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SEC: B

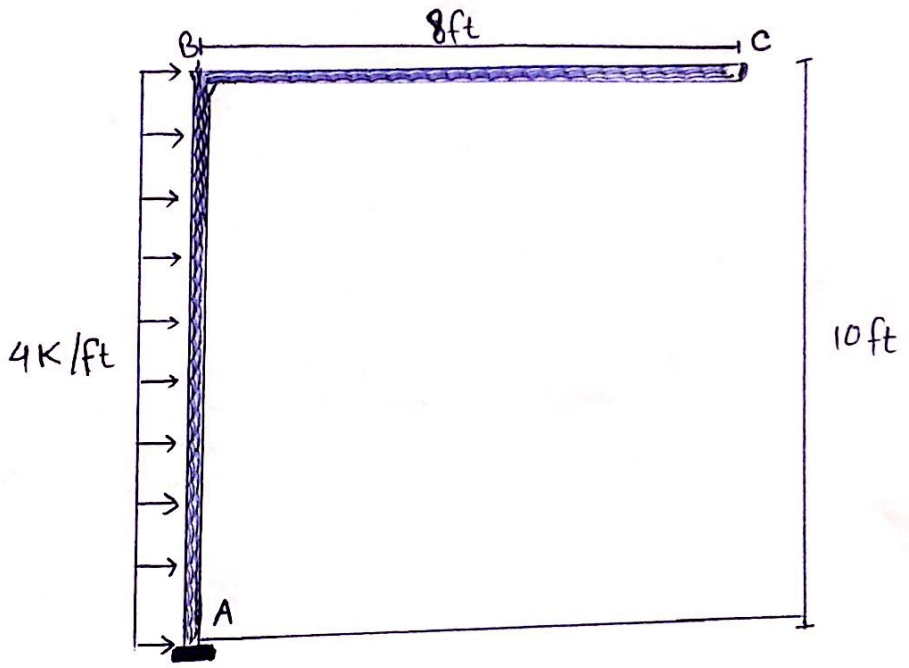
DEPT: BE Civil

SUBJECT: Structure Analysis

Ques # 01

=> Determine the vertical displacement of free end point C on the frame ..... Use method of virtual work.

Given Data:-



$E = 29(10^3)$ ksi

$I = 600\ in^4$

Required:-

Vertical displacement = ?

Solution:-

Now vertical moment

For reaction:-

$$\Sigma M_A = 0$$

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

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

$$\Sigma F_y = 0 \uparrow +$$

$$25 + A_y = 0$$

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

$$\Sigma F_y = 0 \longrightarrow +$$

$$40 - A_x = 0$$

$$A_x = +40$$

Real moments

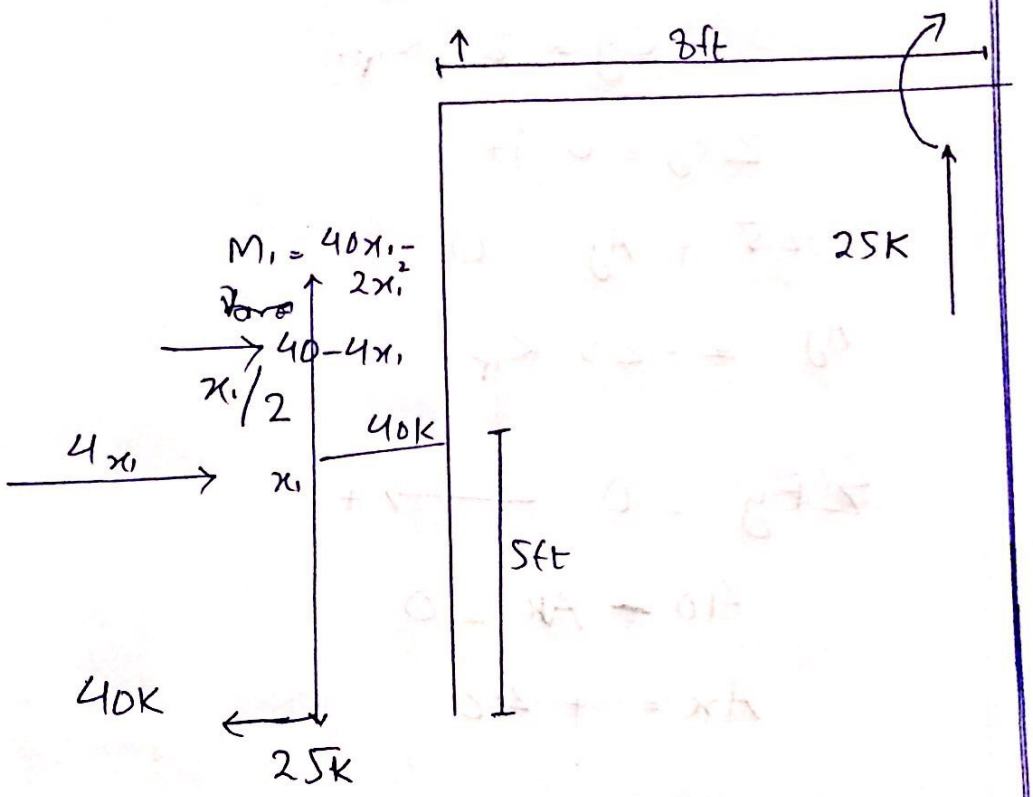
$$\Sigma M_1 = 0$$

$$-40(x_1) + 4x_1(x_1/2) + M_1 = 0$$

$$M_1 = 40x_1 - 2x_1^2$$

$$-25x_2 + M_2 = 0$$

$$M_2 = 25x_2$$



Virtual moments:-

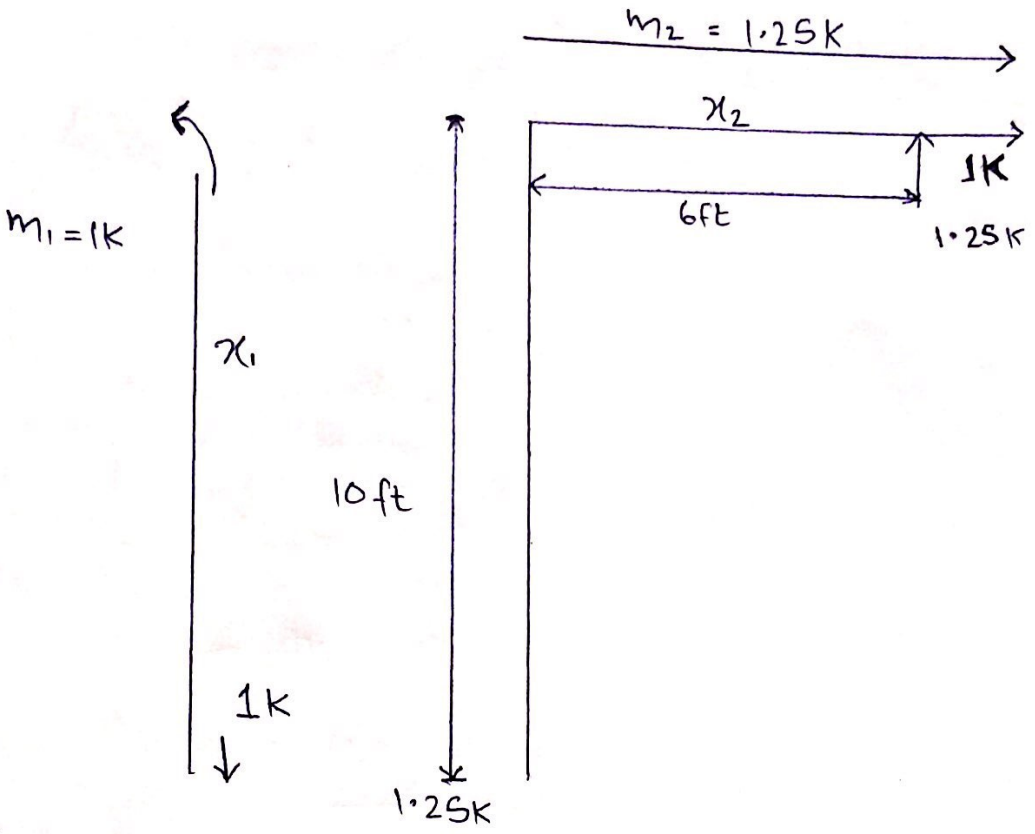
$$\Sigma m_1 = 0$$

$$-1\,(x_1) + m_1 = 0$$

$$m_1 = 1x_1$$

$$-m_2 + 1.25x_2 = 0$$

$$m_2 = 1.25x_2$$



Now, from virtual work equation.

$$1K \cdot \Delta C_h = \int_0^x m \frac{M\,dx}{EI}$$

$$1K \cdot \Delta C = \int_0^{18} \frac{(40x_1 - 2x_1^2)(1x_1)\,dx}{EI}$$

$$\Delta C_H = \frac{8333.3}{EI} + \frac{5333.3}{EI}$$

$$\Delta C_H = \frac{13666.7\ K^2.ft\ (12^3 in^3/1 ft^3)}{(29\times10^3)(600)} \Rightarrow \Delta C_H = 1.357 in$$

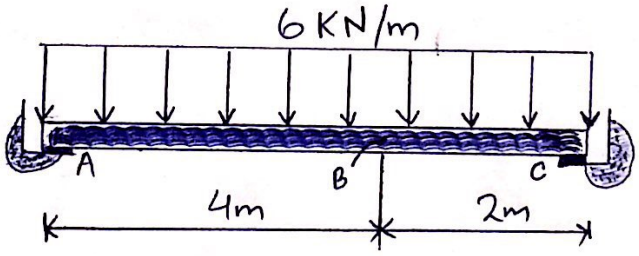
QUES # 02

=> 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 (10)^6 mm^4. Use Castigliano's theorem.

Given DATA:-

E = 200 GPa

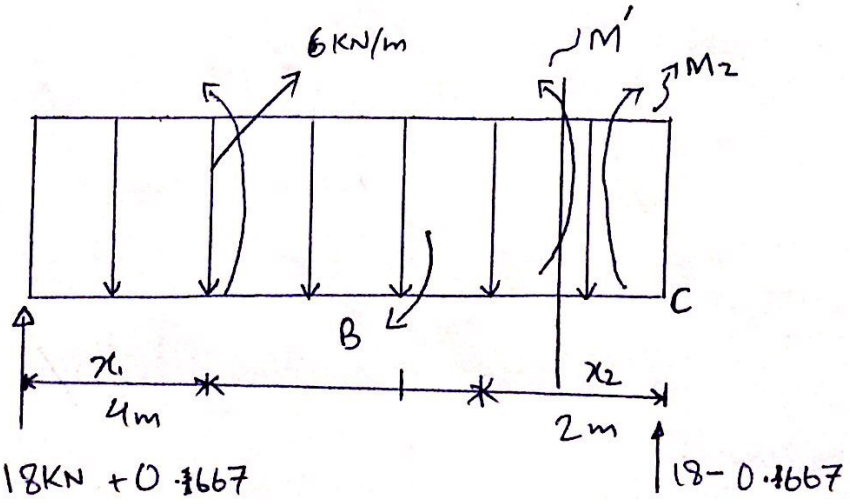
I = 60 (10)^6 mm^4



Required:-

slope and displacement at B = ?

Solution:-



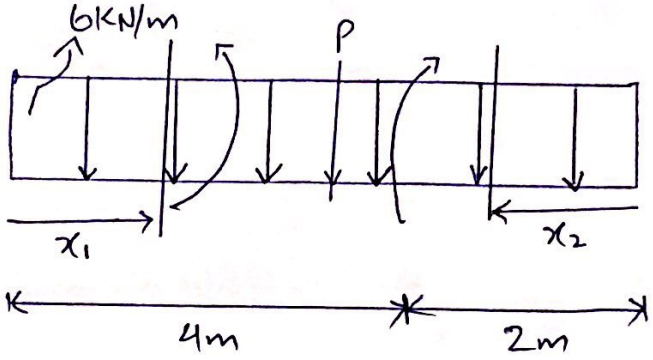
$$R_1 + R_2 = 0$$

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

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

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

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



$$R_1 + R_2 = 1$$

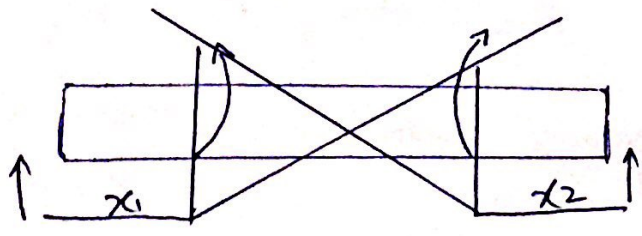
$$\circlearrowright + \quad \Sigma M_A = 0$$

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

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

$$R_2 = 1 - 0.1667 \text{ KN}$$

$$R_2 = 0.8333 \text{ KN}$$



$18 + 0.1667$ $\qquad$ $18 - 0.8667$

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

$$\theta_B = \int_0^2 M\left(\frac{2M}{2M'}\right)\frac{dx}{EI} = \int_0^4 \frac{(18x_1 - 2x_1^2)(0.1667x_1)\,dx}{EI}$$

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

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

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

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

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

for the displacement function are shown in figure "b"

$\frac{2M_1}{2MP} = 0.333x_1$ and $\frac{2M_2}{2P} = 0.667x_2$

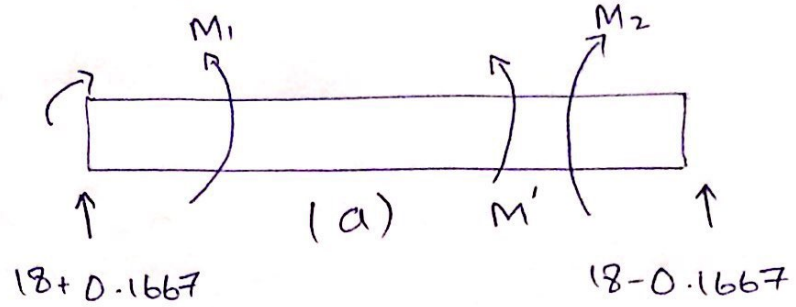
also set $P = 0$

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

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

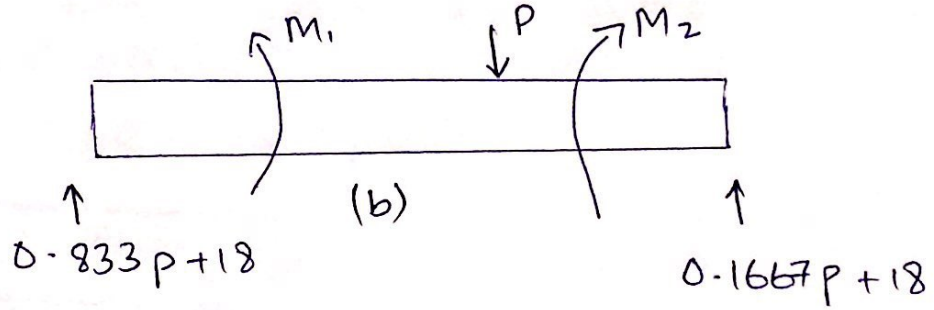
$$M_1 = (18 + 0.1667M')x_1 - 2x_1^2$$

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



$$M_1 = (0.833p + 18)x_1 - 2x_1^2$$

$$M_2 = (0.1667p + 18)x_2 - 2x_1^2$$



The displacement function shown in above figure "a"

$$\frac{2M_1}{2M'} = 0.1667x \quad \text{and} \quad \frac{2M_2}{2M'} = 0.1667x^2$$

Set $M' = 0$ then

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

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

Thus;

$$\Delta_B = \int_0^2 M \left(\frac{2M}{2P}\right) \frac{dx}{EI}$$

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

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

$$\Delta_B = \frac{218.5}{EI} = \frac{218.5}{(200\times10^6)(0.00006)}$$

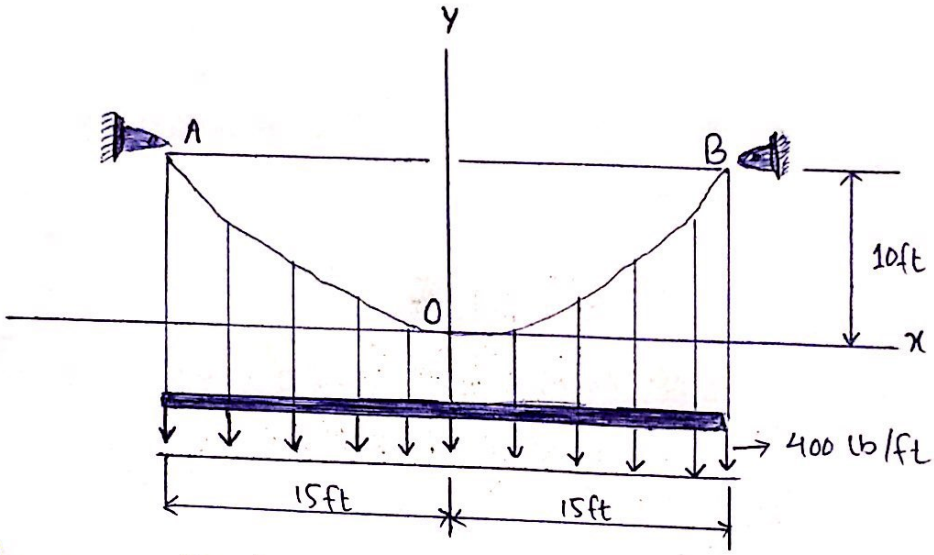
$$\Delta_B = 0.018m$$

OR

$\Delta_B = 18mm$

Ques # 03 :

=> The cable is subjected to the uniform loading. If the slope .... in the cable at O and B.



Given Data:-

=> length of origin to top = 10ft

=> length of origin to left = 15ft.

=> length of origin to right = 15ft

=> Load = 400 lb/ft.

=> Required :

equation of curve and force = ?

Solution:-

As we know that;

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

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

$$y = 0.0444 x^2$$

Now,

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

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

by $\frac{\circ}{\circ}$ by 1000

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

Now;

We Know that;

$$T_B = T_{max} = \sqrt{F_u^2 + (W_o L)^2}$$

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

$$= 7500 \text{ lb}$$

$\div$ by 1000

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

Now,

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

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

$$= 7500 \text{ lb}$$

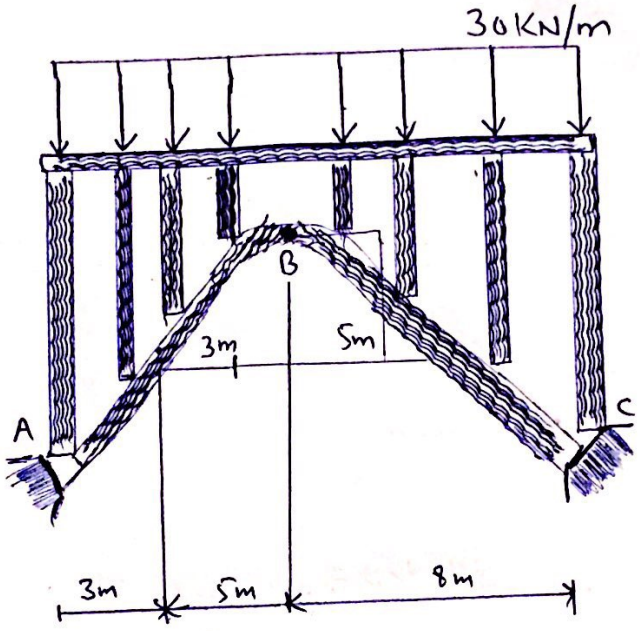
$\div$ by 1000

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

QUES # 04: PG-12

⇒ The three-hinged spandrel arch is subjected to the uniform load of 30 KN/m. Determine ..... at point ▷.

Given Data:-



Required =?

Interval moment at point ▷

Solution:-

Member AB;

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

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

member BC;

$$\curvearrowright + \quad \Sigma M_C = 0$$

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

Solving :-

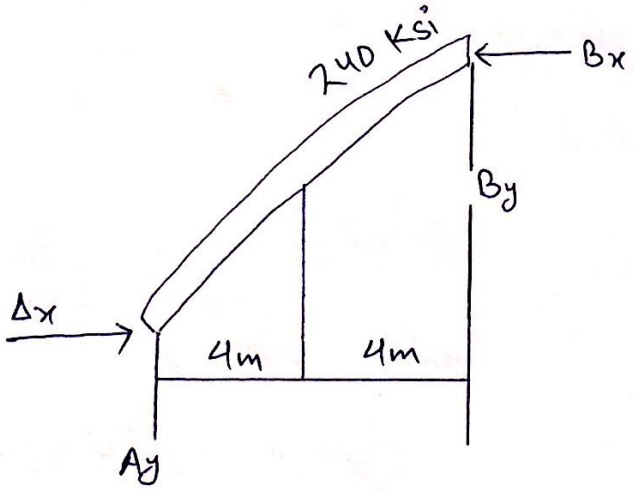
$$B_x = 192\ KN \quad , \quad B_y = 0$$

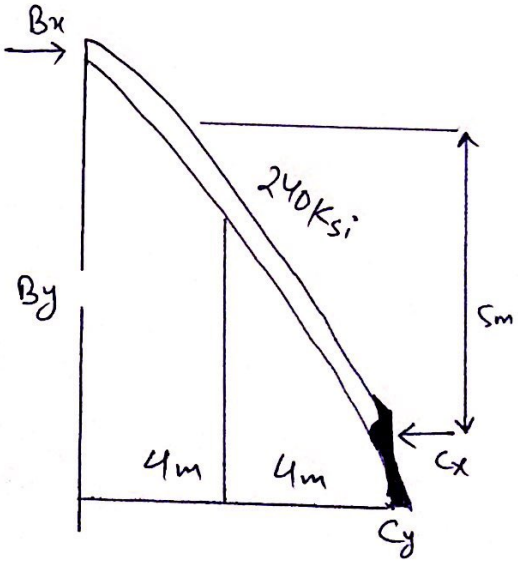
Segment BD ;

$$\curvearrowright + \quad \Sigma M_D = 0$$

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

$$\boxed{M_D = 9KN.m}$$ **Ans:**





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