Final Term paper

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Sec:- B

Subject:- Structural Analysis

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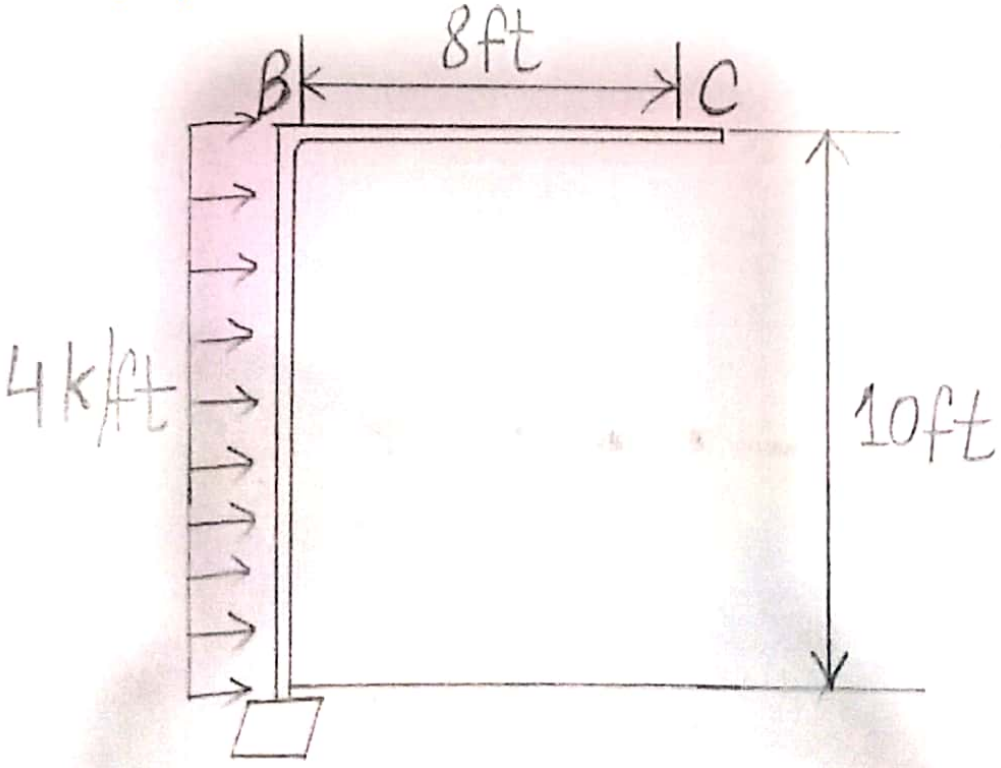
Deptt- BE(C)

Question #01

Determine the vertical displacement of free end point C on the frame shown in Figure. Take $E = 29(10^3)$ Ksi and $I = 600\ in^4$ for both members. Use method of Virtual Work.



(2)

Sol:-

$$\zeta + \Sigma M_A = 0$$

$$-4(10)(5) + C_y(8) - 0$$

$$C_y = 25 \text{ kip}$$

$$\Sigma f_y = 0 \uparrow +$$

$$25 + A_y = 0$$

$$A_y = -25 \text{ kip}$$

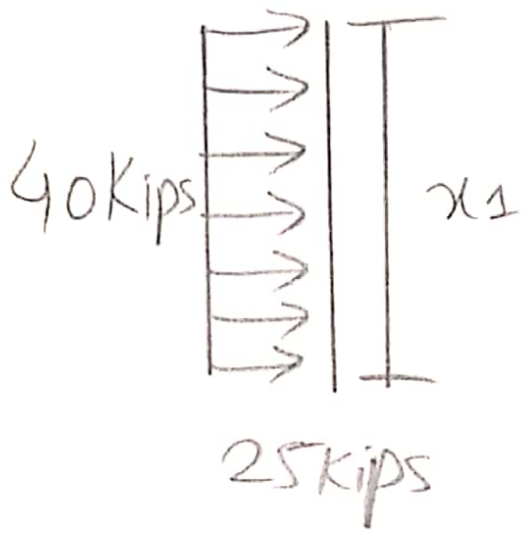
$$\Sigma F_x = 0 \rightarrow +$$

$$40 - A_x = 0$$

$$A_x = 40 \text{ kips}$$

(3)

Taking Section,

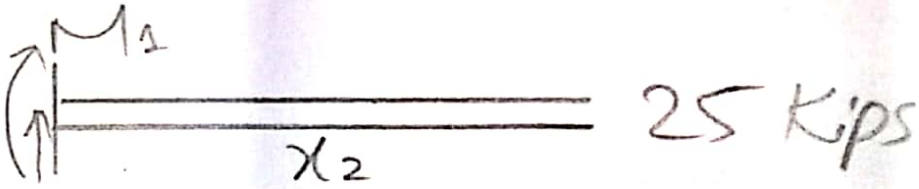


Real moment

$$\circlearrowleft + \Sigma M_1 = 0$$

$$-40(x_1) + 4x_1\left(x_1/2\right) + C x_1 = 0$$

$$M_1 = 4x_1 - 2x_1$$

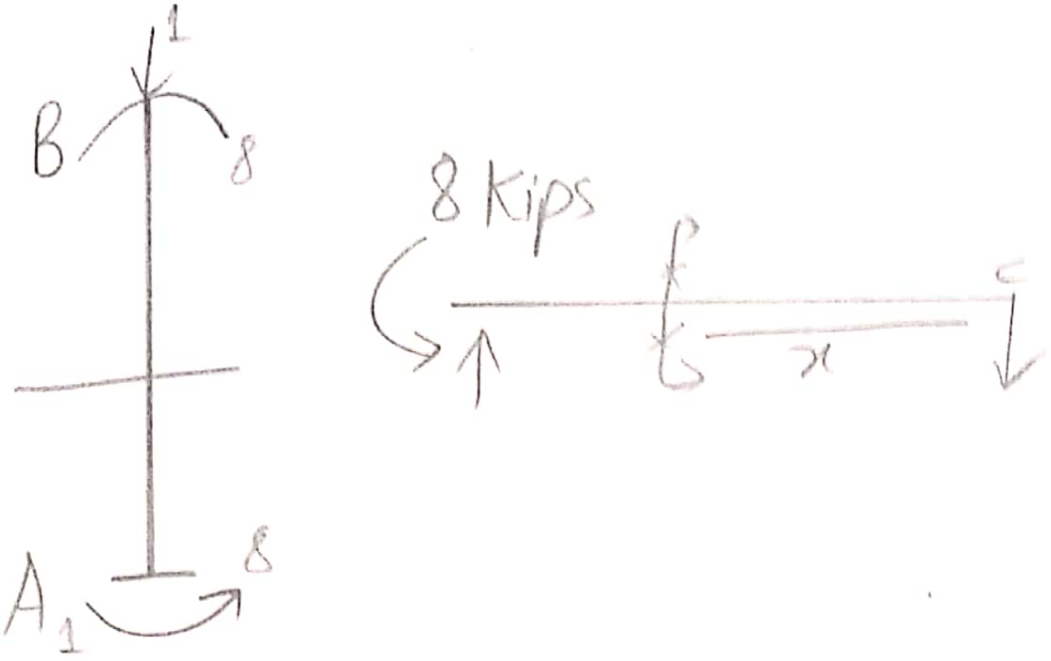


$$-25(x_2) + M_2 = 0$$

$$M_2 = 25\,x_2$$

kips

Vertical moment



Members	BA	CB
origin	B	C
limit	0-10	0-8
M	$2x^2$	0
m	8	x

By virtual work method

$$1 \cdot \Delta_1 = \int_0^{10} \frac{(2x^2)(8)dx}{EI}$$

$$+ \int_0^8 \frac{(0)(x)}{EI}$$

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$$1 \cdot \Delta_1 = \frac{16x^3}{3}\Big|_0^{10} + 0$$

$$1 \cdot \Delta_1 = \frac{16 \times 1000}{3} / EI$$

$$1 \cdot \Delta_1 = \frac{5333.33}{29 \times 10^3 \times 600}$$

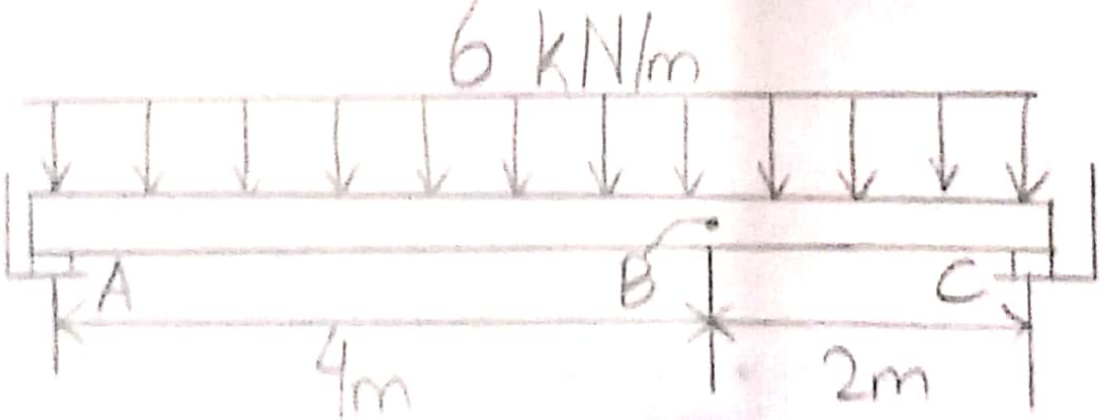
$$1 \cdot \Delta_1 = 3.06 \times 10^{-4} \text{ in}$$

$$\boxed{1 \cdot \Delta_1 = 3.06 \times 10^{-4} \text{ in}}$$

Any

Question # 02

Determine the slope and displacement at point B. Assume the support at A is a pin and C is a roller. Take E = 200 GPa, I = 60 (10⁶) mm⁴. Use Castigliano's Theorem.

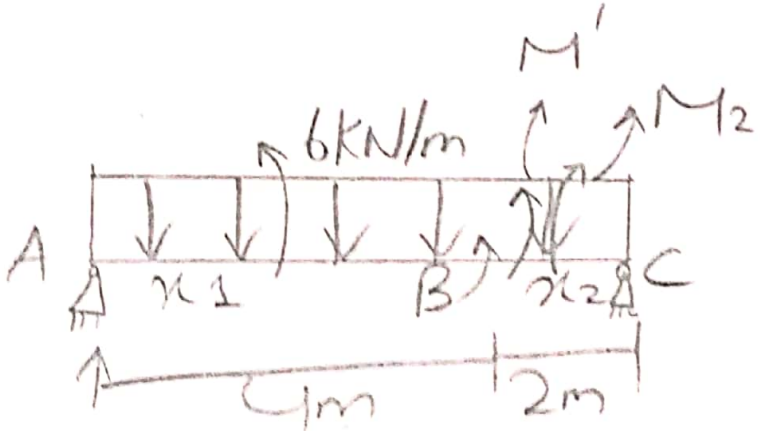


(7)

Sol:-

Slope and displacement at point "B"

(a)



$$R_1 + R_2 = 0 \rightarrow (i)$$

$$\Sigma M_{1A} = 0 \quad \circlearrowleft +$$

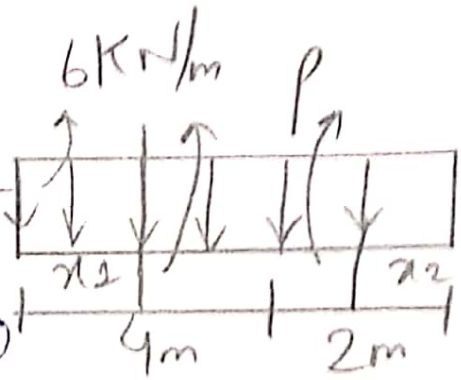
$$1 + R_2(6) = 0$$

-0.16667 put in (i)

$$R_1 + (-0.16667) = 0$$

$$R_1 = 0.16667 \text{ KN}$$

b.



$R_1 + R_2 = 1$

$\zeta + \Sigma M_A = 0$

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

$R_1 = 0.6667\,KN$

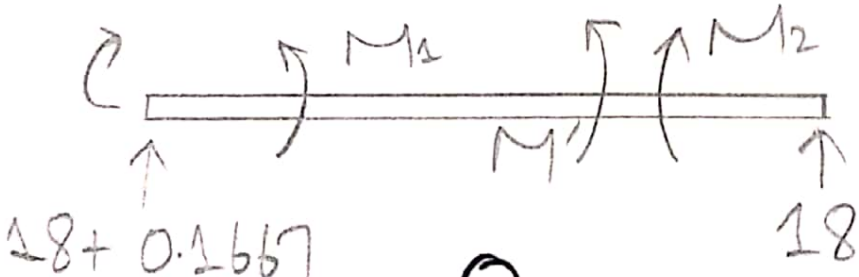
$R_2 = 1 - 0.6667$

$R_2 = 0.3333\,KN$

$R_2 = 0.333\,KN$

$M_1 = (18 + 0.16667M')x_1 - 2x_1^2$

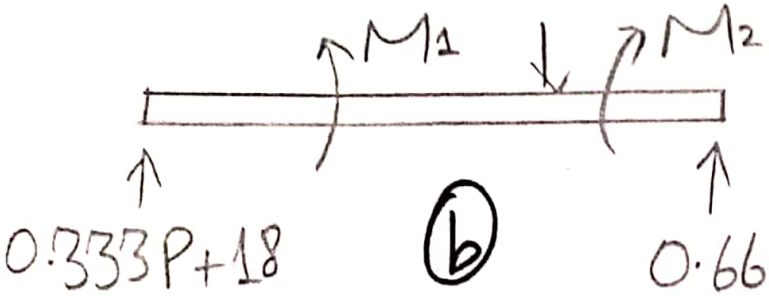
$M_2 = (18 - 0.1667M')x_2 - 2x_2^2$



(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,

$$\frac{\partial M_1}{\partial M'} = 0.1667x_1 \text{ and}$$

$$\frac{\partial M_2}{\partial M'} = 0.1667x_2$$

Set

$M' = 0$ then

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

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

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

$$\theta_B = \int_0^2 M \left(\frac{\partial M_1}{\partial M'}\right) \frac{dx}{EI}$$

$$= \int_0^4 \frac{(18x_1 - 2x_1^2)(0.1667x_1)dx_1}{EI}$$

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

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

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

$$\theta_B = \frac{49.31}{(200 \times 10^6 \text{ kPa})(0.0006)}$$

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

For the displacement functions are shown in figure "b"

$$\frac{\partial M_1}{\partial M_p} = 0.333x_1 \quad \text{and} \quad \frac{\partial M_2}{\partial M_p} = 0.667x_2$$

also set $p = 0$

Now,

$$M_1 = (18x_1 - 2x_1^2)\ KN.m$$
$$M_2 = (18x_2 - 2x_2^2)\ KN.m$$

Thus

$$\Delta B = \int_b M_1 \left(\frac{\partial M}{\partial P}\right) \frac{dx}{EI}$$

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

$$+ \int_0^2 \frac{(30x_2 - 2x_2^2)(0.667x_2)\,dx}{EI}$$

$$\Delta B = \frac{218.5}{EI}$$

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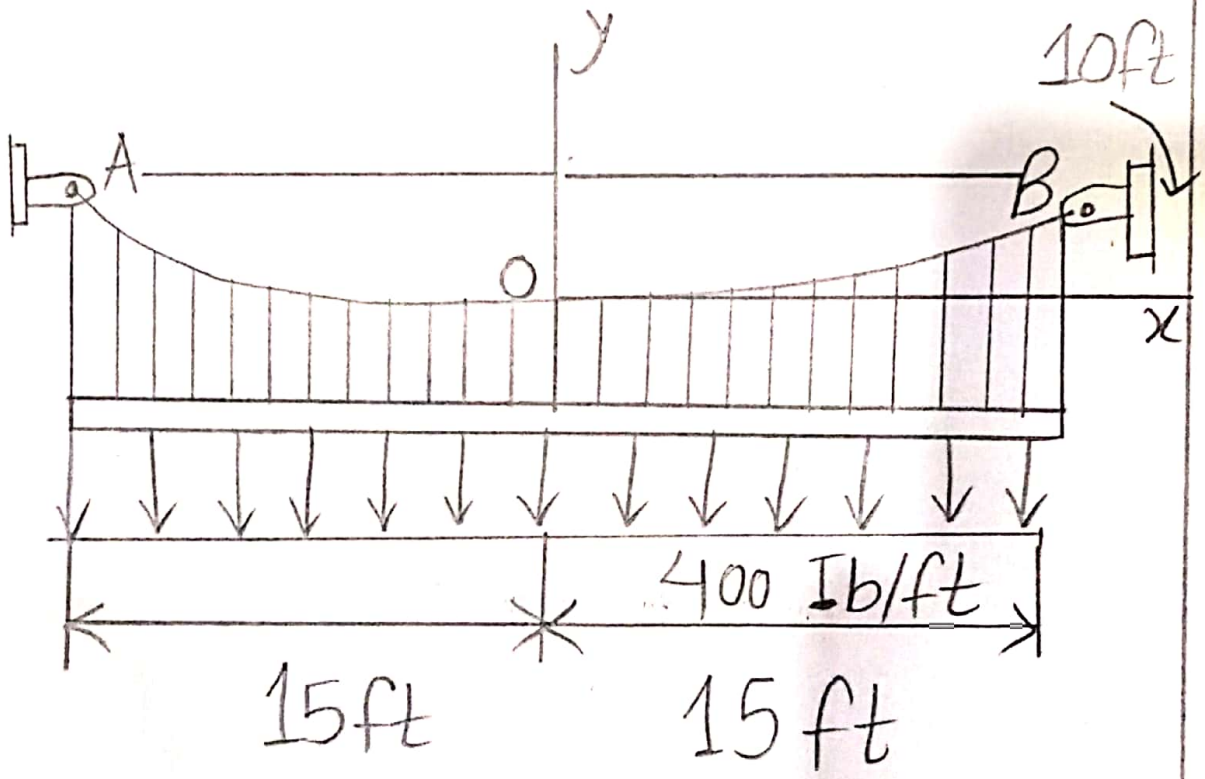
$$\Delta B = \frac{218.5}{(200\times10^{6})(0.00006)}$$

$$\Delta B = 0.018\text{m or } 18\text{mm}$$

Ans

Question # 03

The Cable is Subjected to the uniform loading. If the Slope of the cable at point O is zero, determine the equation of the curve and the force in the cable at O and B.



Sol:-

As we know that,

$$y = \frac{h}{L^2} x^2 = \frac{10}{15^2} x^2$$

$$y = \frac{10}{225} x^2$$

$$y = 0.0444 x^2$$

Now,

$$T_o = Fu = \frac{W_o L^2}{2h} = \frac{400(15)^2}{2(10)}$$

$$T_o = 4500 \text{ lb}$$

Divide by 1000,

$$T_o = 4500/1000$$

$$T_o = 4.5 \text{ K}$$

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As we know that,

$$T_B = T_{MAX} = \sqrt{Fu^2 + (W_o L)^2}$$

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

$$= \sqrt{20250000 + (400 \times 15)^2}$$

$$= \sqrt{20250000 + (6000)^2}$$

$$= 7500 \text{ lb}$$

$$T_B = T_{MAX} = 7.5K$$

As we know,

$$T_B = T_{MAX} = W_o L \sqrt{1 + \left(\frac{L}{2h}\right)^2}$$

$$T_B = T_{MAX} = 400(15) \sqrt{1 + \left(\frac{15}{2(10)}\right)^2}$$

$$T_B = T_{MAX} = 6000 \sqrt{1 + \frac{225}{400}}$$

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$= 6000\ (1.25)$

$= 7500\ lb$

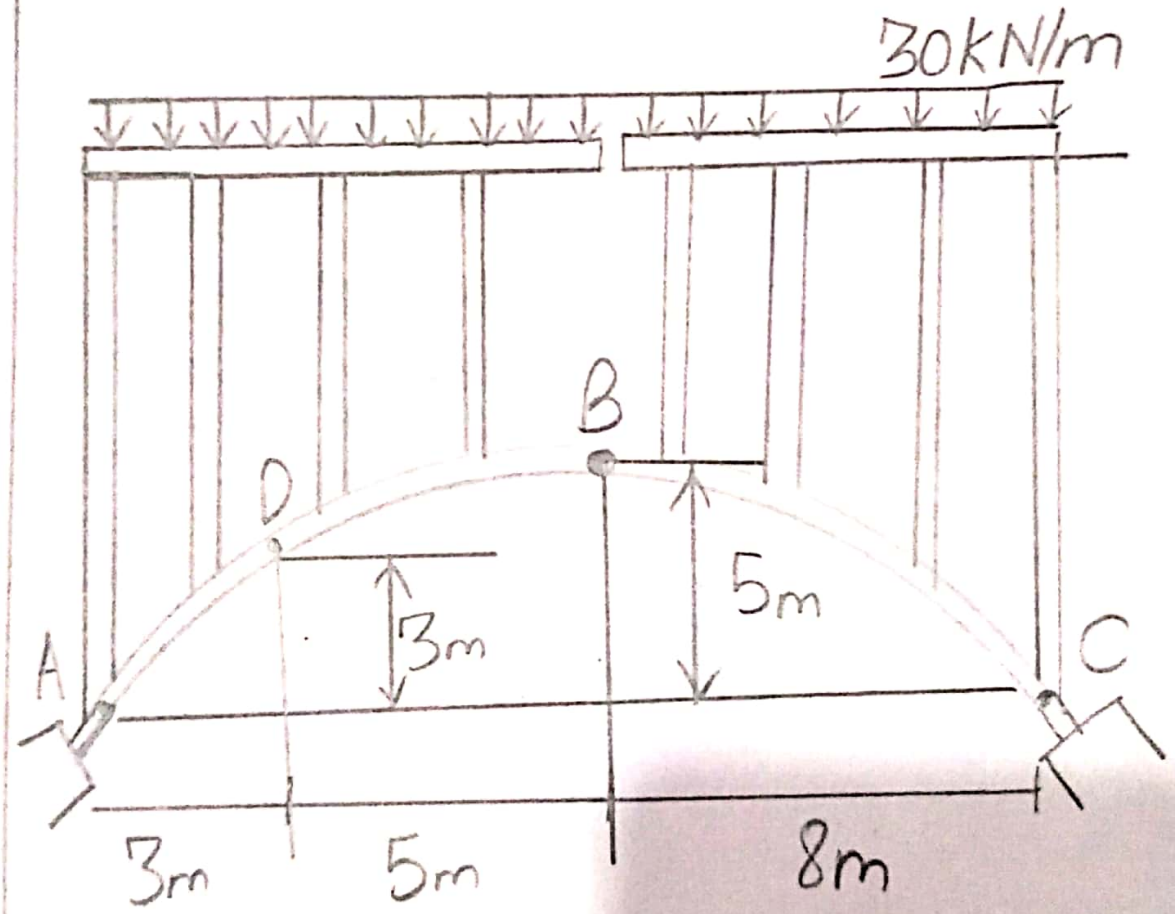
Divide by 1000

$$T_B = T_{MAX} = 7.5\ K$$

Ans

Question # 04

The three hinged spandrel arch is Subjected to the uniform load of 30 KN/m. Determine the internal moment in the arch at point D.



Sol:-

Member AB;

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

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

Member BC;

$$\circlearrowleft + \Sigma M_C = 0$$

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

Now,

$$B_x = 192\ KN,\ B_y = 0$$

Segment BD,

$$\circlearrowleft + \Sigma M_D = 0$$

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

$$\boxed{M_D = 9\ KN \cdot m}$$

Ans

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