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ID # 7944

Section B

fourth Semester

Sub :-> Structural Analysis I

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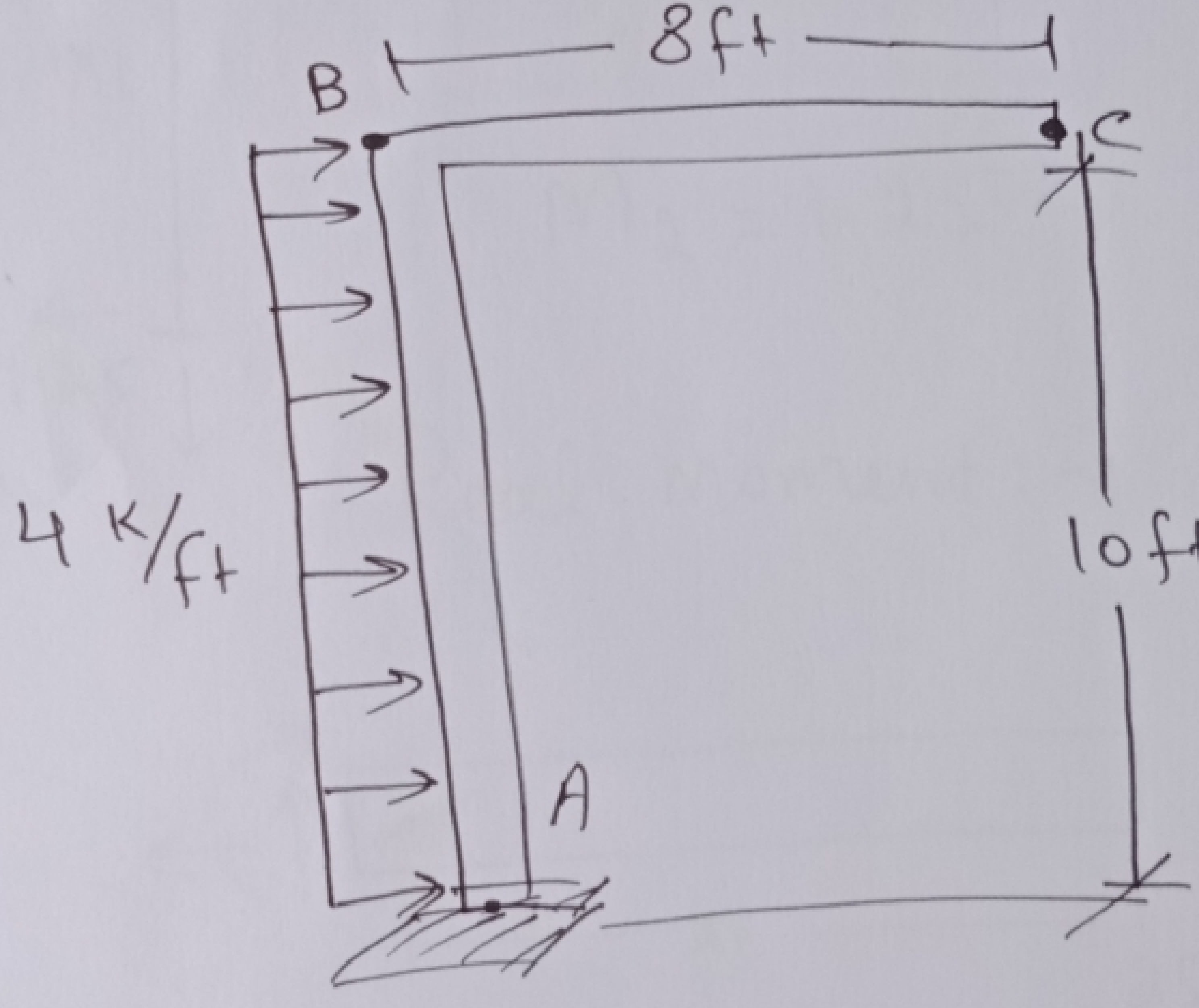
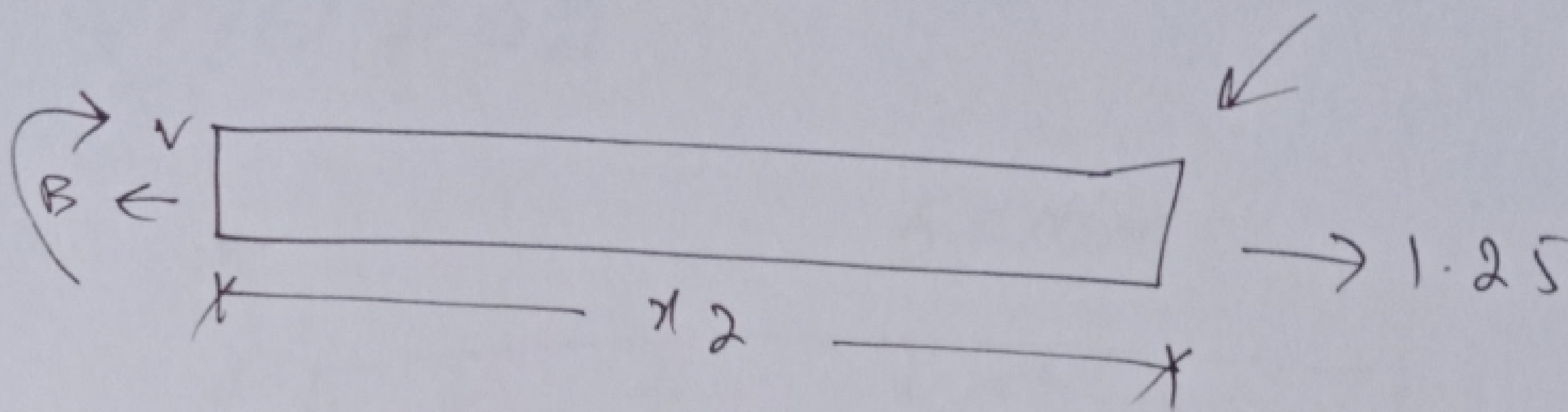
Department of civil Engineering

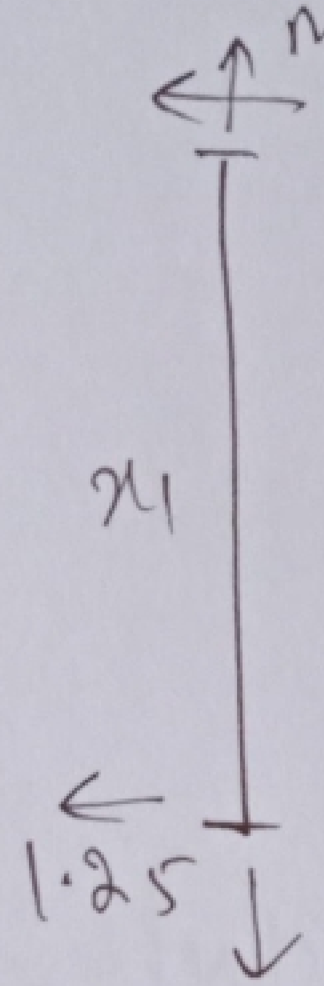
INU peshawer

Q NO # 01 Determine the vertical displacement of free end point. C on the frame shown in figure. Take $E = 29(10^3)$ Ksi and $I = 600 \text{ in}^4$ for both member. use Method of virtual work.

SOL :

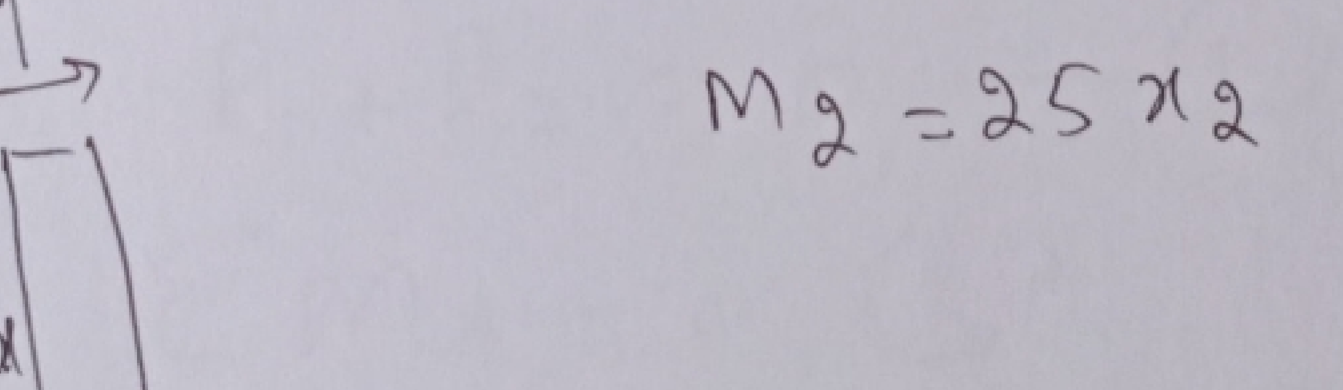




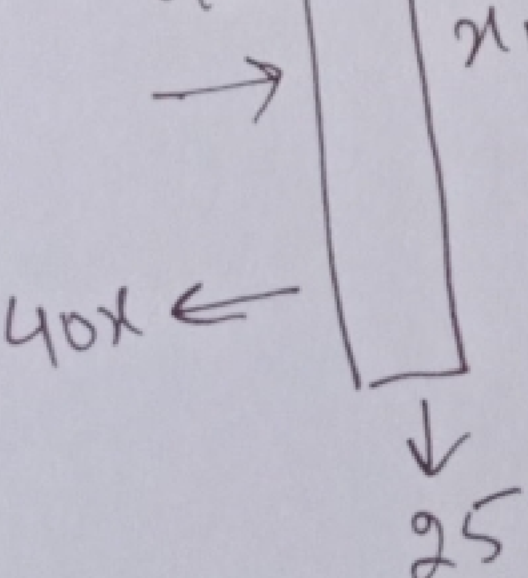


$$M_2 = 1.25$$

Real moment :->



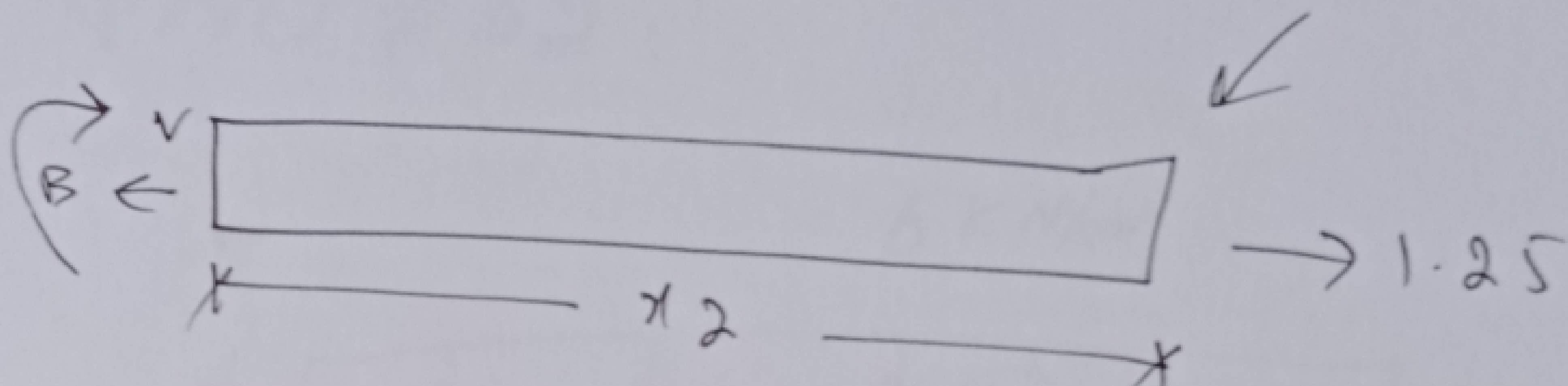
$$M_2 = 25x_2$$

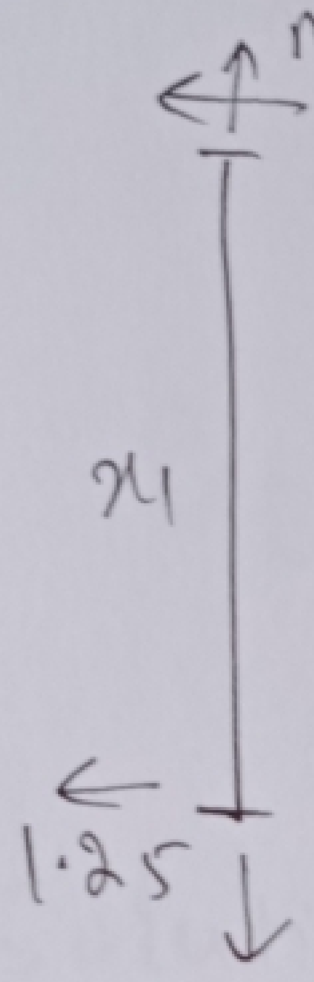


$$M = 40x_1 - \cancel{2}x_1 \frac{1}{\cancel{2}}(x_1)$$

$$= 40x_1 - 2x_1^2$$

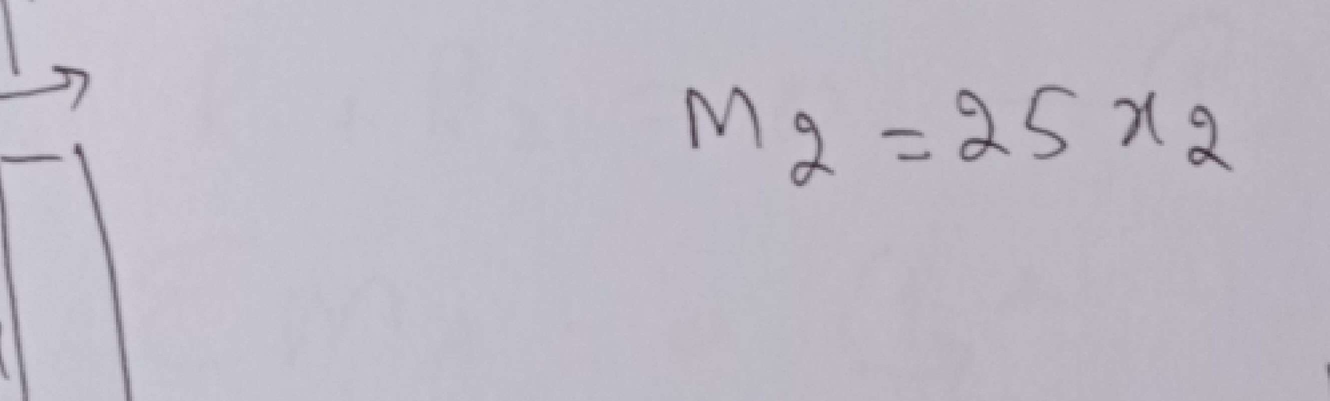
2



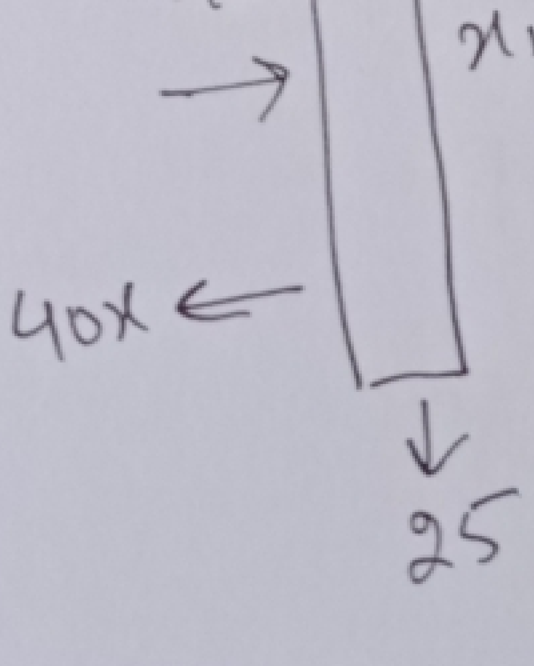


$$M_2 = 1.25$$

Real moment :→



$$M_2 = 25x_2$$



$$M = 40x_1 - \cancel{2}x_1 \frac{1}{\cancel{2}}(x_1)$$

$$= 40x_1 - 2x_1^2$$

(3)

Now put virtual work

$$1 \cdot \Delta_c = \int_0^L m \frac{M}{\varepsilon} dx$$

$$= \int_0^{10} 1x_1 \frac{(40x_1 - 2x^2)}{EI} dx$$

$$+ \int_0^{8} \frac{(1.25x_2)(25x_2)}{EI} dx^2$$

$$\Delta \cdot c = \frac{1}{EI} \left(\frac{40x^3}{3} - \frac{4x^4}{4} \right) \Big|_0^{10}$$

$$+ \left(\frac{31.25}{3} x_2^3 \right) \Big|_0^8$$

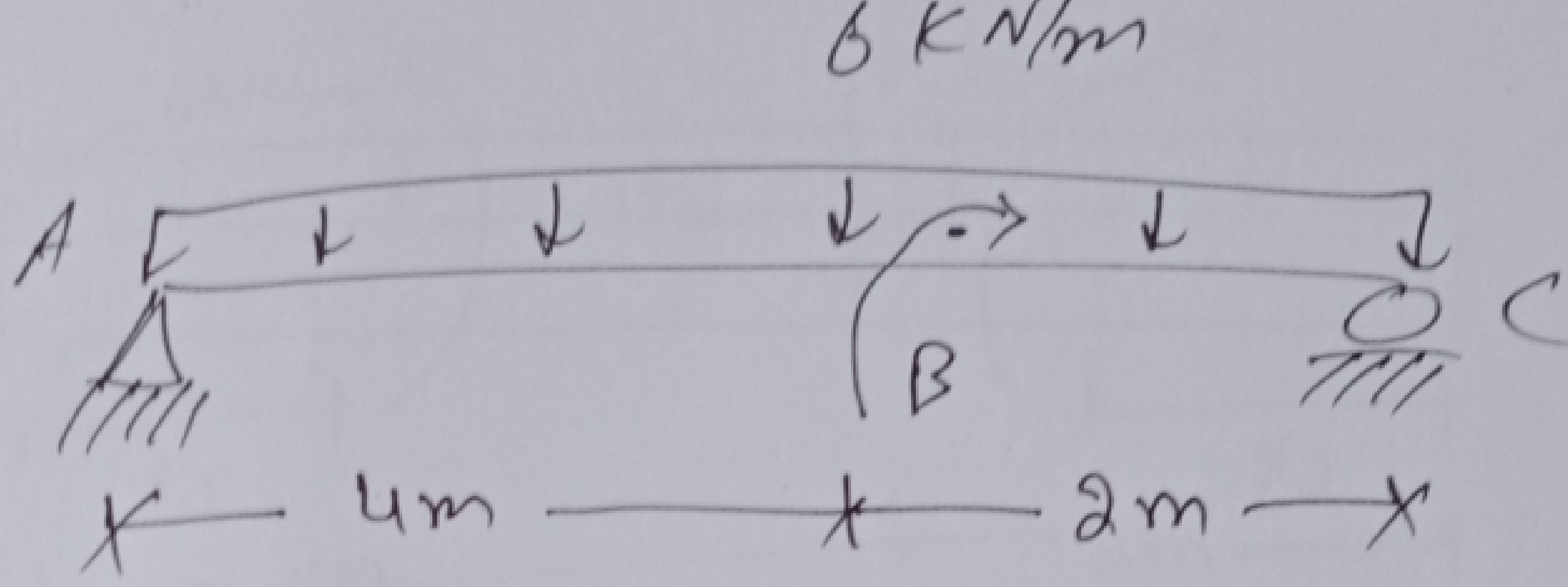
$$\Delta \cdot c = \frac{1}{EI} (23333.33 + 10666.66)$$

$$\Delta c = \frac{33999.99}{(200)(60 \times 10^6)}$$

$$\boxed{\Delta \cdot c = 2.833 \times 10^{-6} \text{ inch}}$$

(1)

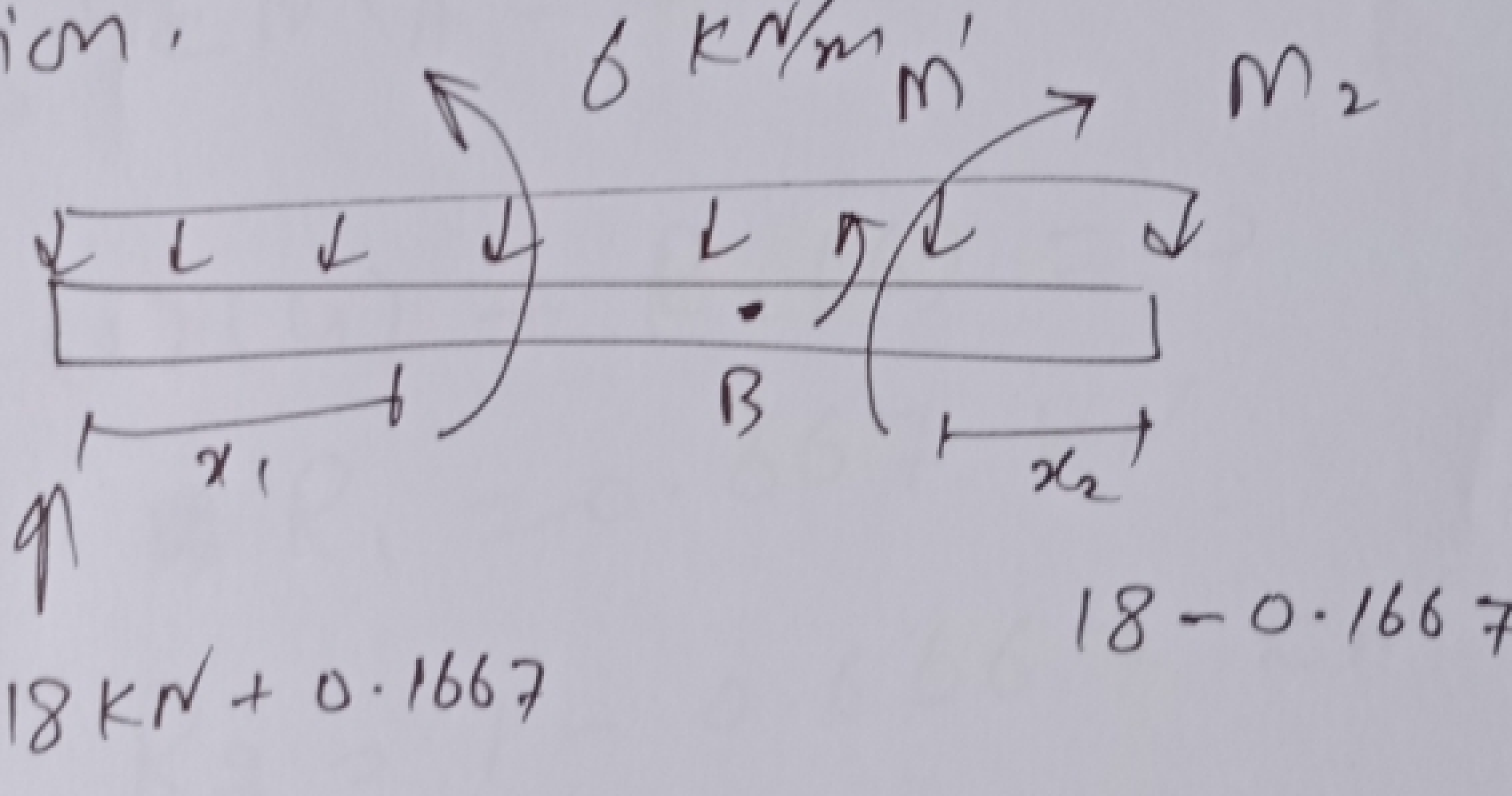
QNO #02



Required

slope & displacement at point 'B'

Solution.



$$R_1 + R_2 = 0 \quad \text{—— (1)}$$

$$\Sigma M_A = 0 \quad \circlearrowright +$$

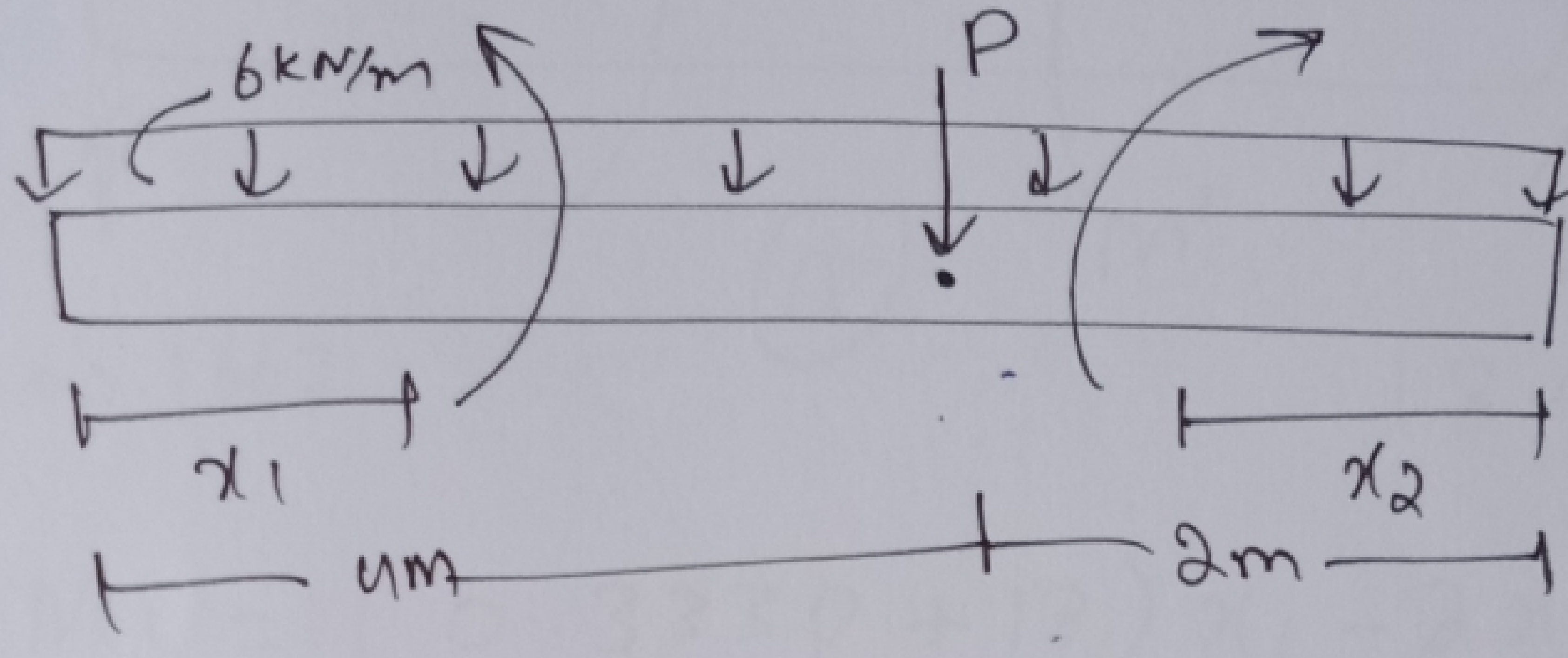
$$1 + R*6 = 0$$

$\Rightarrow$ -0.16667 put in (1)

$$R_1 + (-0.1667) = 0$$

②

$R_1 = 0.16667 \, kN$



$R_1 + R_2 = 1$

$\curvearrowright + \Sigma M_A = 0$

$-(1)(4) + R_2(6) = 0$

$R_1 = 0.667 \, kN$

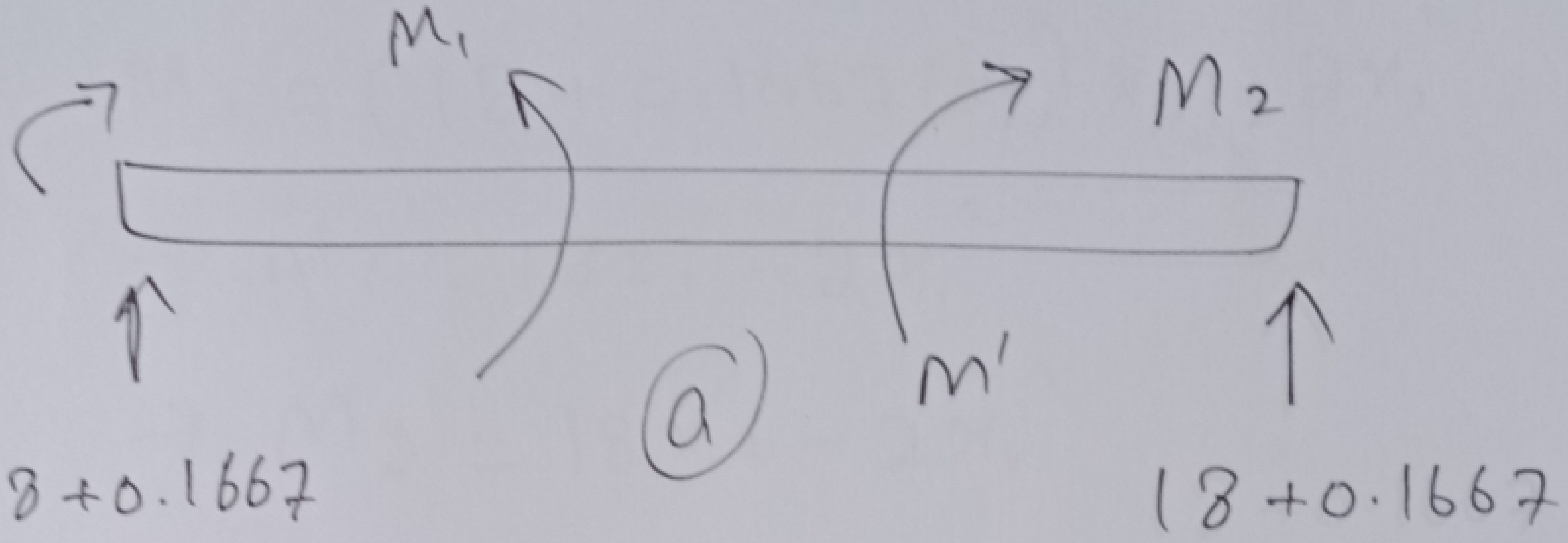
$R_2 = 1 - 0.6667 \, kN$

$\boxed{R_2 = 0.333 \, kN}$

$M_1 = (18 + 0.1667 M')(x_1 - 2x_1^2$

$M_2 = (18 - 0.1667 M')(x_2 - 2x_2^2)$

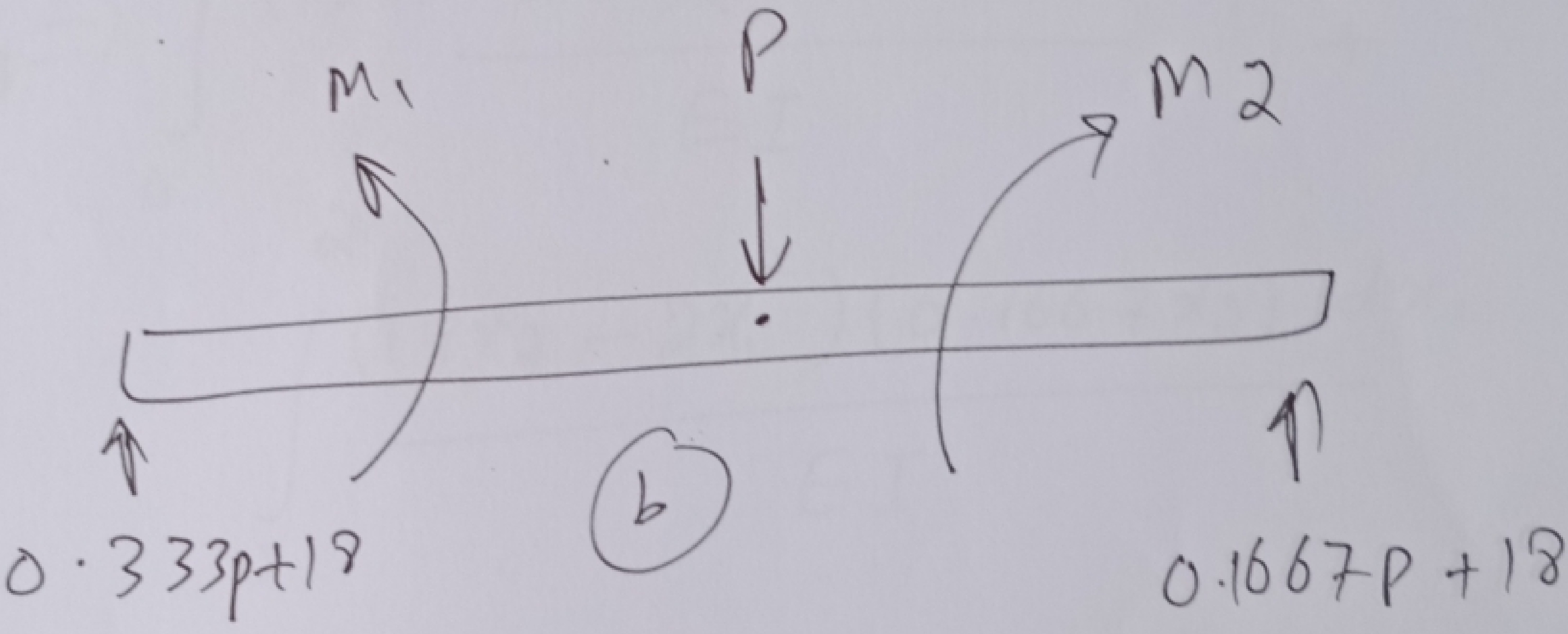
(3)



(a)

$$M_1 = (0.333P + 18)x_1 - 2x_1^2$$

$$M_2 = (0.667P + 18)x_2 - 2x_2^2$$



(b)

The displacement function shown in the figure (a) above

$$\frac{\partial M_1}{\partial m'} = 0.1667x_1 \quad \& \quad \frac{\partial M_2}{\partial m'} = 0.1667x_2$$

Set $m' = 0$ Then

(4)

$$M_1 = (18 + 0.1667(0))\, x_1 - 2x_1^2$$

$$\rightarrow M_1 = 18x_1 - 2x_1^2$$

$$\rightarrow M_2 = 18x_2 - 2x_2^2$$

$$\theta_B = \int_0^L M \frac{\partial M}{\partial M'} \frac{dx}{EI}$$

$$\theta_B \Rightarrow \int_0^4 \frac{(18x_1 - 2x_1^2)(0.3337x_1)\, dx_1}{EI} +$$

$$\int_0^2 \frac{(18x_2 - 2x_2^2)(0.1667x_2)\, dx_2}{EI}$$

$$\theta_B = \frac{49.31}{EI} = \frac{49.31}{(200\times10^6)(0.00006)}$$

$$\theta_B = 0.4411 \text{ rad}$$

For the displacement function are shown in figure (b)

$$\frac{\partial M_1}{\partial M_p} = 0.333x_1 \text{, and } \frac{\partial M_2}{\partial p} = 0.1667x_2$$

also set $p = 0$

Then $M_1 = (18x_1 - 2x_1^2)$ kN.m

$M_2 = (18x_2 - 2x_2^2)$ kN.m

Thus

$$\Delta_B = \int_0^L M\left(\frac{\partial M}{\partial p}\right)\frac{dx}{EI}$$

$$\Delta_B = \int_0^4 \frac{(30x \cdot x_1 - 2x_1^2)(0.333x_1)\,dx}{EI} +$$

$$\int_0^2 \frac{(30x \cdot x_1 - 2x_1^2)(0.667x_1)\,dx}{EI}$$

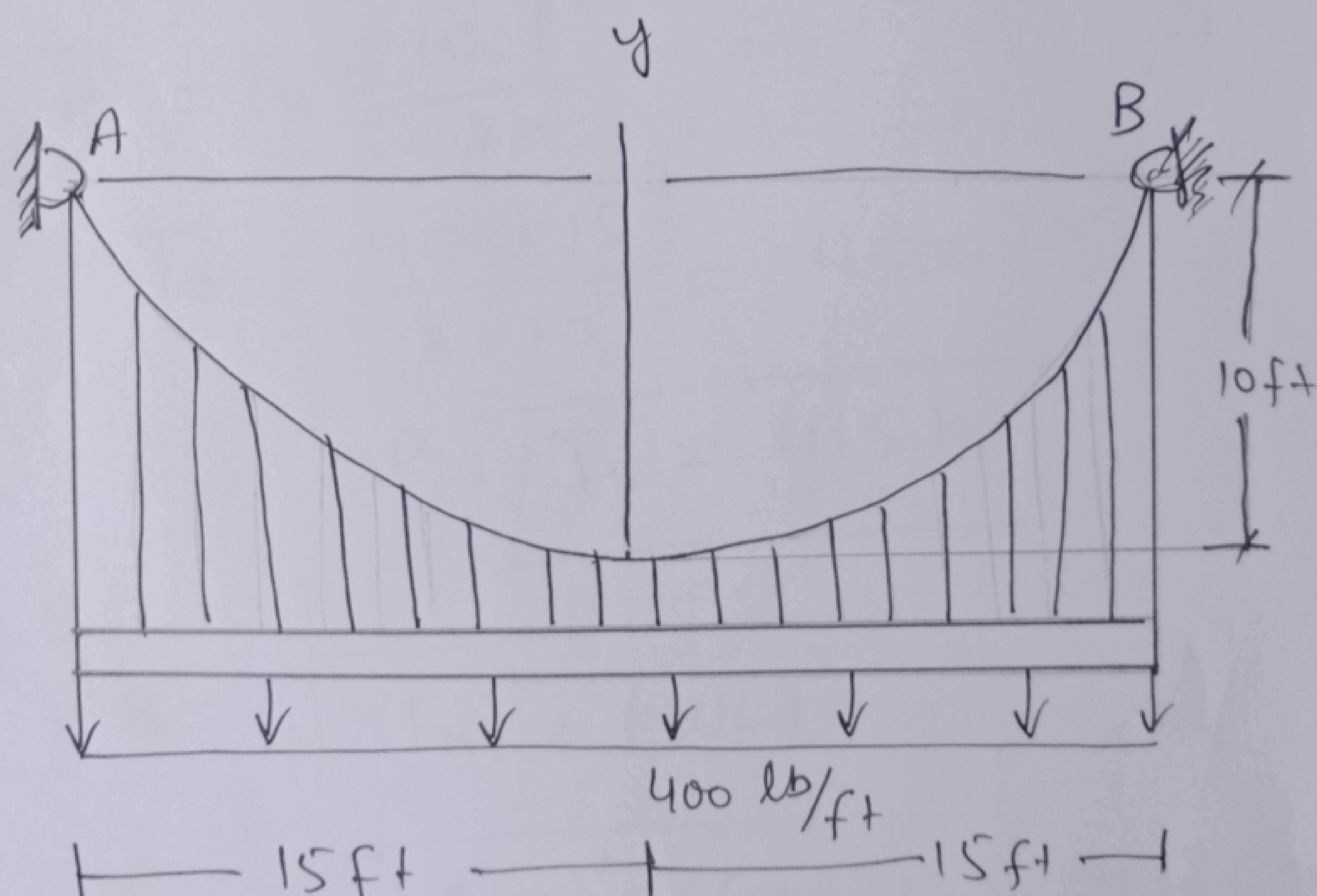
$$\Delta_B = \frac{218.5}{(200\times10^6)(0.00006)} = 0.018\,m$$

$$\boxed{\Delta_B = 18\,mm}$$

Q No # 03 The cable is subjected to uniform loading. If the slope of the cable at point O is zero, determine the equation for the curve and the force in cable at O and B.

Sol:→

Given that:



Required

(i) Equation of Curve

(ii) Force at O and B

(i) :→ $y = \frac{h}{L^2} x^2$ [From similar Triangle Ratio]

$$y \Rightarrow \frac{10}{(15)^2} x^2 = 0.044x^2$$

(ii) Forces at O and B.

$$T_O = F_H = \frac{w_o l^2}{2h}$$

$$T_O = \frac{400 \times 15^2}{2 \times 10} = 4500 \text{ lb}$$

OR $\boxed{T_O = 4.5K}$

$$T_B = \sqrt{(F_H)^2 + (WL)^2}$$

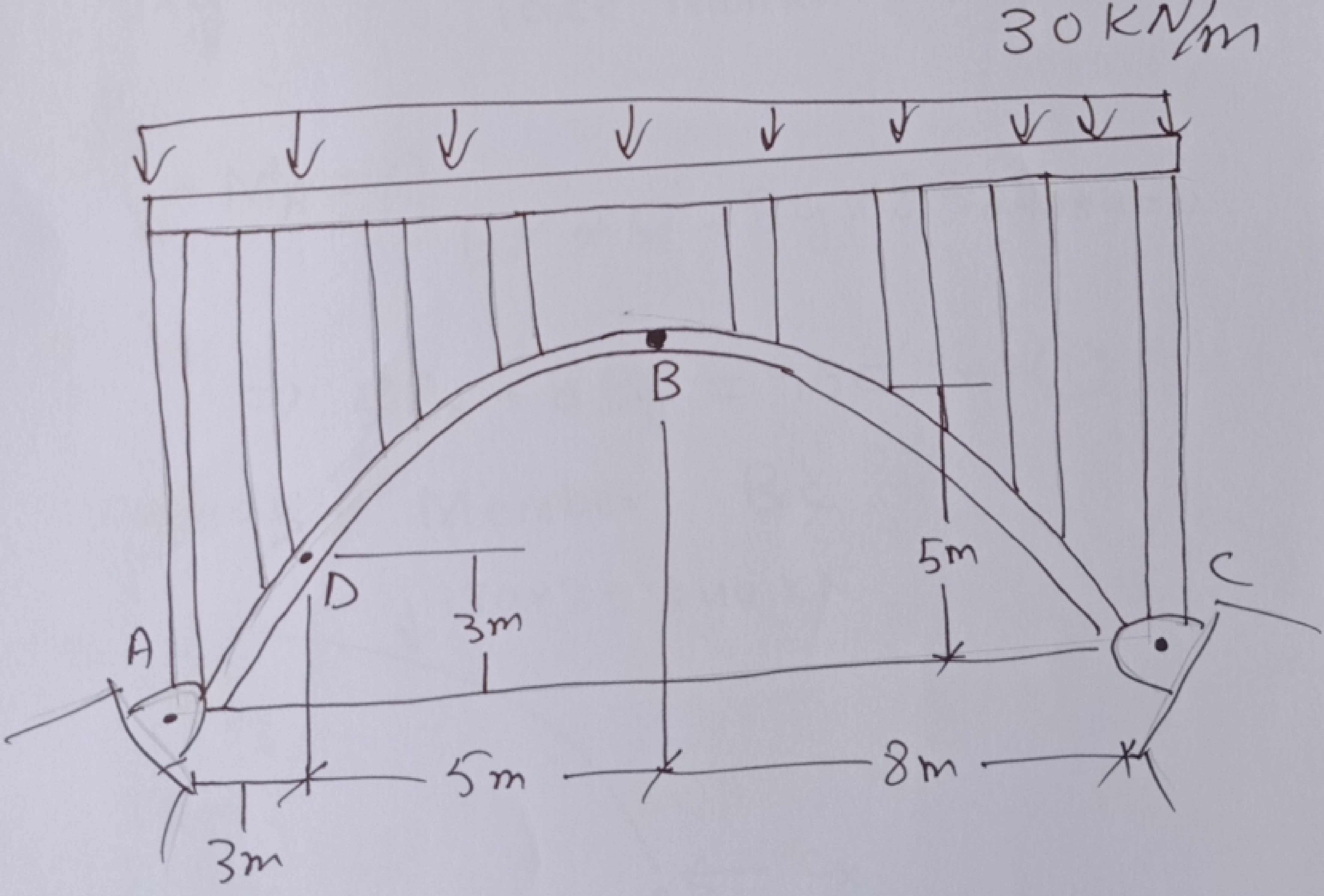
$$T_B = \sqrt{(4500)^2 + (400 \times 15)^2} = 7500 \text{ lb}$$

OR $\boxed{T_B = 7.5K}$

QNO#04 The Three-hinged Spandral Arch is subjected to the uniform load of 30 KN/m. Determine the internal moment in the arch at point D.

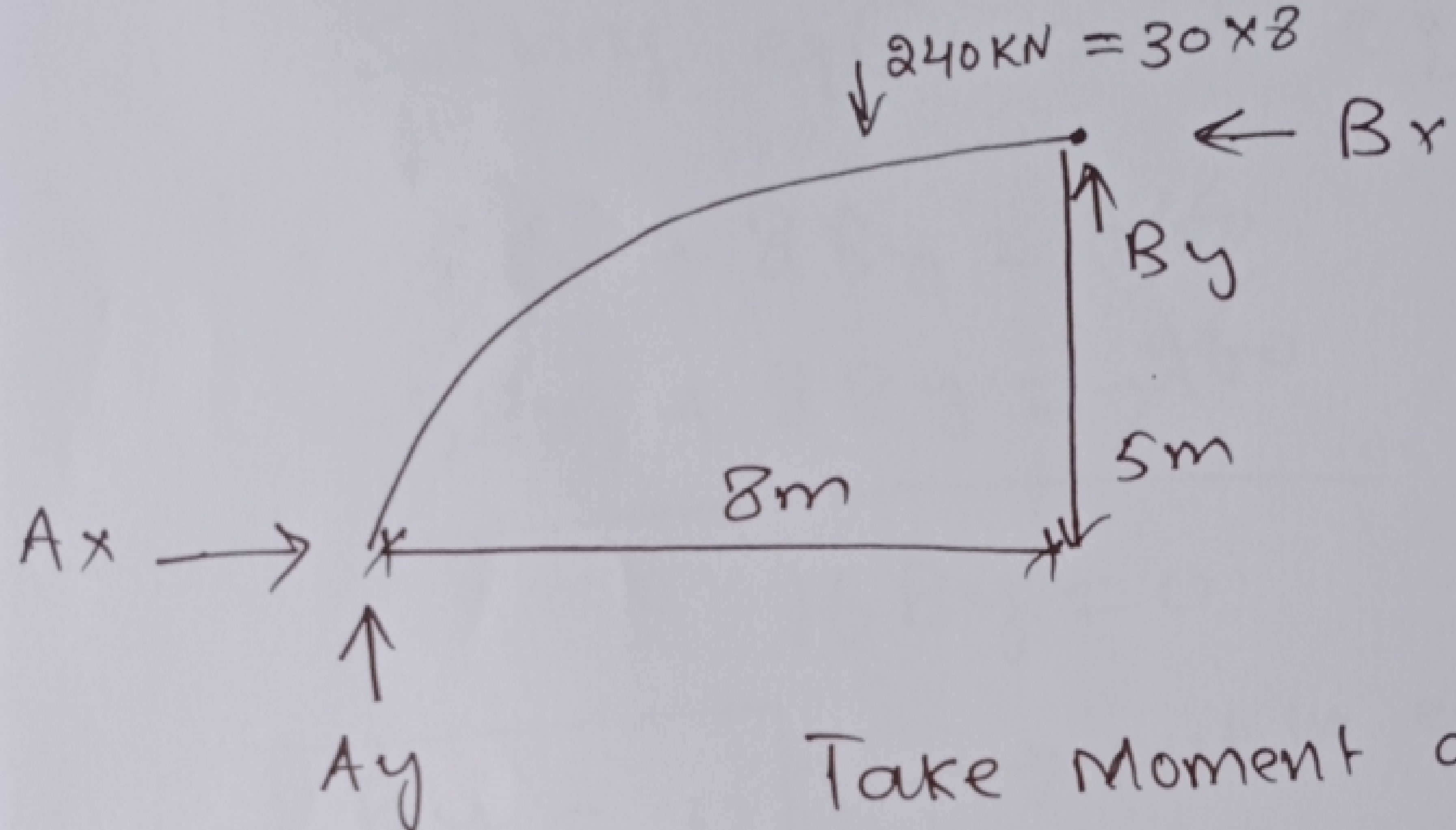
Sol:→

Given



Required Internd Moment at a Point "D"

So lets consider member AB.

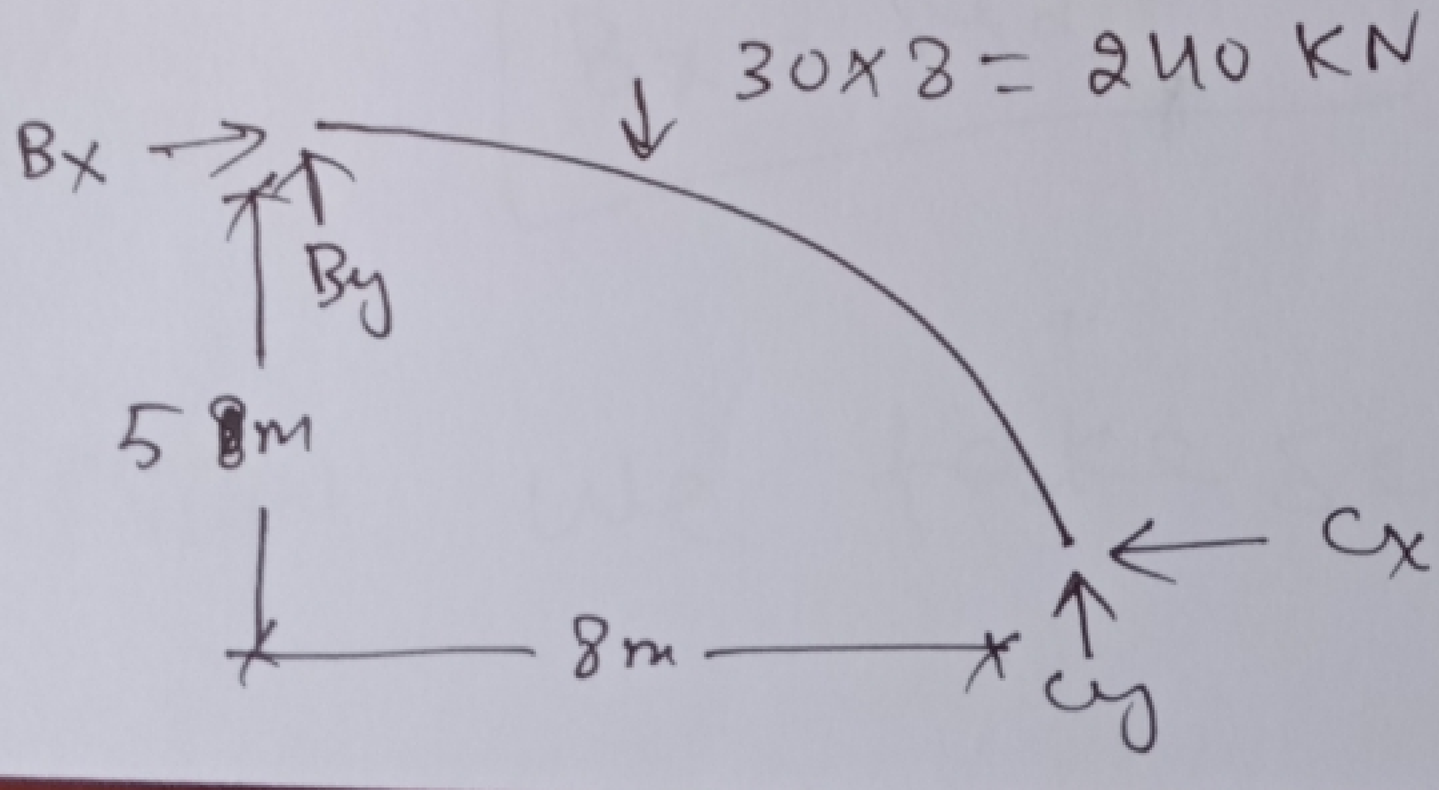


Take Moment at point A

$\circlearrowleft + M_A = 0$ $\quad Bx * 5 + By * 8 - 240 * 4 = 0$

$\Rightarrow 5B_x + 8B_y = 960$ — (1)

Conside Member BC



(3)

$\circlearrowleft + \Sigma M_c = 0$

$-B_x * 5 + B_y * 8 + 240 * 4 = 0$

$-5B_x + 8B_y = -960$ —— (ii)

Solving eq (i) and eq (ii)

$\cancel{5B_x} + 8B_y = \cancel{960}$

$\cancel{-5B_x} + 8B_y = \cancel{-960}$

$16B_y = 0$

$\boxed{B_y = 0}$ ⟶ put in eq (i) we get B_x

$\boxed{B_x = 192 \text{ KN}}$

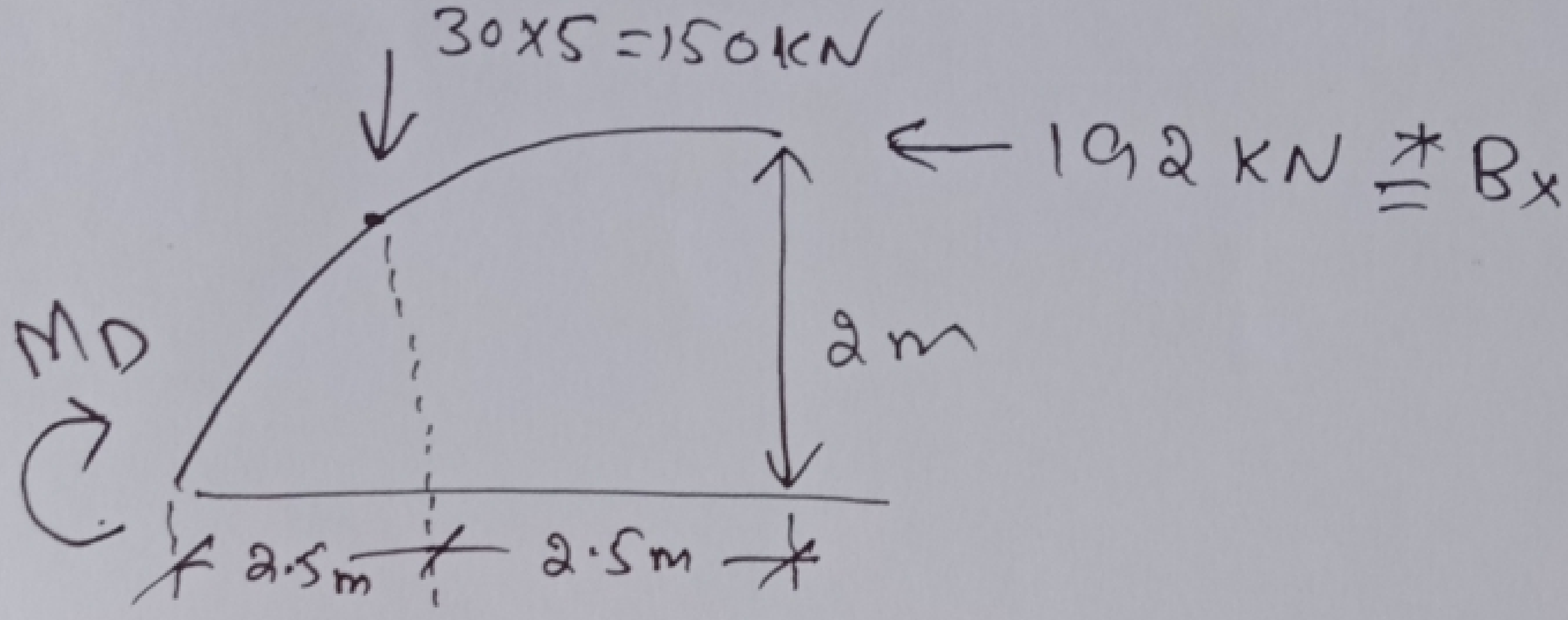
$5B_x + 8(0) = 960$

$B_x = \frac{960}{5} = 192 \text{ KN}$

$\boxed{B_x = 192 \text{ KN}}$ ✓

Now we take segment BD.

So sagment BD as.



$$\circlearrowright + \sum M_D = 0$$

$$192 * 2 - 150 * 2.5 - M_D = 0$$

$$384 - 375 - M_D = 0$$

$$\boxed{M_D = 9 \text{ kN/m}}$$