Name:

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Subject:

Structural-Analysis 1

Instructor:

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Date:

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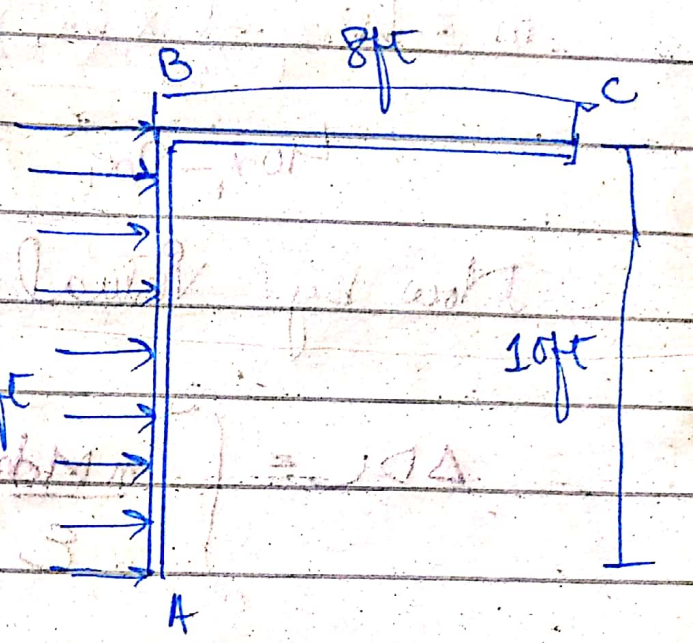
Question No 1:

Given Data:

Uniform load = 4k/ft

$E = 29 \times 10^3$ ksi

$I = 600 in^4$

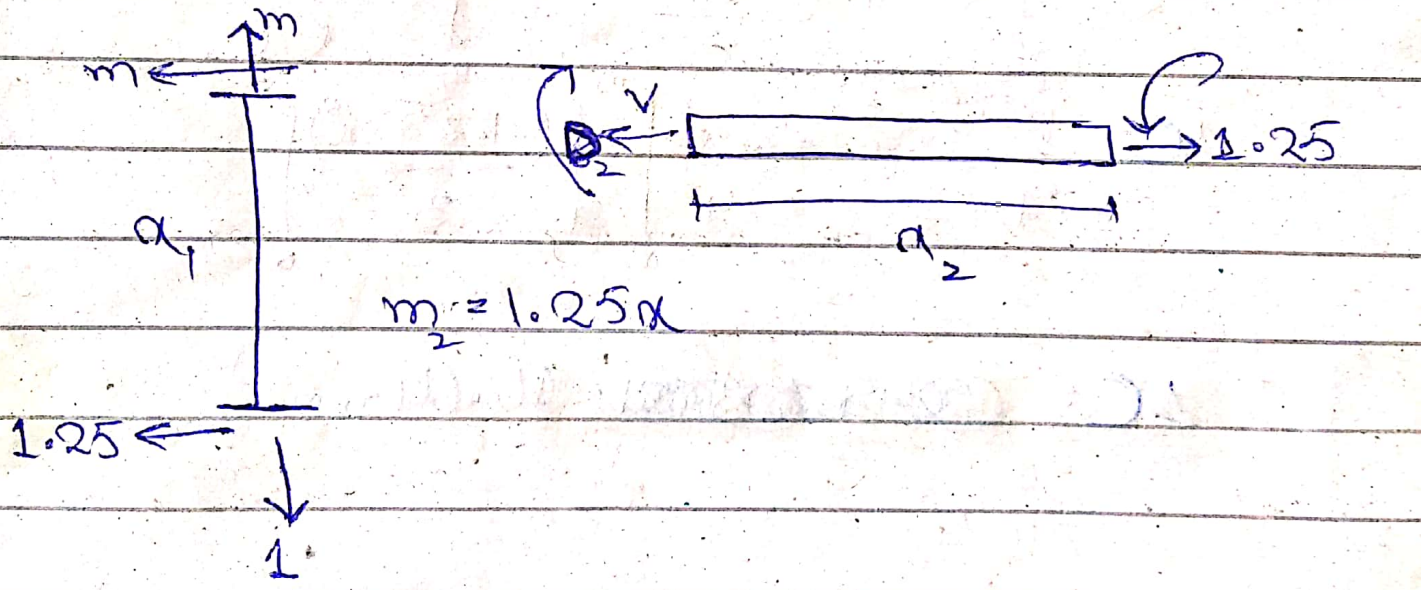


Required:

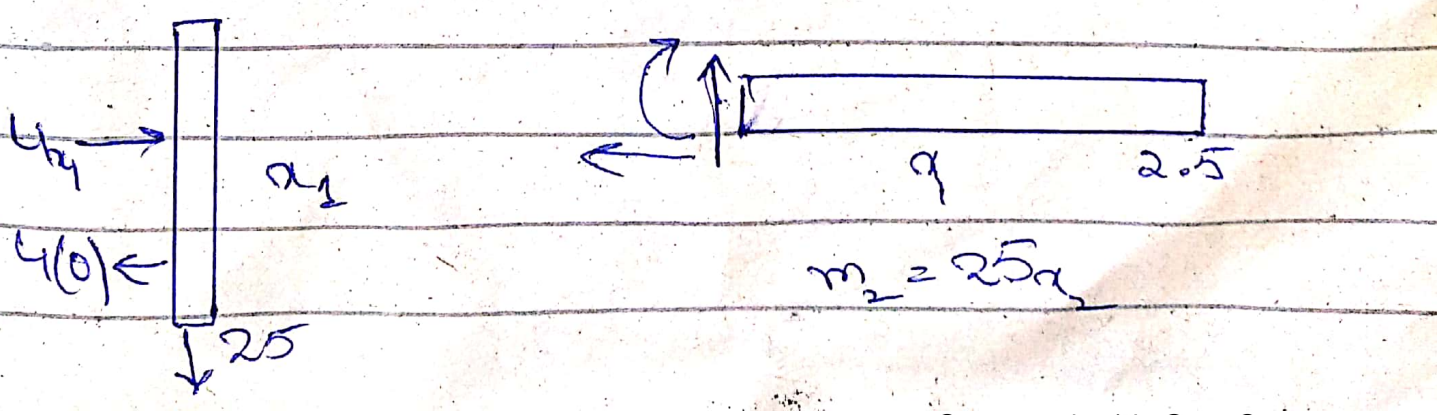
Vertical displacement.

Solution:

Now vertical moment.



Real Moment:



$$m'' = \frac{40x_1 - \frac{1}{2}x_1(x_2)}{40x_1 - 2x_2^2}$$

Now by Virtual work equation

$$\Delta DL = \int_0^2 \frac{mM\,dx}{E}$$

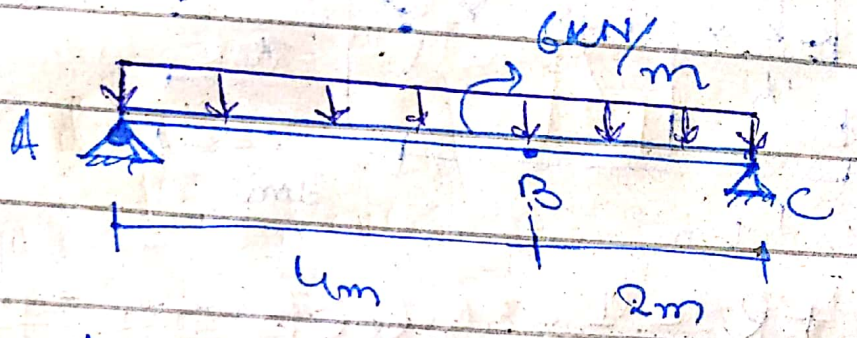
$$\Delta C = \int_0^{10} (1 x_1)\left(\frac{40x_2 - 2x^2}{E}\right)dx + \int_0^3 \left(\frac{1.25x_2}{EI}\right)(25x_2)\,dx$$

$$\Delta C = \frac{1}{EI}\left|\frac{42x^3}{3} - \frac{2x^3}{4}\right|_0^{10} + \left|\frac{(31.252x^3)}{3}\right|_0^8$$

$$\Delta C = 10.64\ mm \quad \text{Ans.}$$

Question No 2:

Given data:

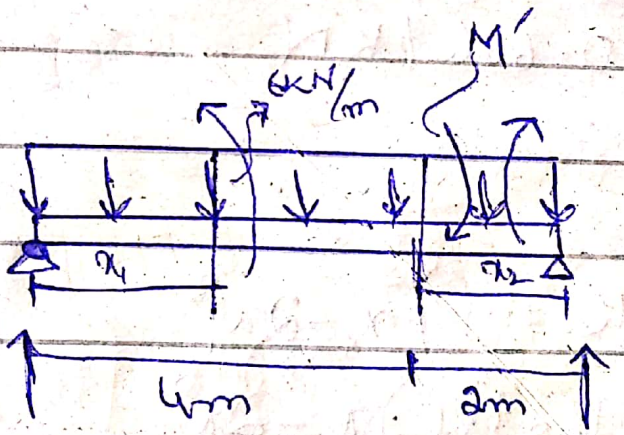


Required:

Slope and displacement at point 'B'

Solution:

(A)



18KN + 0.1667 18 - 0.1667

$$R_1 + R_2 = 0 \quad \text{---(1)}$$

$$\Sigma M_A = 0 \quad (\circlearrowleft +)$$

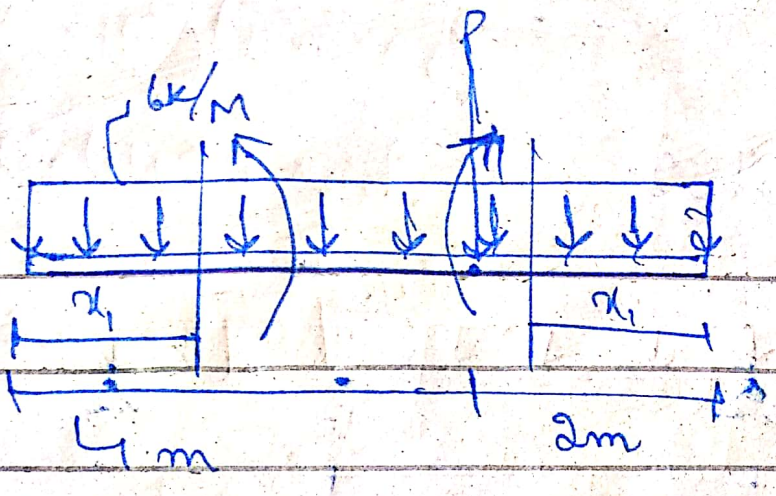
$$1 + R_2(6) = 0$$

$$\Rightarrow -0.16667 \quad \text{Put in (1)}$$

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

$$R_1 = 0.1667 \text{ KN}$$

(B)



$$R_1 + R_2 = 1$$

$$\circlearrowleft + \Sigma M_A = 0$$

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

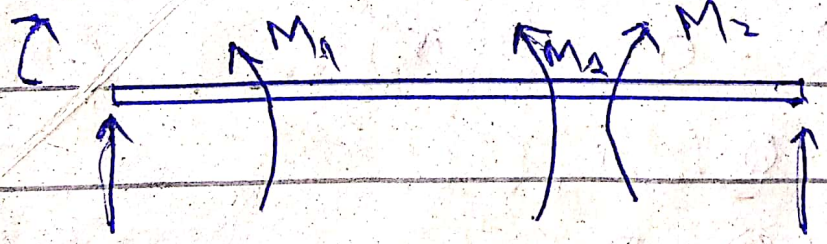
$$R_1 = 0.6667\,KN$$

$$R_2 = 1 - 0.6667\,KN$$

$$R_2 = 0.333\,KN$$

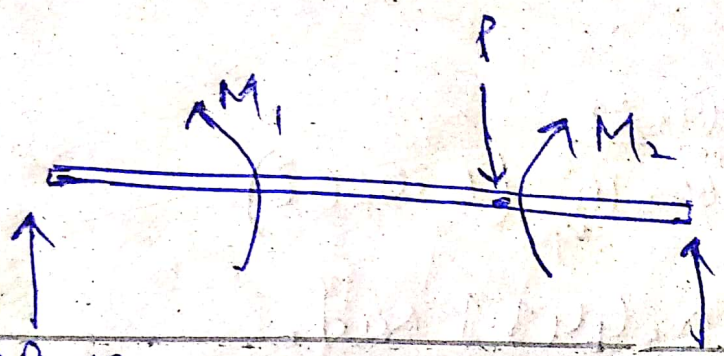
$$M_1 = (18 + 0.1667M)x_1 - 2x_1^2$$

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



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

$$M_2 = (0.667P + 18)x_2 - 2x_1^2$$



The displacement functions shown in the figure a above

$\frac{\partial M_1}{\partial M'} = 0.1667x_1$ and $\frac{\partial M_2}{\partial M'} = 0.1667x_2$, Set $M'=0$

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

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

$$\theta_B = \int_0^2 M\left(\frac{\partial M}{\partial M_1}\right)\frac{dx}{EI} = \int_0^4 \frac{(18x_1 - 2x_1^2)(0.1667x_1)}{EI}\,dx + \int_0^2 \frac{(18x_2 - 2x_2^2)(0.1667x_2)}{EI}\,dx_2$$

$$\theta_B = \frac{42.65}{EI} + \frac{6.66}{EI}$$

$$\theta_B = \frac{49.31}{EI}$$

$$\theta_B = \frac{49.31}{(200\times10^6)(0.0006)}$$

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

→ For displacement functions are shown in figure 'b'

$\frac{\partial M_1}{\partial M_p} = 0.333x_1$ and $\frac{\partial M_2}{\partial p} = 0.667x_2$ also $P=0$

Thus $M_1 = (18x_1 - 2x_1^2)$ KN-m

$M_2 = (18x_2 - 2x_2^2)$ KN-m

Thus,

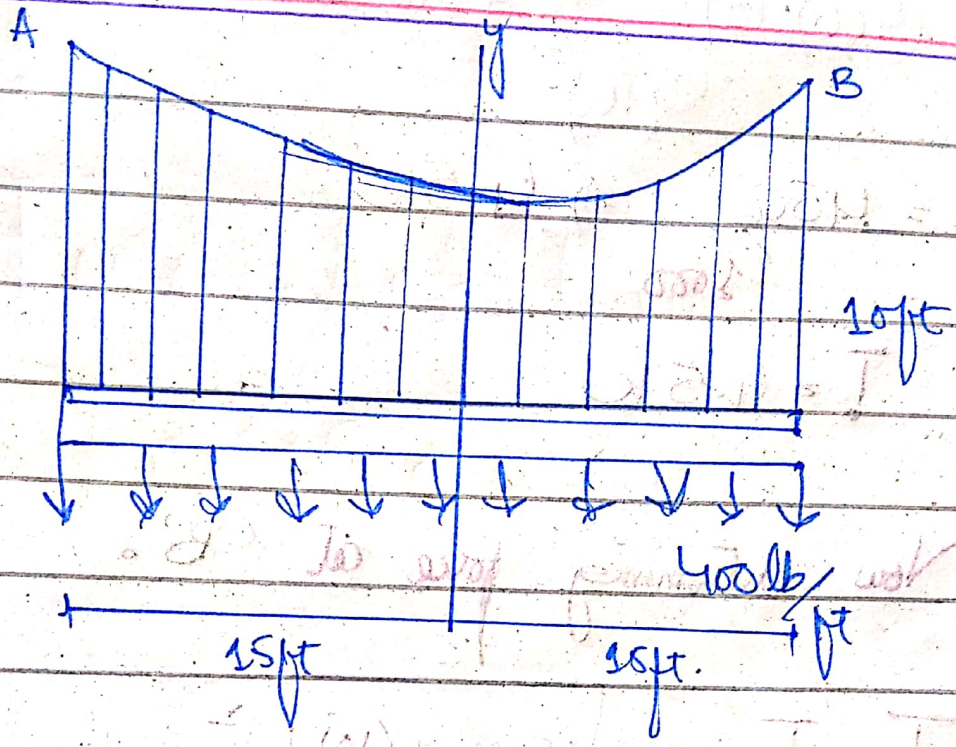
$$\Delta_B = \int M\left(\frac{\partial M}{\partial p}\right)\frac{dx}{EI}$$

$$\Delta_B = \int_0^4 \frac{(30x_1 - 2x_1^2)(0.333x_1)dx}{EI} + \int_0^2 \frac{(30x_2 - 2x_2^2)(0.667x_2)dx}{EI}$$

$$\Delta_B = \frac{218.5}{EI} = \frac{218.5}{(200\times10^6)(0.0006}$$

$$= 0.018 \text{ m} \quad \text{or} \quad 18 \text{ mm}.$$

Question No 3:



Required:

(i) Equation of the curve = ?

(ii) Forces at O & B = ?

Solution:

(i) Determining equation of the curve:

$$y = \frac{h}{L^2} x^2$$

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

$$y = 0.044 x^2$$

→ Determining forces at point 'O' & 'B'.

$$T_o = FH = \frac{W_o L^2}{2h}$$

$= \frac{(400)(15)^2}{2(10)} = 4500\ lb.$

$= 4500/1000 \Rightarrow 4.5K$

$T = 4.5K$

(iii) Now determining force at 'B'.

$T_B = T_{max} = \sqrt{(FH)^2 + (W_0 L)^2}$

$= \sqrt{(4500)^2 + ((400)(15))^2}$

$\Rightarrow T_B = 7500\ lb.$

$T_B = 7.5K.$

Or: $T_B = T_{max} = W_0 L \sqrt{1 + \left(\frac{L}{2H}\right)^2}$

$T_B = 400(15)\sqrt{1 + \left(\frac{15}{2(0)}\right)^2}$

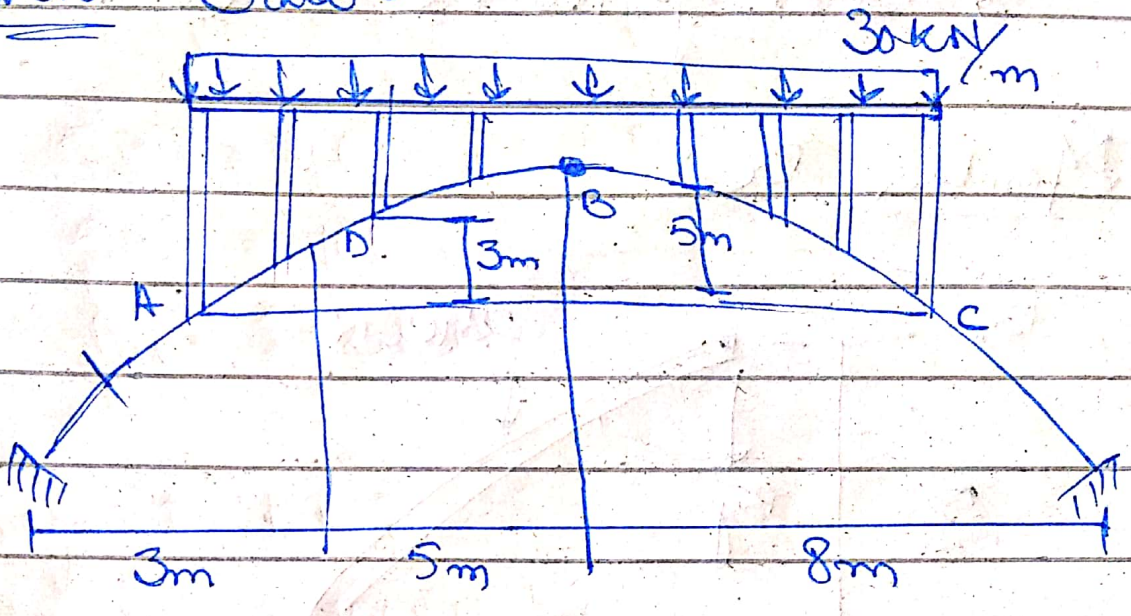
$T_B = 7500\ lb.$

Or

$T_B = 7.5K.$

Question No 4:

Given Data:

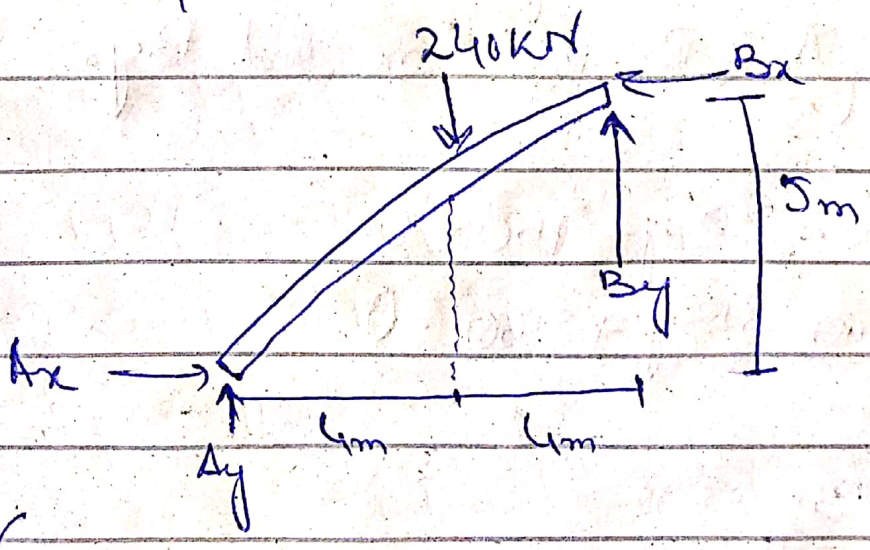


Required:

Internal moment in the arch at point D = ?

Solution:

Member AB:

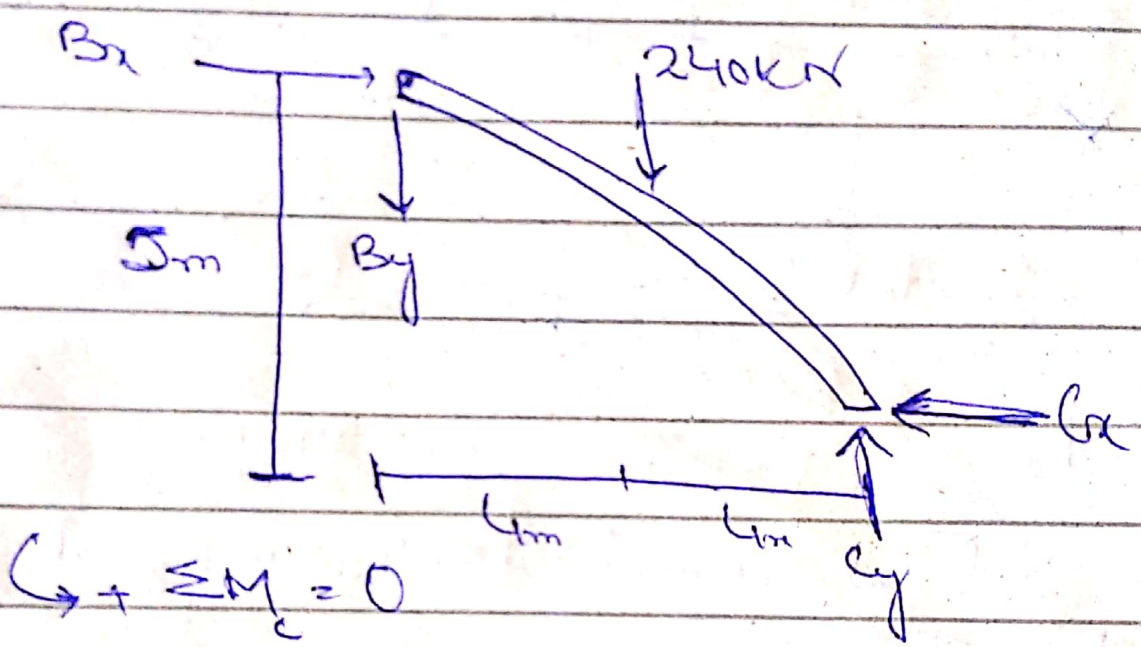


$$\circlearrowleft + \Sigma M_A = 0$$

$$B_x(5) + B_y(8) - 240(4) = 0$$

$\Rightarrow 5B_x + 8B_y - 960 = 0$ —— (A)

Member BC:



$\curvearrowright + \Sigma M_c = 0$

$-B_x(5) + B_y(8) + 240(4) = 0$

$\Rightarrow -5B_x + 8B_y + 960 = 0$ —— (B)

Solving eq A & B for Bx and By.

$5B_x + 8B_y - 960 = 0$

$+ -5B_x + 8B_y + 960 = 0$

$B_y = 0$

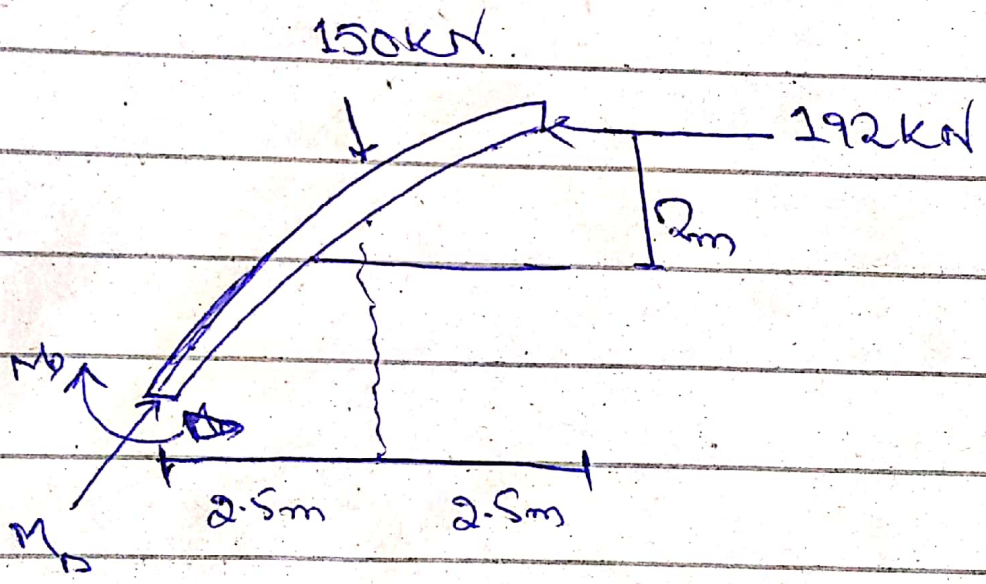
Putting B_y in eq (A)

$5B_x + 8(0) - 960 = 0$

$5B_x = 960$.

$B_x = 192\,KN$.

Segment DB:



$\circlearrowleft + \Sigma M_D = 0$

$\Rightarrow 192(2) - 150(2.5) - M_D = 0$

$\Rightarrow 384 - 375 = M_D$

$M_D = 9\,KN-m$

↳ internal moment at 'D'.