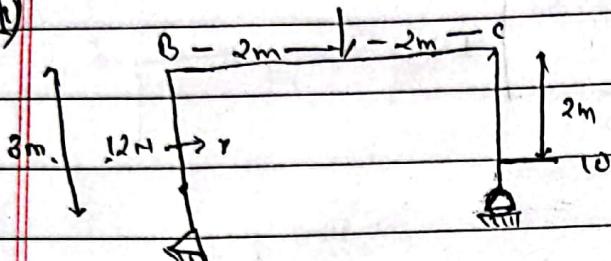


Q) Analyze the given frame & draw its axial Shear & bending moment diagram. And locate the salient points

ii)



$$\sum F_x = 0$$

$$A_x + 12 - 10 = 0$$

$$A_x = -2 \text{ kN}$$

$$\sum F_y = 0$$

$$A_y + D_y - 20 = 0$$

$$A_y + D_y = 20 \quad \text{(i)}$$

$$\sum M_A = 0 \quad (\text{clockwise})$$

$$12 \times 1.5 + 20 \times 2 - 10 \times 1 - D_y \times 4 = 0$$

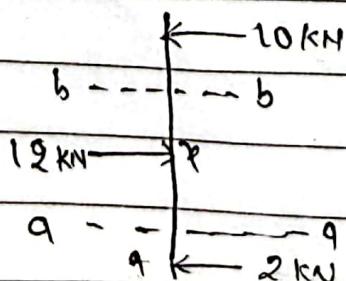
$$-4D_y = -48$$

$$\therefore D_y = -12 \text{ kN}$$

$$\therefore D_y = 12 \text{ kN}$$

$$\therefore A_y = 8 \text{ kN}$$

Span AB



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section A+

$$\text{Shear force } (V_x) = 2 \text{ kN} \quad [0 < x < 1.5]$$

$$V_A = 2 \text{ kN}$$

$$V_{xL} = 2 \text{ kN}$$

$$\text{moment } (M_x) = 2x$$

$$M_A = 0 \text{ kNm}$$

$$M_{xL} = 3 \text{ kNm}$$

section XB

$$\text{Shear force } (V_x) = 2 - 12 \quad [0 < x < 1.5]$$

$$= -10 \text{ kN}$$

$$V_{xR} = -10 \text{ kN}$$

$$V_{xL} = -10 \text{ kN}$$

$$\text{moment } (M_x) = (1.5 + x) 2 - 12x$$

$$= 3 + 2x - 12x$$

$$= 3 - 10x$$

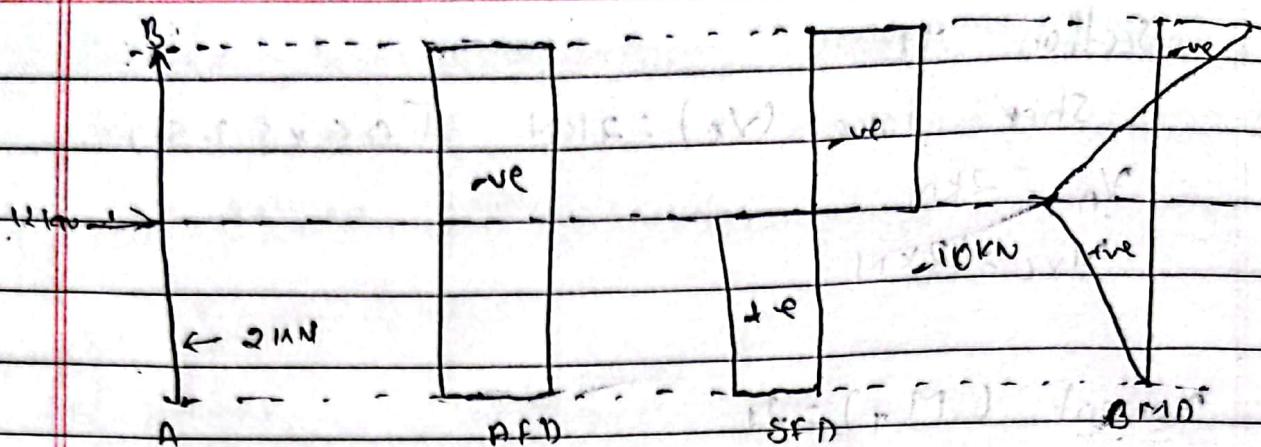
$$[0 \leq x \leq 1.5]$$

$$M_{xL} = 3 \text{ kNm}$$

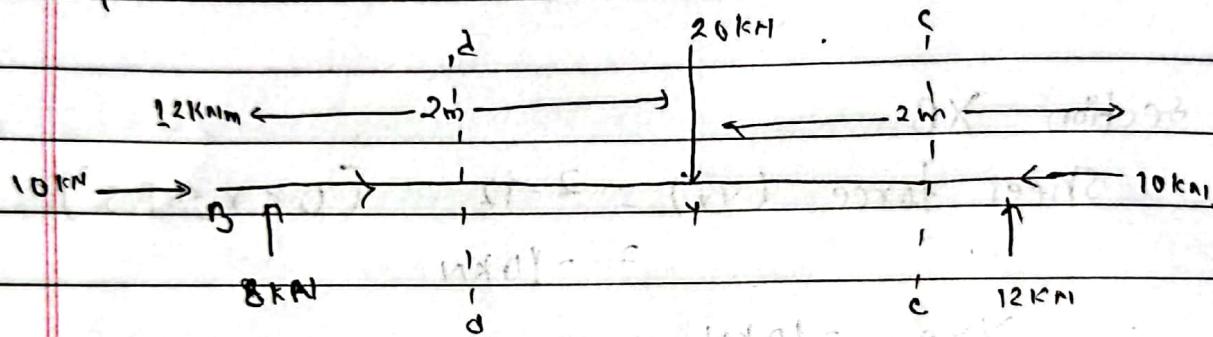
$$M_{xR} = -12 \text{ kNm}$$

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Span BC



Section BY

$$V_x = 8 \text{ kN} (1 - \frac{x}{2}) \quad (0 \leq x \leq 2)$$

$$V_{B,F} = 8 \text{ kN}$$

$$V_{Y_L} = 8 \text{ kN}$$

$$M_x = -12 + 8x \quad (0 \leq x \leq 2)$$

$$M_{B,F} = -12 \text{ kNm}$$

$$M_{X_L} = 11 \text{ kNm}$$

Section YC

$$V_x = 8 - 20 \quad (0 \leq x \leq 2) \\ = -12$$

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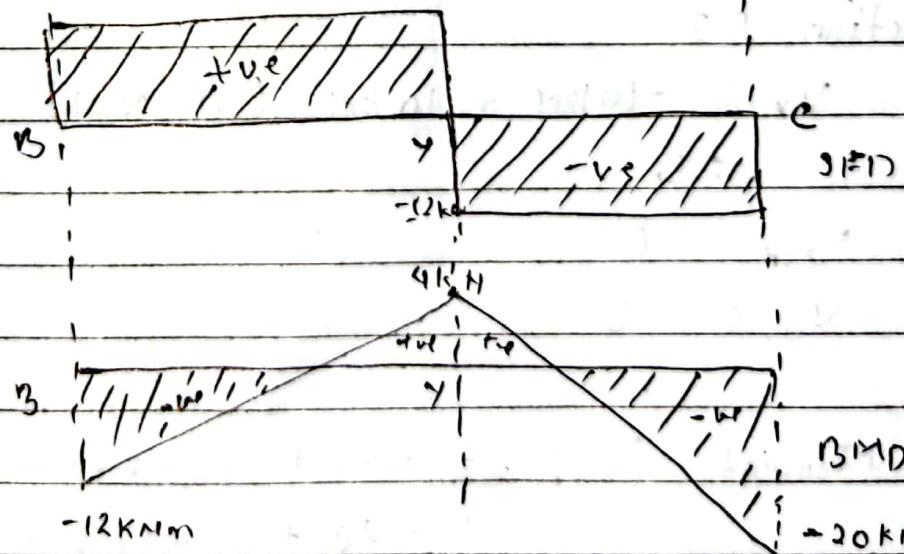
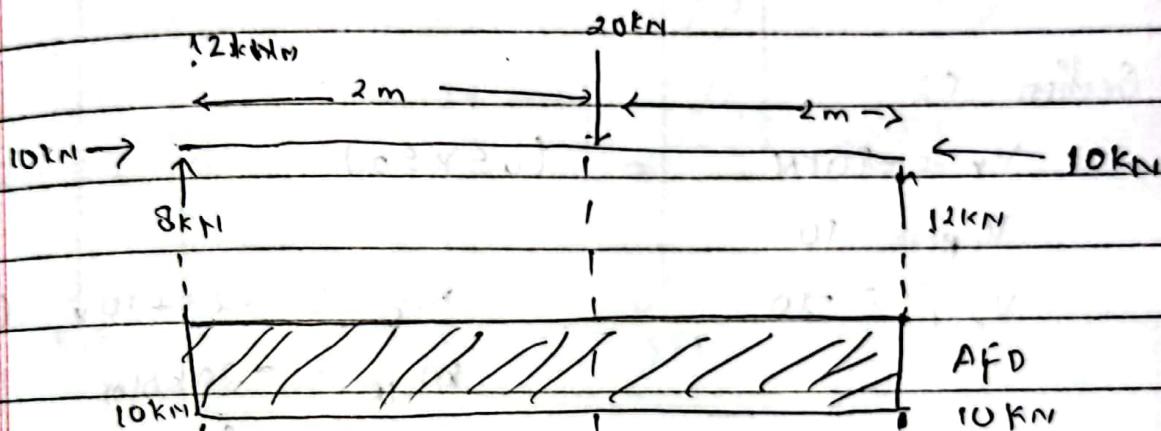
$$V_{VR} = -12 \text{ kN}$$

$$V_{LL} = -12 \text{ kN}$$

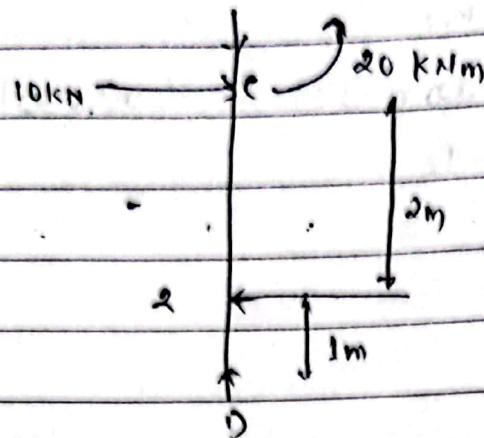
$$\begin{aligned} M_i &= 8(2+x) - 20x - 12 \quad (0 \leq x \leq 2) \\ &= 16 - 12x - 12 \\ &= 4 - 12x \end{aligned}$$

$$M_{XR} = 4 \text{ kNm}$$

$$M_{LL} = -20 \text{ kNm}$$



Span CD



Section C2

$$V_x = -10 \text{ kN} \quad (0 \leq x \leq 2)$$

$$V_{z,R} = -10$$

$$V_{z,L} = -10$$

$$M_y = -20 + 10x \quad (0 \leq x \leq 2)$$

$$M_{z,R} = -20 \text{ kNm}$$

$$M_{z,L} = 0 \text{ kNm}$$

Section D2

$$V_x = -10 \text{ kN} + 10 \text{ kN} \quad (0 \leq x \leq 1)$$

$$= 0$$

$$V_{z,R} = 0$$

$$V_{z,L} = 0$$

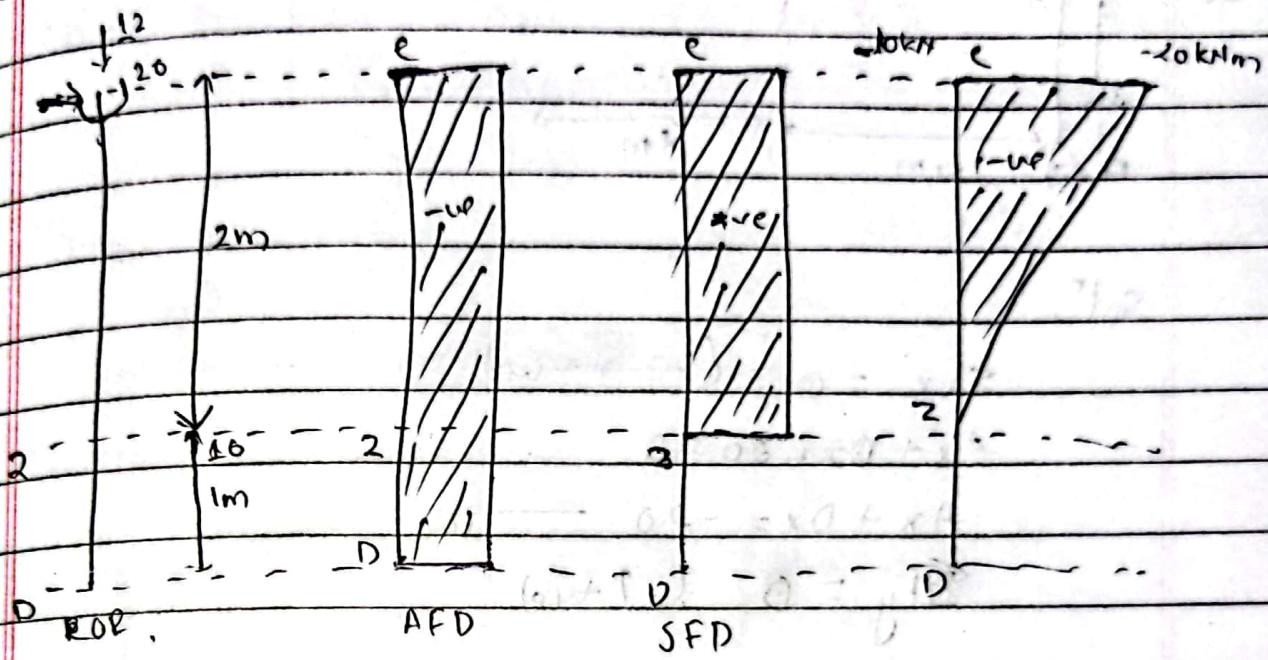
$$\begin{aligned} \text{Moment } (M_y) &= -20 + 10(2+x) - 10x \\ &= -20 + 20 + 10x - 10x \\ &= 0. \end{aligned}$$

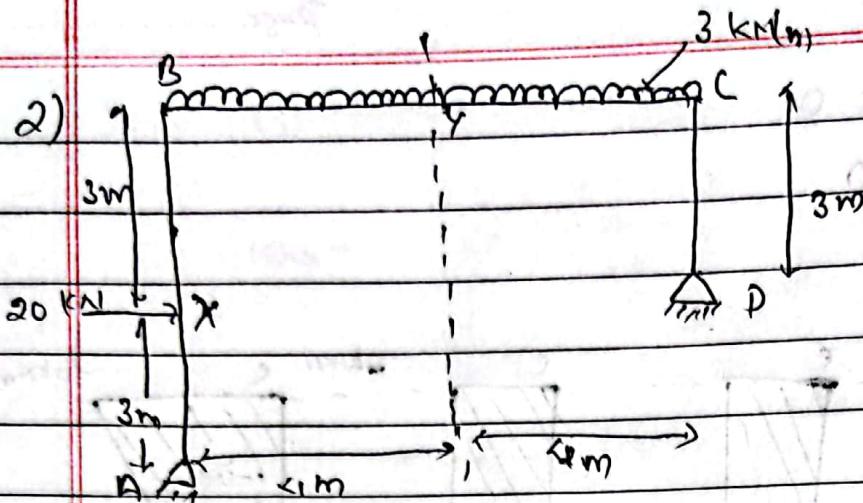
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$$M_{z,r} = 0$$

$$M_0 = 0$$





Sol:

$$\sum F_x = 0 \quad (\rightarrow +ve)$$

$$F_x + D_x + 20 = 0$$

$$A_x + D_x = -20 \quad \text{--- (i)}$$

$$\sum F_y = 0 \quad (\uparrow +ve)$$

$$A_y + D_y - 24 = 0$$

$$A_y + D_y = 24 \quad \text{--- (ii)}$$

$$\sum M_B = 0$$

$$20 \times 3 + 24 \times 4 - 8 D_y + 3 D_x = 0$$

$$60 + 96 - D_y \cdot 8 + 30 = 0$$

$$3D_x - 8D_y = -156 \quad \text{--- (iii)}$$

now,

$$\sum M_y = 0 \quad \text{Internal hinge}$$

$$12 \times 2 - 3D_x - 4D_y = 0$$

$$3D_x + 4D_y = 24 \quad \text{--- (iv)}$$

solving (iii) & (iv)

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$$D_x = -12 \text{ kN}$$

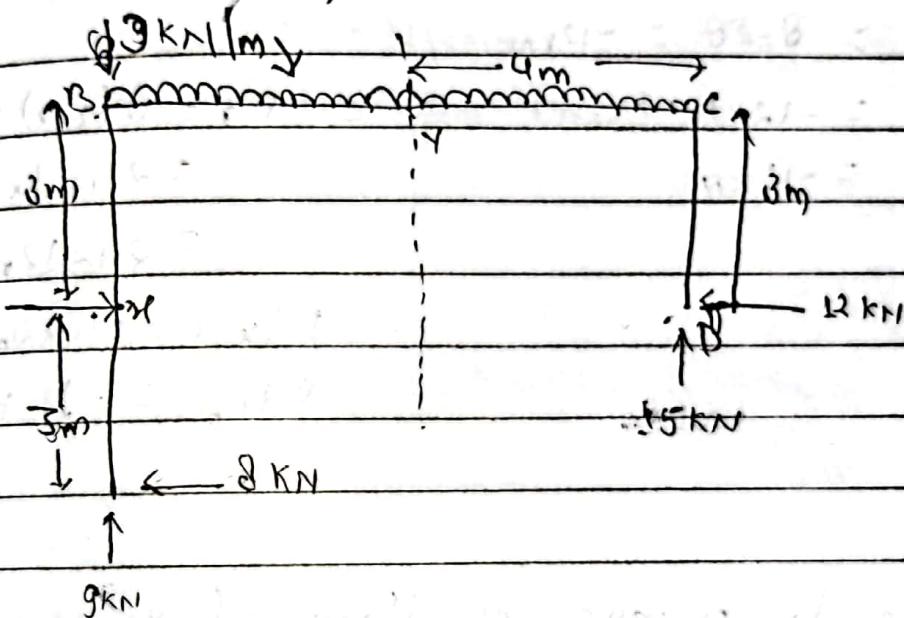
$$D_y = 15$$

Using D_x & D_y , from eqn (i) & (ii)

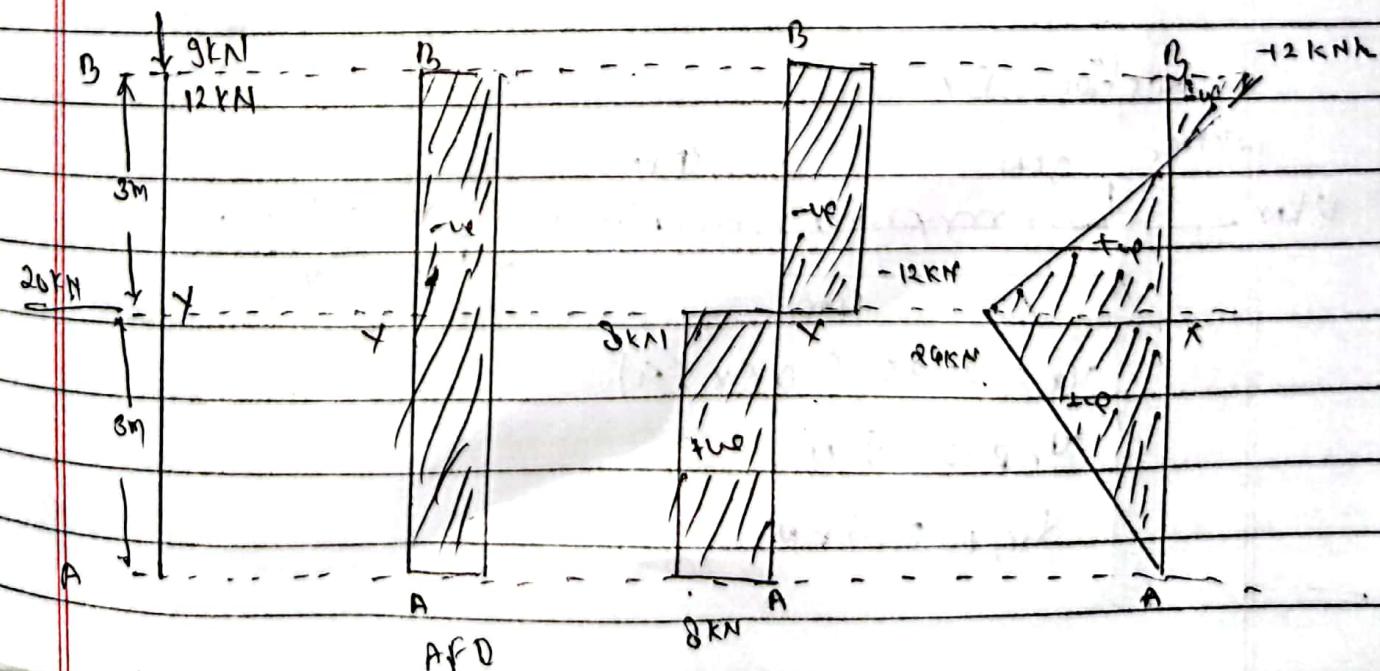
$$F_x = -8 \text{ kN}$$

$$F_y = 9 \text{ kN}$$

Then we have,



Span AB



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Section Ax

$$V_x = 8 \text{ kN} \quad (0 \leq x \leq 3)$$

$$V_A = 8 \text{ kN}$$

$$V_{x,L} = 8 \text{ kN}$$

$$M_x = 8x \quad (0 \leq x \leq 3)$$

$$M_A = 0$$

$$M_{x,L} = 24 \text{ kNm}$$

Section XB

$$V_B = 8 - 2x = -12 \text{ kN}$$

$$V_{x,R} = -12 \text{ kN}$$

$$V_{B,L} = -12 \text{ kN}$$

$$\begin{aligned} M_x &= 8(3+x) - 20x \quad (0 \leq x \leq 2) \\ &= 24 + 8x - 20x \\ &= 24 - 12x \end{aligned}$$

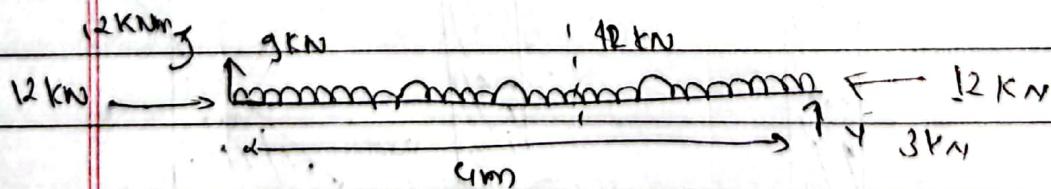
$$M_{x,R} = 24 \text{ kNm}$$

$$M_{B,L} = -12 \text{ kN}$$

Span BC

Due to presence of hinge at Y, separating section into BY & YC

Section BY



$$V_x = 9 - 3x \quad (0 \leq x \leq 4)$$

$$V_{B,R} = 9 \text{ kN}$$

$$V_{Y,L} = -3 \text{ kN}$$

let 'B' be point of zero shear

$$9 - 3b = 0$$

$$b = 3\text{m}$$

$$v_x = 9x - 3x^2 - 12 \quad (0 \leq x \leq 4)$$

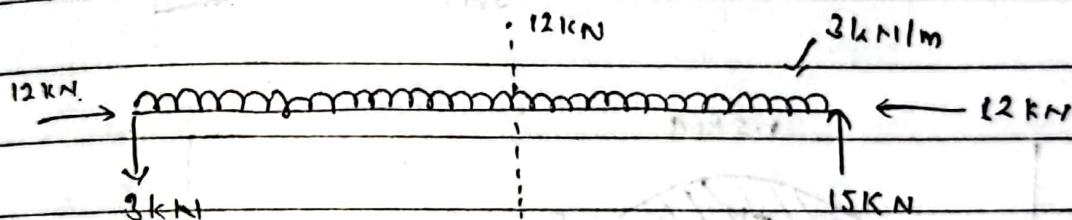
$$v_x = \frac{3x^2}{2} - 12$$

$$M_{y,R} = -12 \text{ kNm}$$

$$M_{y,L} = 6$$

$$M_{L,\text{max}} = 15 \text{ kNm}$$

Section Y L



$$v_x = -3 - 3x \quad (0 \leq x \leq 4)$$

$$v_{y,R} = -3 \text{ kN}$$

$$v_{y,L} = -15 \text{ kN}$$

$$m_x = -3x - 3x^2$$

$$= -3x - \frac{3x^2}{2}$$

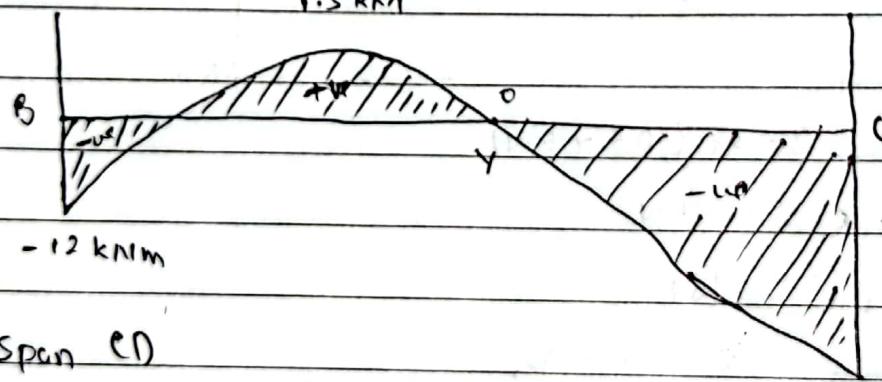
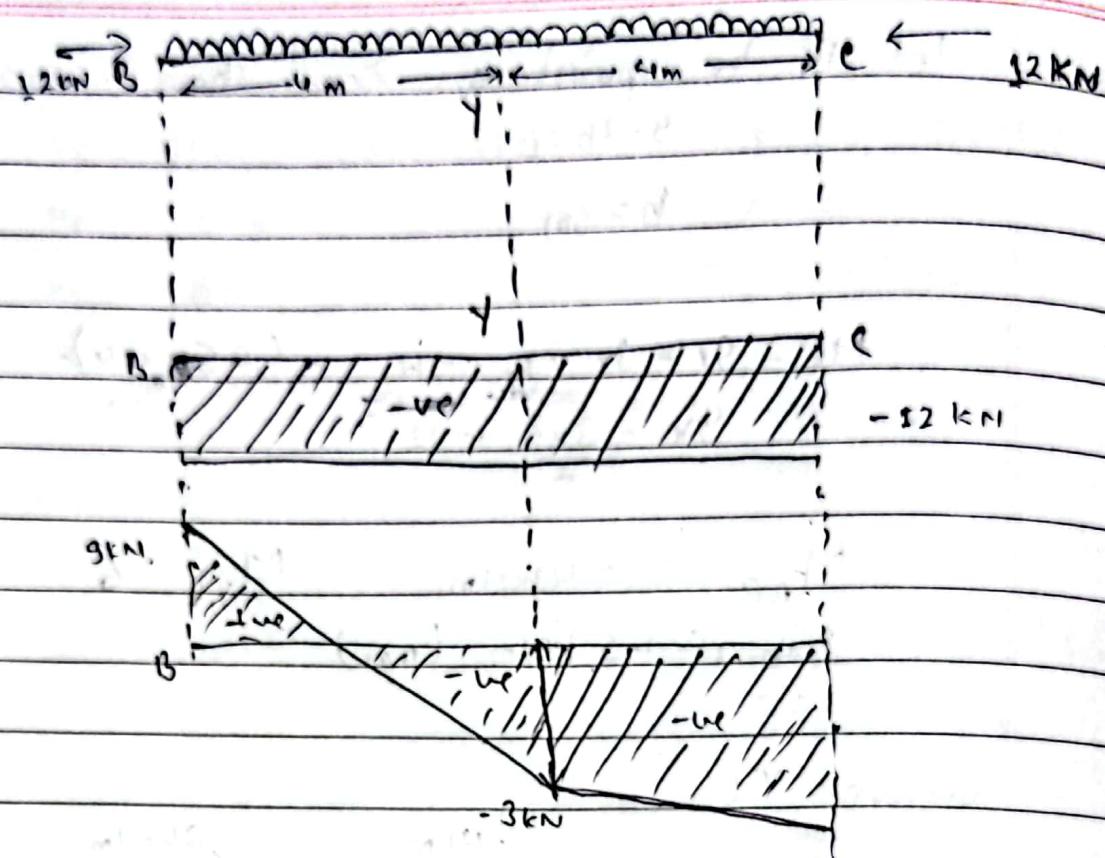
$$\Rightarrow M_{y,R} = 0$$

$$M_{y,L} = -36 \text{ kNm}$$

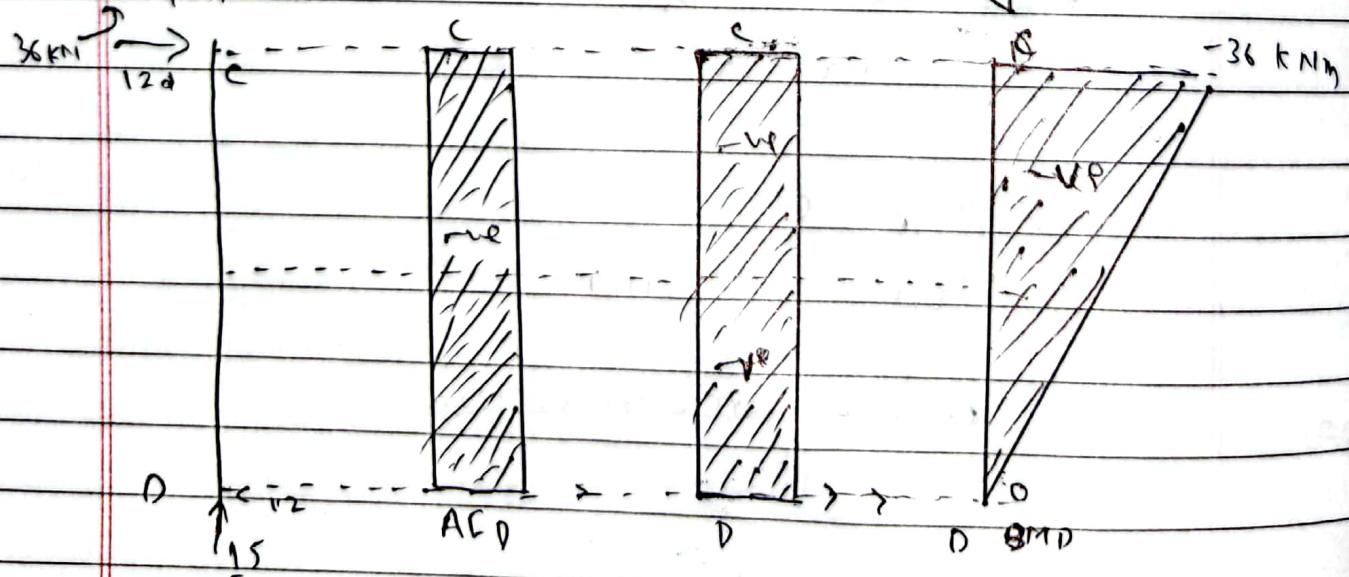
~~12 kN~~

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Pg 8 kNm



Span CD



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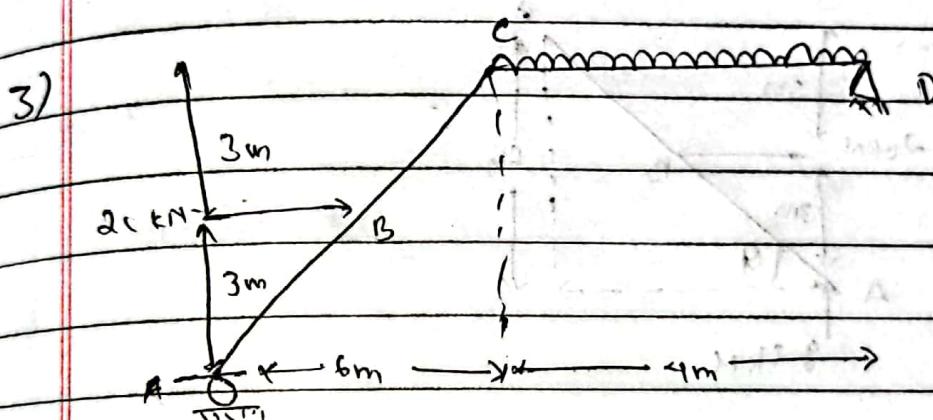
$$V_x = -12 \text{ kN}$$

$$V_{c,R} = -12 \text{ kN}$$

$$V_p = -12 \text{ kN}$$

$$M_x = -3l + 12x \quad (0 \leq x \leq 3)$$
$$\Rightarrow M_{l,R} = -3l \text{ kNm}$$

$$M_0 = 0$$



Sol:

$$\sum F_x = 0 \quad (\rightarrow \text{true})$$

$$\therefore 20 \text{ kN} \neq D_x = 0$$

$$\therefore D_H = -20$$

$$\therefore D_x = 20 \text{ kN} (\leftarrow)$$

$$A_y + D_y - 16 = 0$$

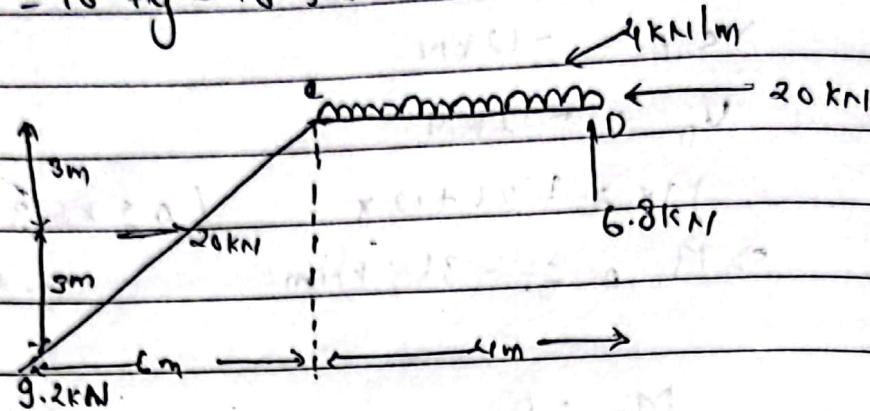
$$\therefore A_y + D_y = 16 \quad \text{---(i)}$$

$$\sum M_0 = 0$$

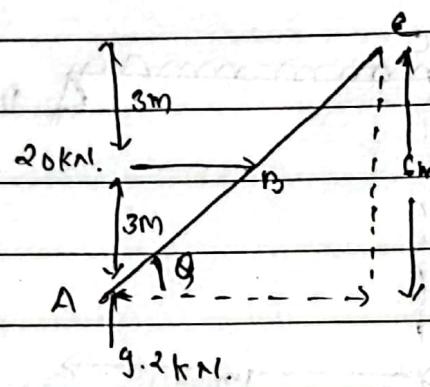
$$\therefore -16 \times 2 - 20 \times 3 + A_y \times 10 = 0$$

$$\therefore A_y = 9.2 \text{ kN}$$

$$\sigma D_y = 16 - \alpha_y = 16 - 9.2 = 6.8 \text{ kN}$$



Taking inclined member.



Here,

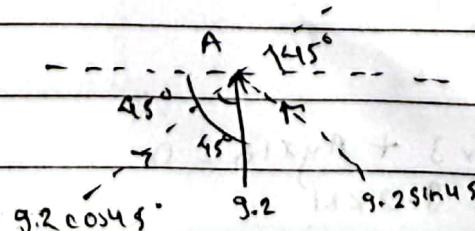
$$\tan \theta = \frac{6}{3}$$

$$\theta = 45^\circ$$

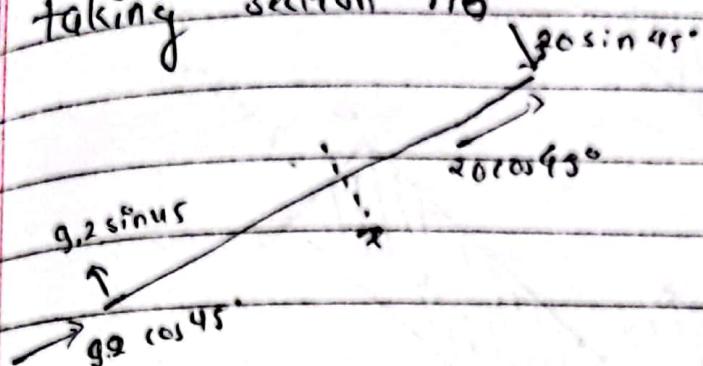
$$AB = BC = \frac{6}{\sin 45^\circ} = \frac{6}{\sin 45^\circ} \approx 8.48 \text{ m}$$

$$AB = BC = \frac{8.48}{2} = 4.24 \text{ m}$$

Taking point A & B



taking section AB



$$V_x = 9.2 \sin 45^\circ (0 \leq x \leq 4.24)$$

$$V_R = 6.50 \text{ kN}$$

$$V_{A,L} = 6.50 \text{ kN}$$

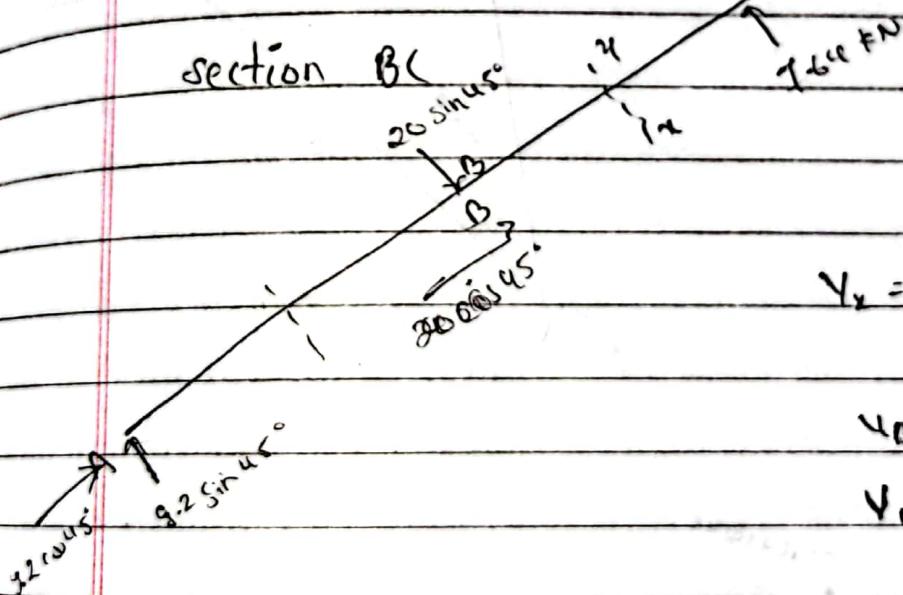
$$M_y = 6.50 x$$

$$M_p = 0$$

$$M_{0,L} = 27.6 \text{ KNm}$$

$$(20 \cos 45^\circ \times 9.2 \cos 45^\circ) : 90^\circ = 6.50 \text{ kN}$$

section BC



$$V_x = 9.2 \sin 45^\circ - 20 \sin 45^\circ \\ = -7.64 \text{ kN}$$

$$V_{B,R} = -7.64 \text{ kN}$$

$$V_{L,L} = -7.64 \text{ kN}$$

$$M_x = 6.50 (4.24 + x) - 20 \sin 45^\circ x \quad (0 \leq x \leq 4.24) \\ = 27.6 + 6.5x - 14.14x \\ = 27.6 - 7.64x$$

$$M_{0,R} = 27.6 \text{ KNm}$$

$$M_{L,L} = -4.7936 \text{ KNm}$$

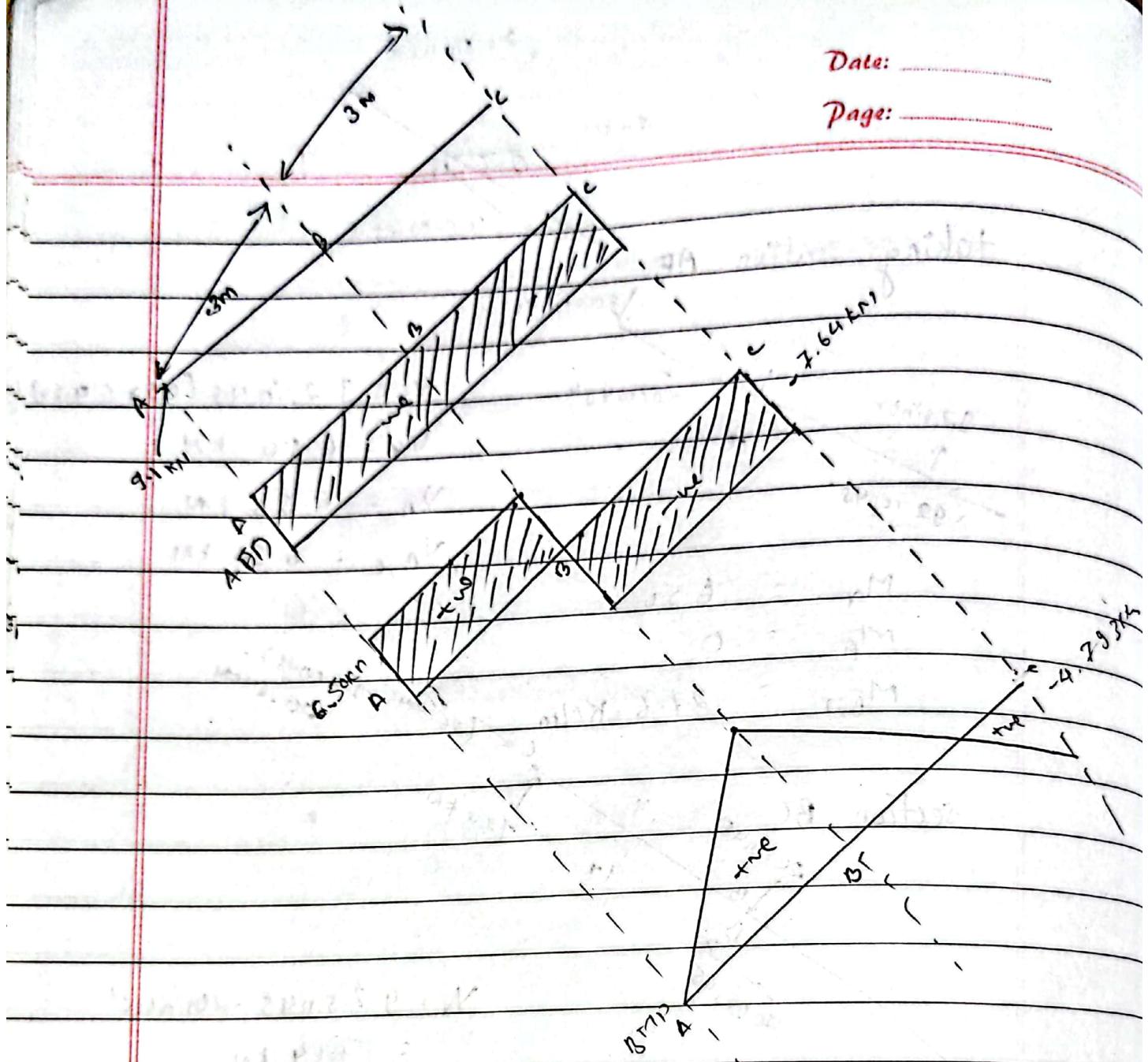
20 sin 45°

Date:

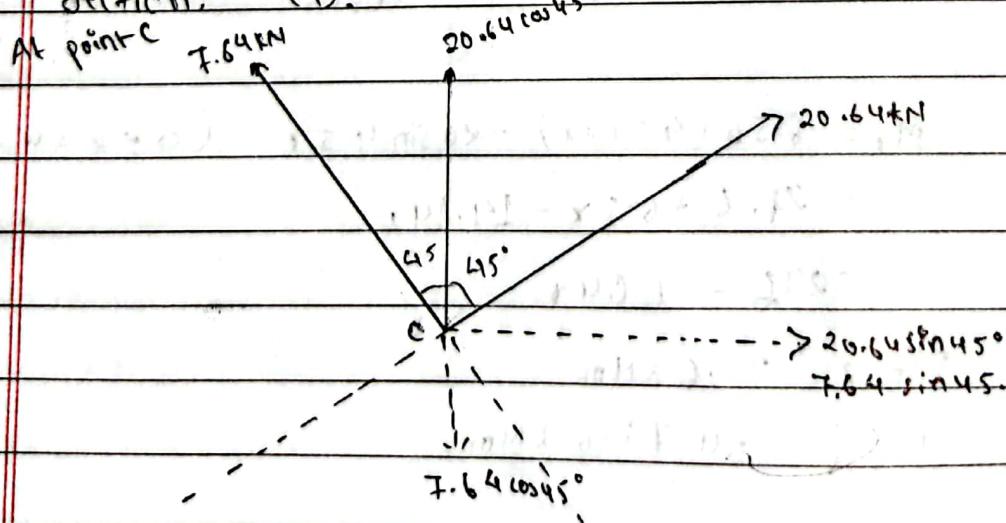
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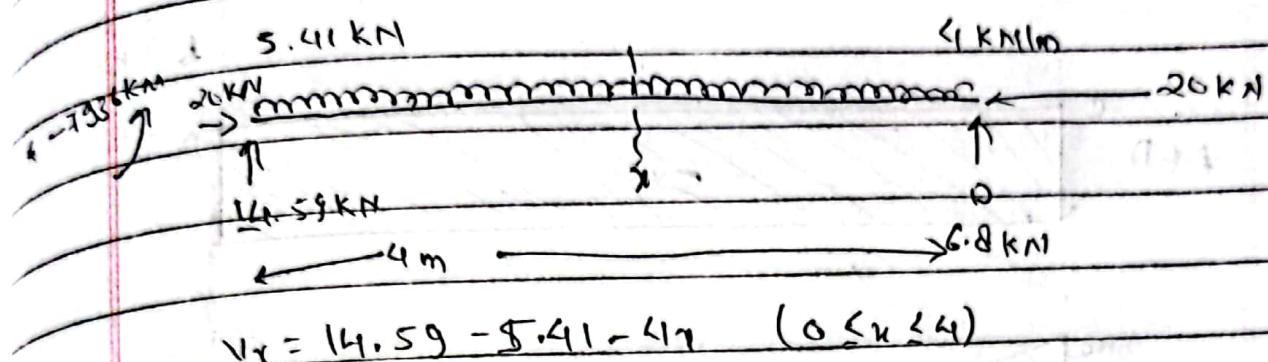
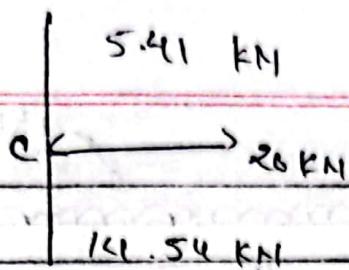


Section CD.



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$$V_x = 14.54 - 5.41 - 4x \quad (0 \leq x \leq 4)$$

$$V_{L,R} = 9.18 \text{ kN}$$

$$V_D = -6.8 \text{ kN}$$

point of zero shear,

$$0 = 9.18 - 4x$$

$$x = 2.295 \text{ m}$$

$$M_x = -4.7936 + 9.18x - \frac{4x^2}{2}$$

$$= -4.7936 + 9.18x - 2x^2$$

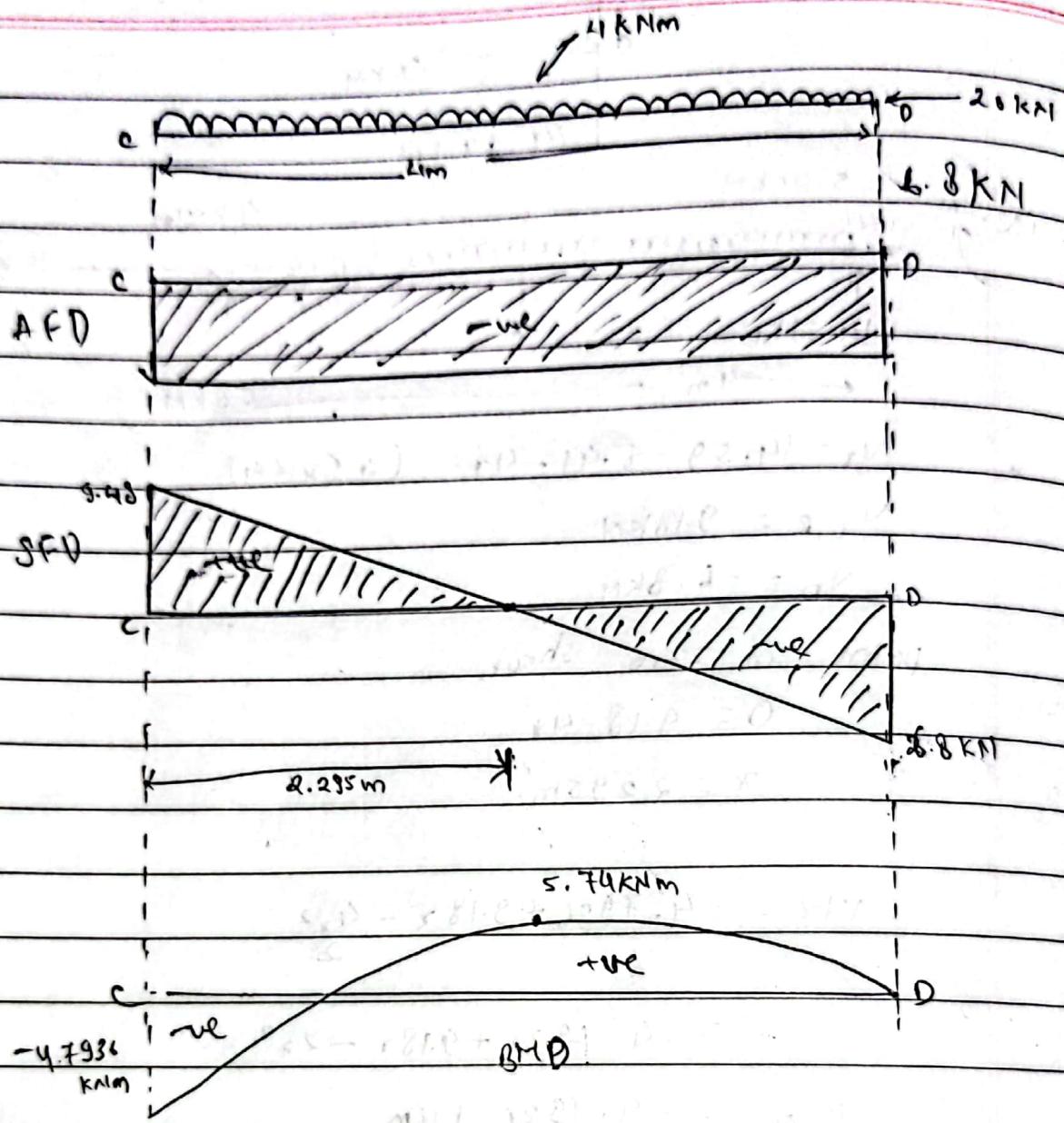
$$M_{ep} = -4.7936 \text{ kNm}$$

$$M_D = -0.07 = 0 \text{ kNm}$$

$$M_{max} = 5.74 \text{ kNm}$$

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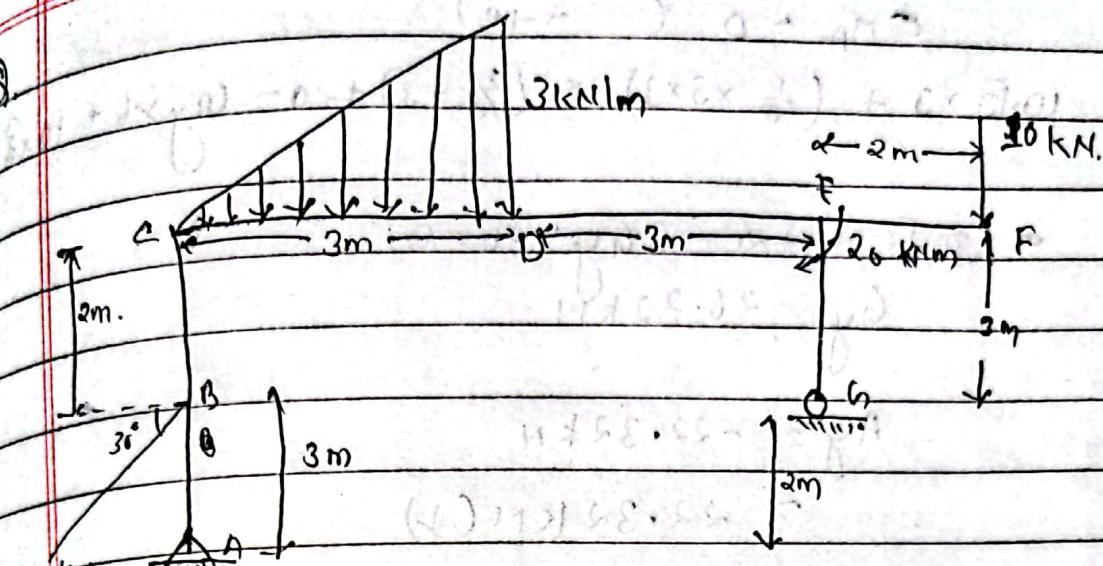
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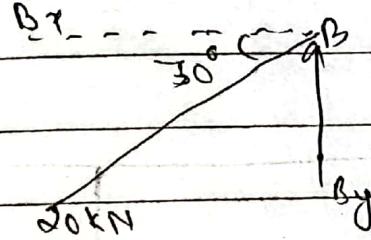
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8



At point B



$$B_x = 20 \cos 30^\circ \\ = 10\sqrt{3} \text{ kN}$$

$$B_y = 20 \sin 30^\circ \\ = 10 \text{ kN}$$

now,

$$\sum F_{x,P} = 0, (\rightarrow \text{true})$$

$$\therefore 10\sqrt{3} - Ax = 0$$

$$Ax = 10\sqrt{3} \text{ kN.}$$

$$\sum F_y = 0 \quad (\uparrow + \downarrow)$$

$$Ay + Ry - g/2 = 0$$

$$Ay + Ry = g/2 - \uparrow$$

$$C_{M_B} = 0 \quad (+ve)$$

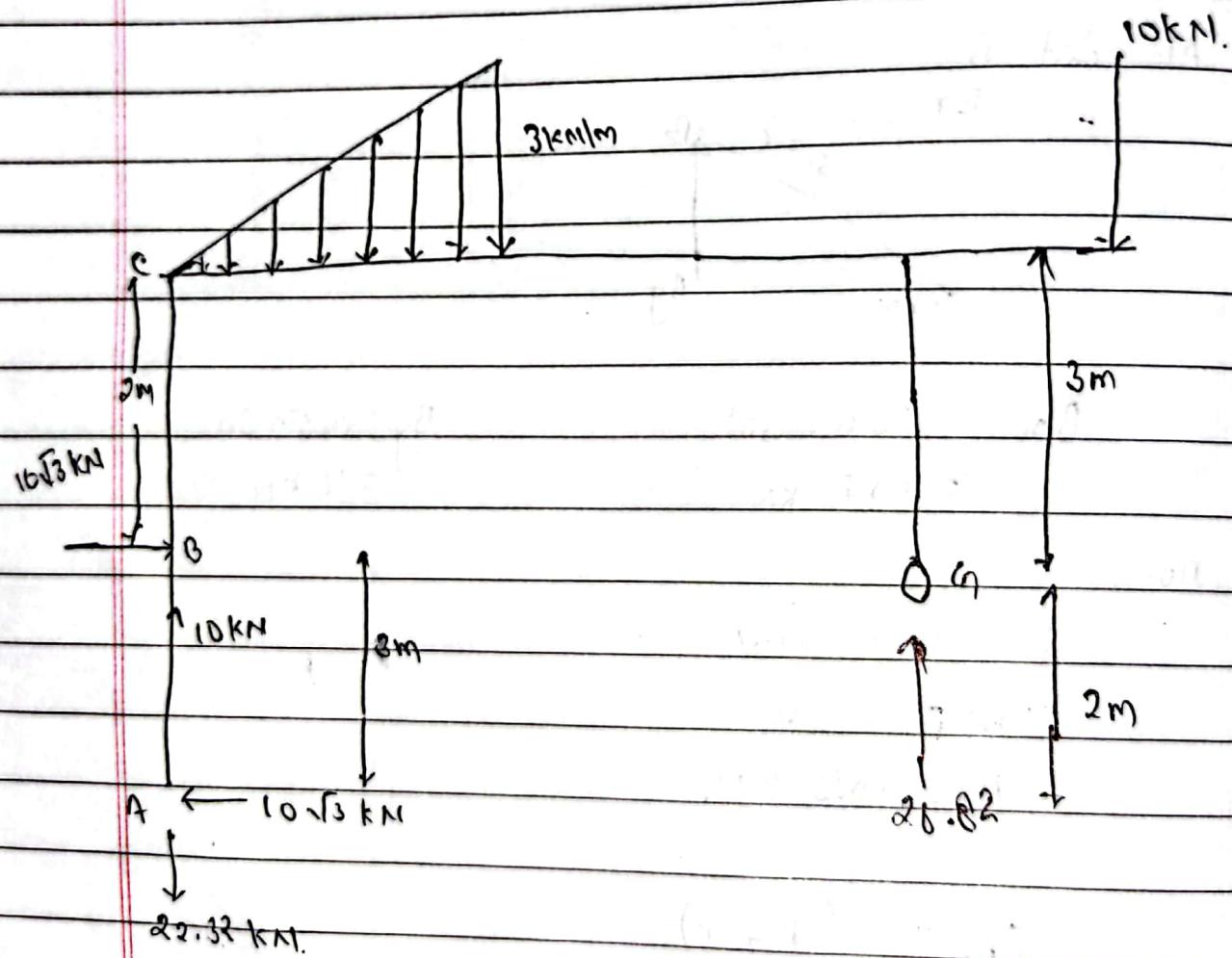
$$10\sqrt{3} \times 3 + \left(\frac{1}{2} \times 3 \times 3\right) \times (2\sqrt{3} + 3) + 20 - (6y)y^2 + 10 \times 8 = 0$$

$$9 \cdot 30\sqrt{3} + 9 + 20 - 6.6y^2 + 80 = 0$$

$$6y^2 = 26.82 \text{ kN}$$

$$Ay = -22.32 \text{ kN}$$

$$= 22.32 \text{ kN} (+ve)$$

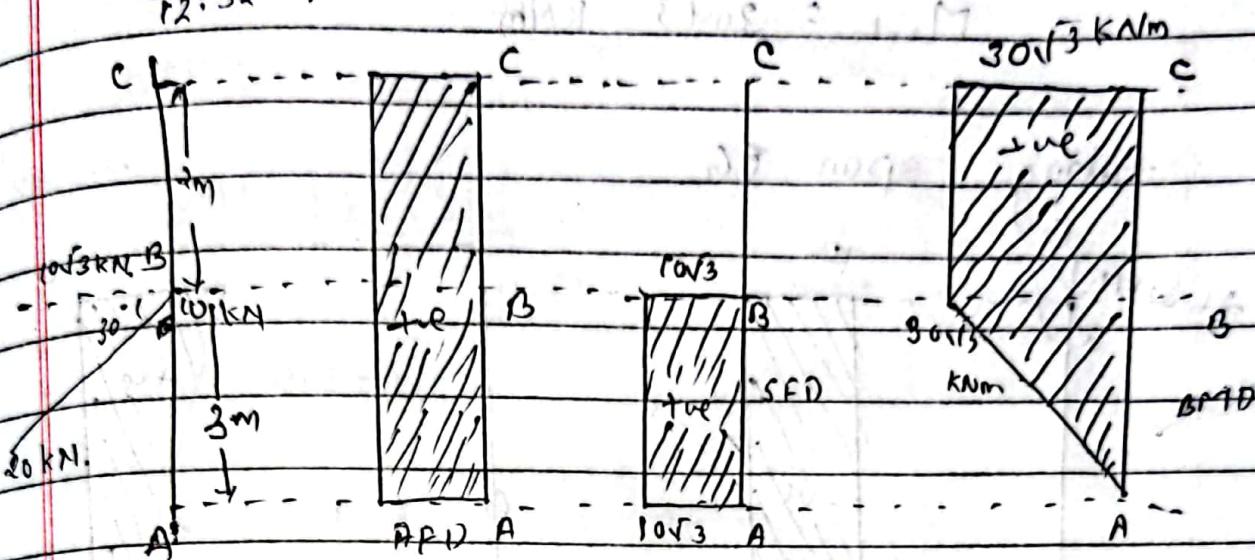


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Taking Span ABC

12.32 kN.



In section AB

$$V_x = 10\sqrt{3} \text{ KN}$$

$$V_{B,L} = 10\sqrt{3} \text{ KN}$$

$$V_{B,L} = 10\sqrt{3} \text{ KN}$$

$$M_x = 10\sqrt{3}x \quad (0 \leq x \leq 3)$$

$$M_A = 0$$

$$M_{B,L} = 30\sqrt{3} \text{ KNm}$$

In section BC

$$V_L = 10\sqrt{3} - 10\sqrt{3} = 0$$

$$V_{B,L} = 0$$

$$V_{L,L} = 0$$

$$M_x = 10\sqrt{3}(3+x) - 10\sqrt{3}x \quad (0 \leq x \leq 2)$$

$$M_L = 30\sqrt{3} + 10\sqrt{3}x - 10\sqrt{3}x$$

$$M_x = 30\sqrt{3} \text{ KNm.}$$

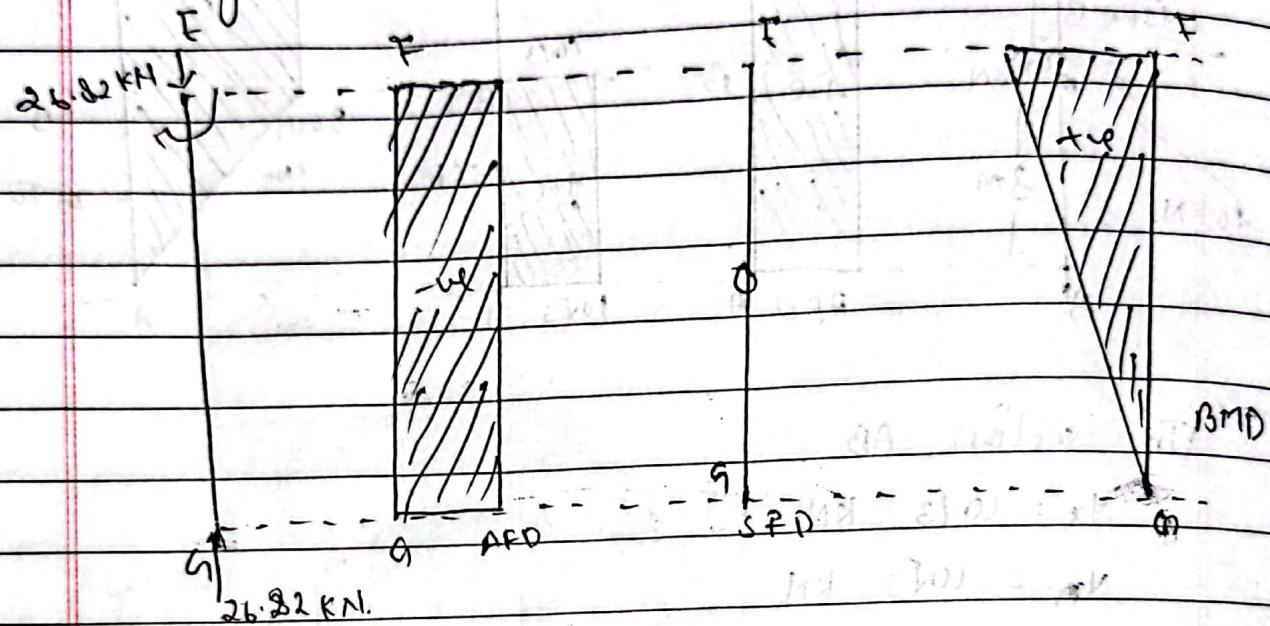
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$$M_{0,R} = 30\sqrt{3} \text{ kNm}$$

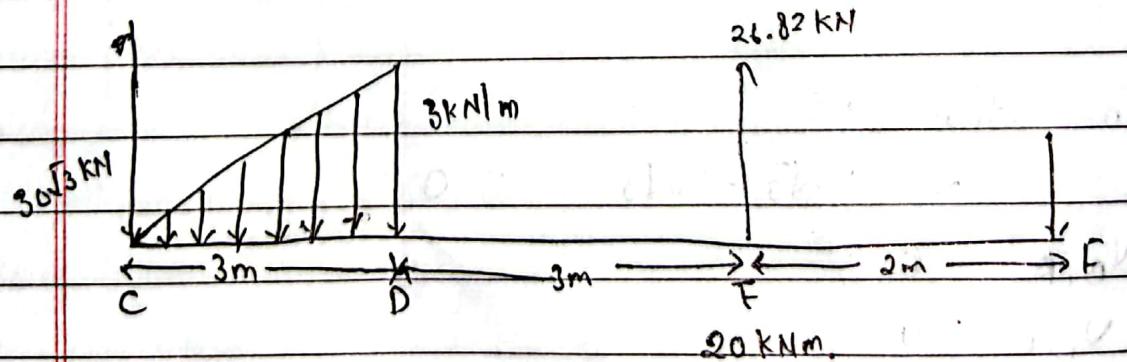
$$M_{u,L} = 30\sqrt{3} \text{ kNm}$$

taking spun FG.



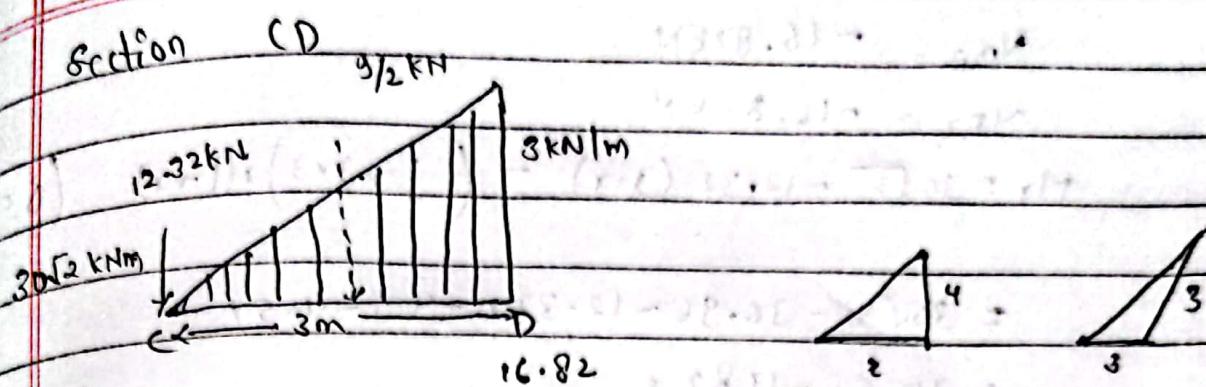
Taking spun (DFE)

$$12.32 \text{ kN}$$



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$$V_x = -12.3 - \frac{x^2}{2}$$

$$= -12.3 - \frac{x^2}{2} \quad (0 \leq x \leq 3)$$

$$4 = x$$

$$V_{L,R} = -12.32$$

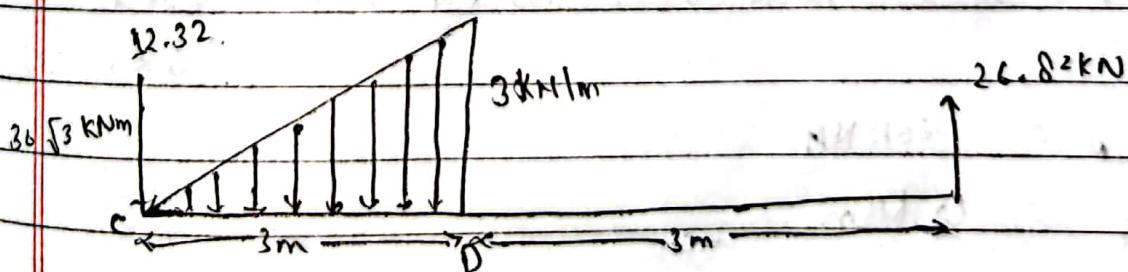
$$V_{D,L} = -16.82$$

$$M_x = 30\sqrt{3} - \frac{x^3}{6} - 12.3x \quad (0 \leq x \leq 3)$$

$$M_{L,R} = 30\sqrt{3} \text{ kNm} \Rightarrow 51.91 \text{ kNm}$$

$$M_{PL} = 10.50 \text{ kNm}$$

Section DE



$$V_x = -12.32 - \frac{1}{2}x^2$$

$$= -16.82 \text{ kN}$$

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$$V_{ER} = -16.82 \text{ kN}$$

$$V_{EL} = -16.82 \text{ kN}$$

$$M_x = 30\sqrt{3} - 12.32(3+x) - \left(\frac{1}{2} \times 3 \times 3\right)x(1+x) \quad (0 \leq x \leq 3)$$

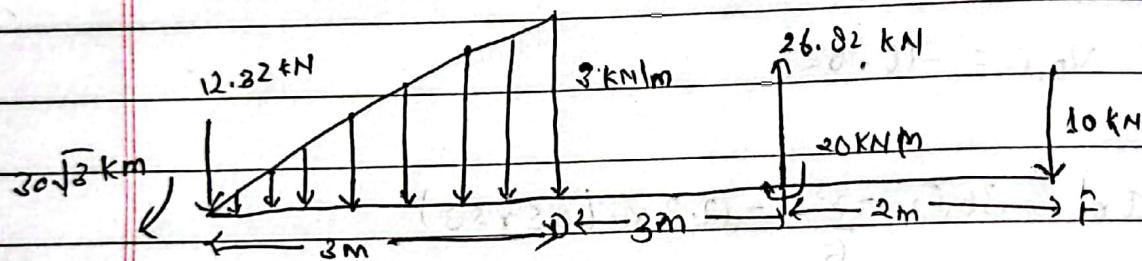
$$= 30\sqrt{3} - 36.96 - 12.32x - 4.5 - 4.5x$$

$$= 10.50 - 16.82 +$$

$$M_{ER} = 16.2 \text{ kNm}$$

$$M_{EL} = -39.6 \text{ kNm}$$

Section FF



$$V_H = -12.32 - \frac{1}{2} \times 3 \times 3 + 26.82 \\ = 10 \text{ kN}$$

$$V_{ER} = 10 \text{ kN}$$

$$V_F = 10 \text{ kN}$$

$$M_x = 30\sqrt{3} - 12.32(6+x) - 4.5(4+x) + 20 + 26.32x$$

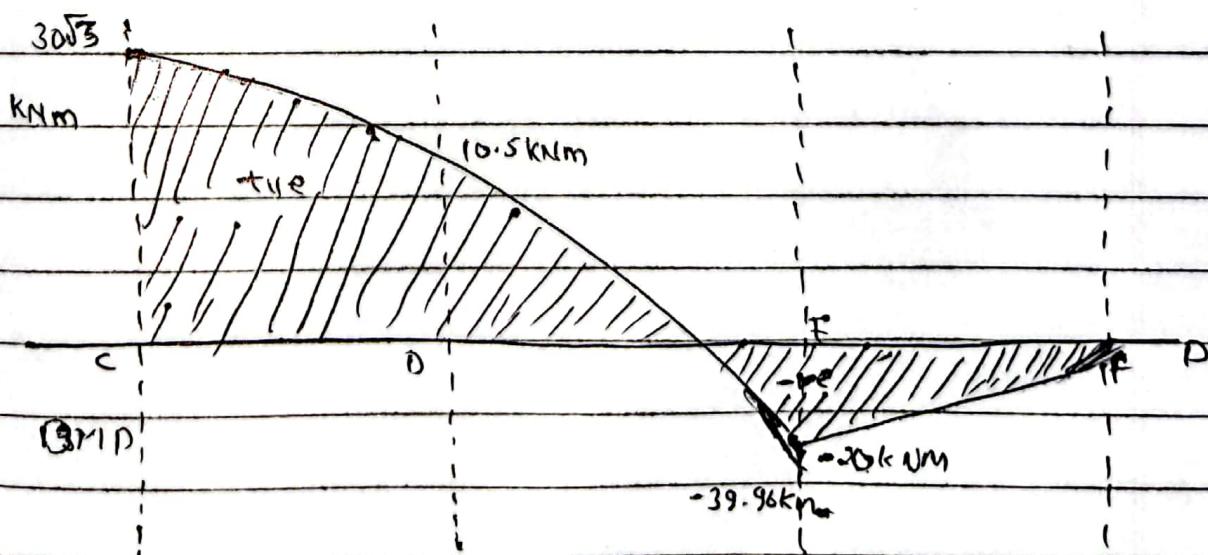
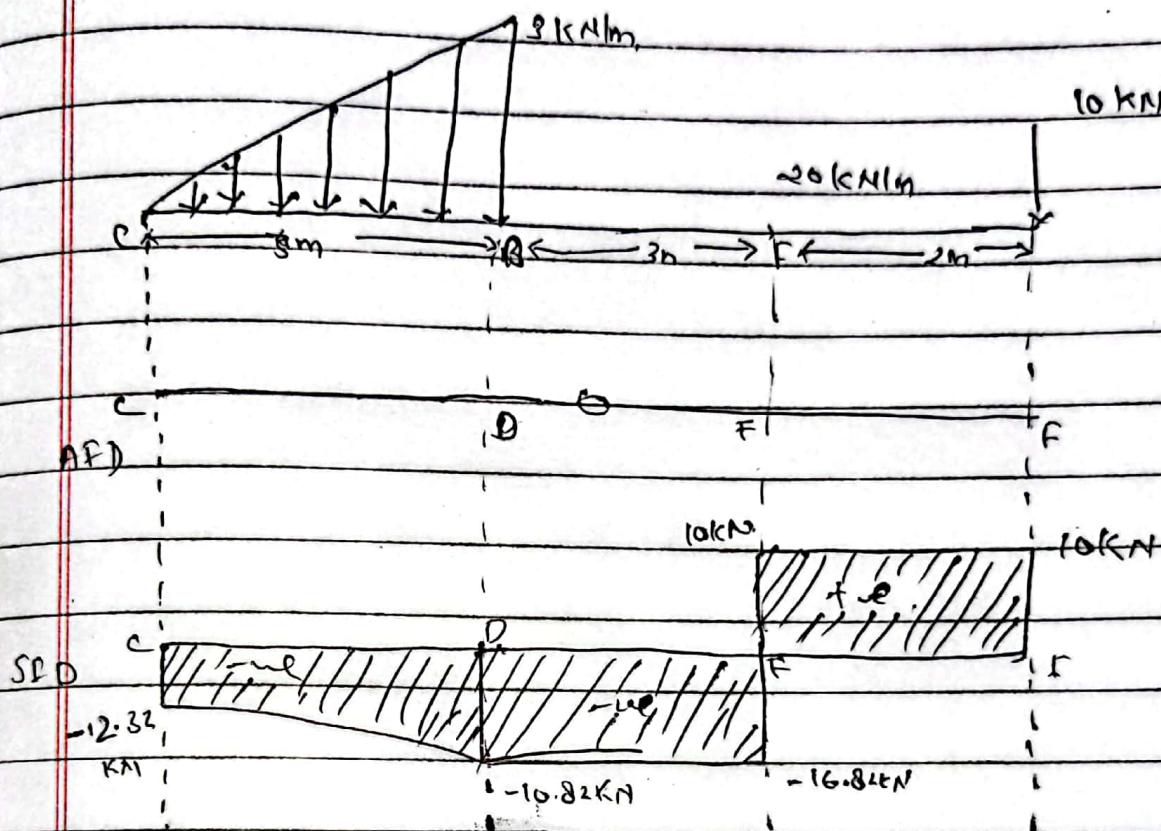
(0 ≤ x ≤ 2)

$$M_{ER} = -26 \text{ kNm}$$

$$M_F = 0 \text{ kNm}$$

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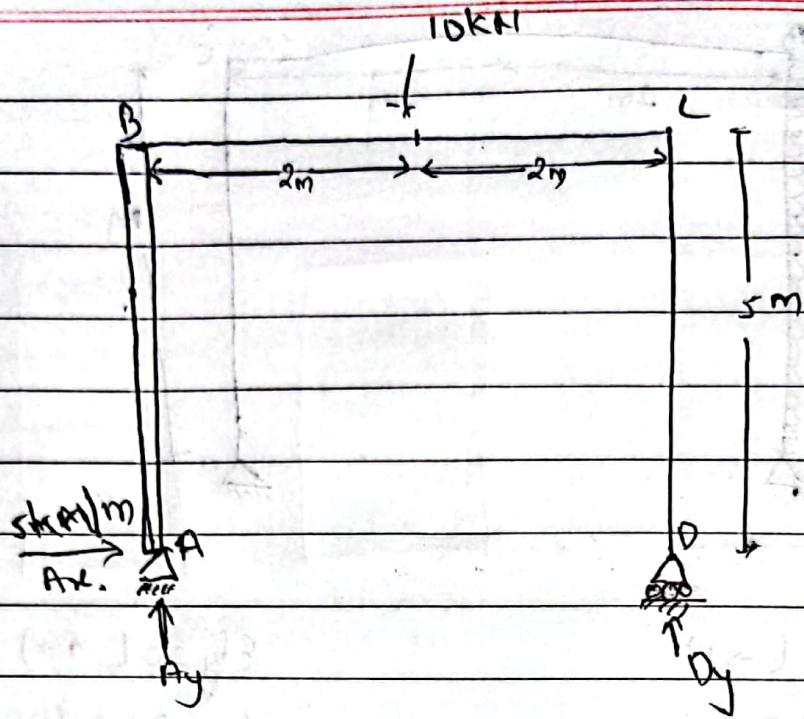
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Q



$$\sum F_x = 0 (\rightarrow)$$

$$Ax + 25 = 0$$

$$Ax = -25$$

$$Ay = 25 (\leftarrow)$$

put the value in ①

$$Ay - 10 + 20.625 = 0$$

$$Ay = -10 + 20.625$$

$$Ay = 10.625 (\downarrow)$$

$$\sum F_y = 0$$

$$Ay - 10 + Dy = 0 \rightarrow i)$$

$$\sum M_A = 0$$

$$(25 \times 2.5) + (10 \times 2) - Dy \times 4 = 0$$

$$4Dy = 82.5$$

$$Dy = 20.625 \rightarrow ii)$$

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For span AB

$$v_x = 5 \text{ kN}$$

$$x=0 \quad v_A = 0 \text{ kN}$$

$$x=5 \quad v_B = 5 \text{ kN}$$

$$M_x = 5 \times x \times \frac{x}{2}$$

$$x=0 \quad M_A = 0 \quad 5 \times 0 \times \frac{0}{2} = 0$$

$$x=5 \quad M_B = 25 \text{ kN} \cdot 5 \times 5 \times \frac{5}{2} = 62.5 \text{ kN}$$

for span BC

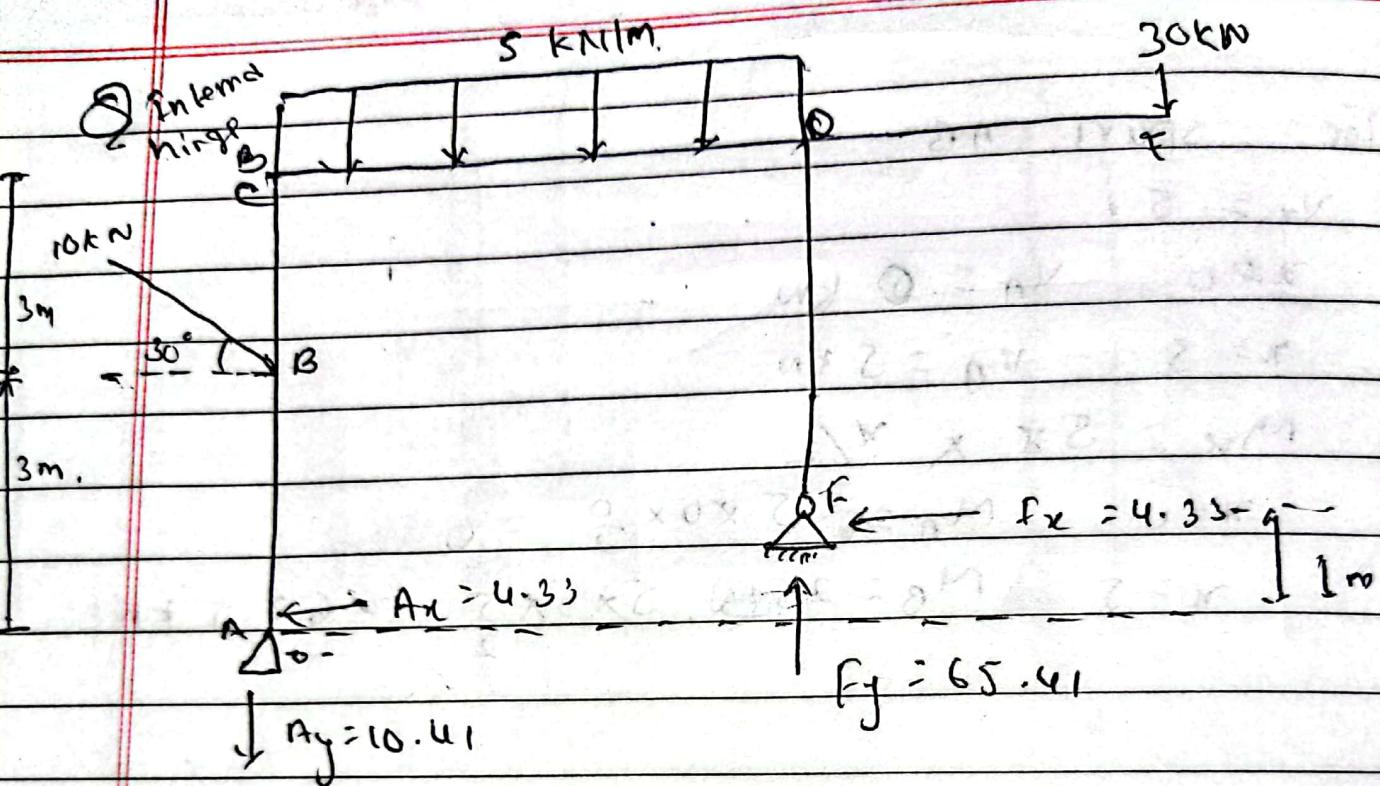
$$v_x = 10 - 5 = 5 \text{ kN}$$

$$v_B = v_C = 0$$

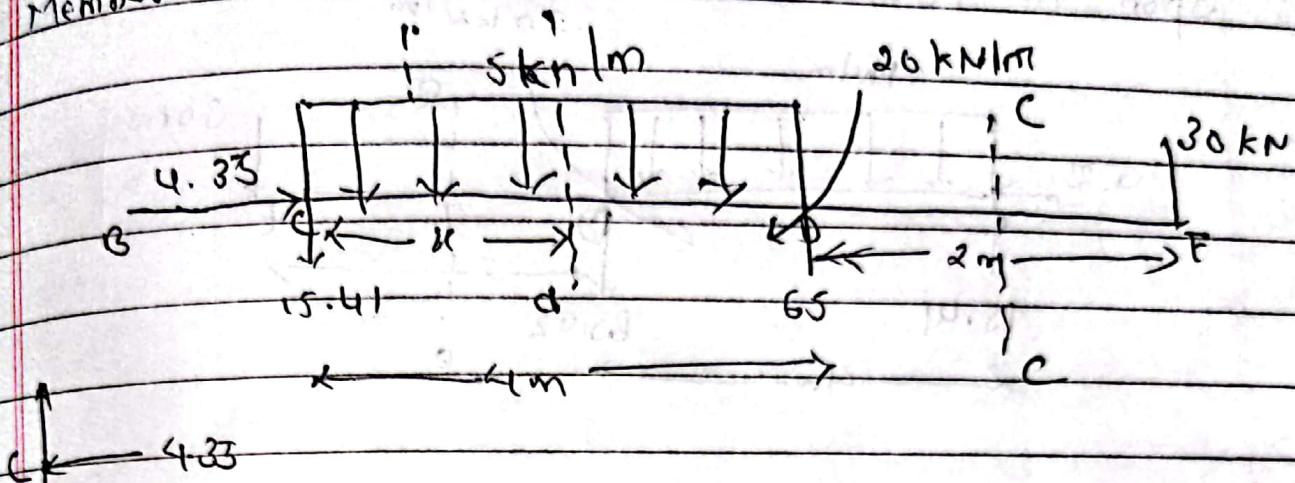
$$M_x = 5 \times (2+2) - 8 \times =$$

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Member CT



A $\leftarrow 4.33$
 15.41

For span (D) ($0 \leq x \leq 4m$)

15.41

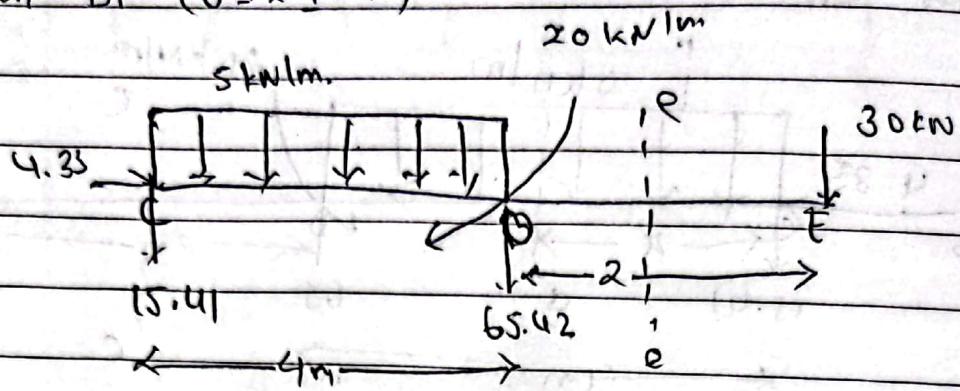
$$V_x = -15.41 - 5x$$

$$\begin{cases} x=0 \\ x=4 \end{cases} \quad \begin{aligned} V_{CL} &= -15.41 \text{ kN} \\ V_{BL} &= -35.41 \text{ kN} \end{aligned}$$

$$M_x = -15.41 - 5x \times \frac{x}{2}$$

$$\begin{cases} x=0 \\ x=4 \end{cases} \quad \begin{aligned} M_{CL} &> 0 \\ M_{DL} &= -61.64 - 40 \\ &= -101.64 \text{ kNm} \end{aligned}$$

Span DF ($0 \leq x \leq 2m$)



$$V_x = -15.41 - 120 + 65.41$$

$$V_x = 30$$

$$\boxed{x=0} \rightarrow V_{D,R} = 30$$

$$V_{F,R} = 30 \quad \cancel{\text{---}}$$

$$\boxed{x=2} \rightarrow V_{F,L} = 30$$

$$V_{F,L} = 30$$

$$M_x = -15.41(4+x) - 20(2+x) + 65.41x$$

$$\Rightarrow M_x = -15.41(u+x) - 20(2+x) + 65.41x + 20 + 21.64$$

$$\Rightarrow M_x = -60 + 30u$$

$$\boxed{x=0} \quad M_{D,R} = -60 \text{ kNm}$$

$$\boxed{x=2} \quad M_F = -60 + 60 = 0 \\ M_F$$