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Section :- A

Subject :- Structure - I

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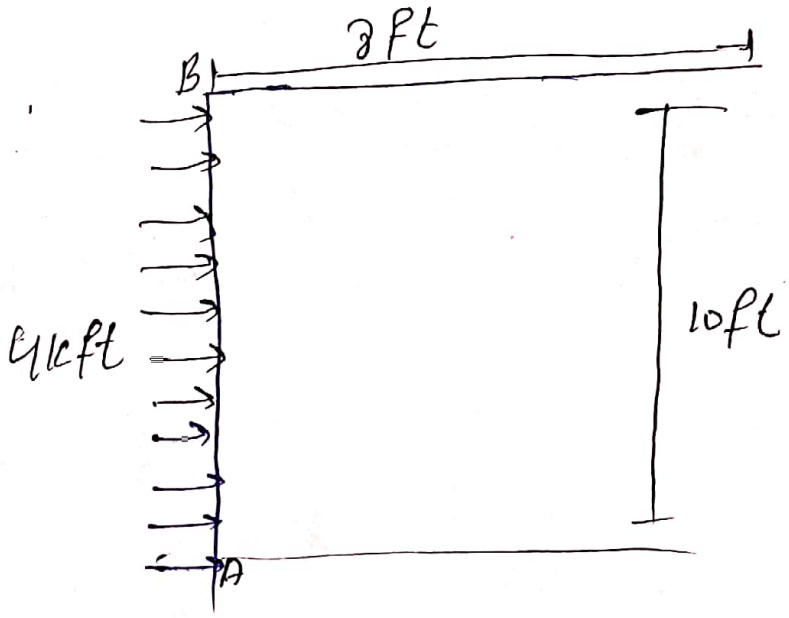
Question #01

Given data :-

$E = 29(10^3)$ ksi

$I = 600 in^4$



Required :-

Verticle displacement = ?

Solution :-

Now vertical moment

For reactions :-

$$\Sigma M_A = 0$$

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

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

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

$$25 + A_y = 0$$

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

$$\Sigma F_x = 0 \longrightarrow +$$

$$40 - A_x = 0$$

$$A_x = +40$$

Real moment;

$$\Sigma M_1 = 0$$

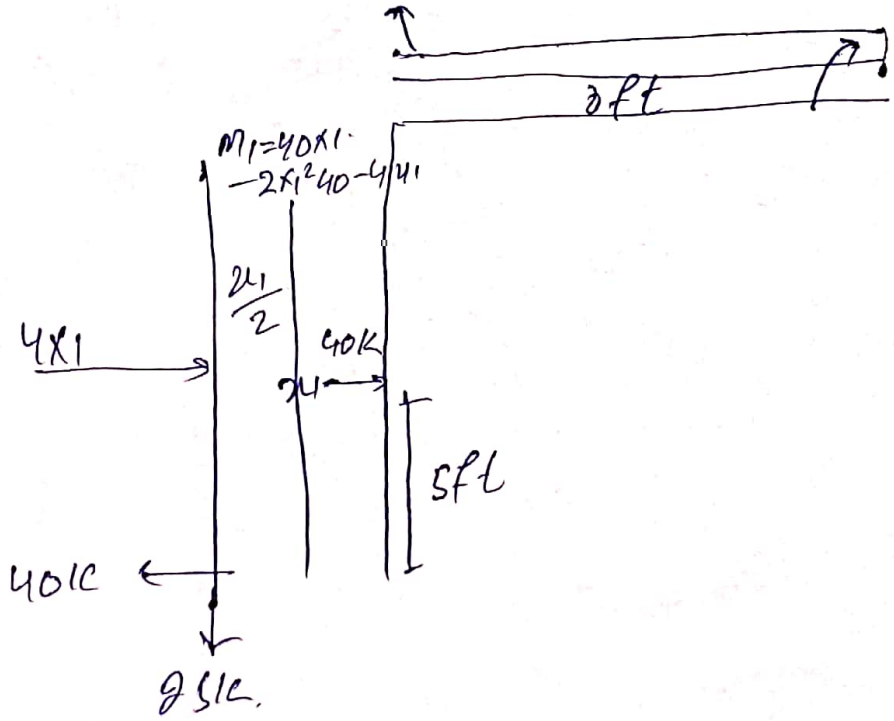
$$-40(x_1) + 4(x_1/2) + M_1 = 0$$

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

$$-25X_2 + M_2 = 0$$

$$M_2 - 25X_2 = -25$$

$$M_2 = 25X_2$$



Virtual moments:

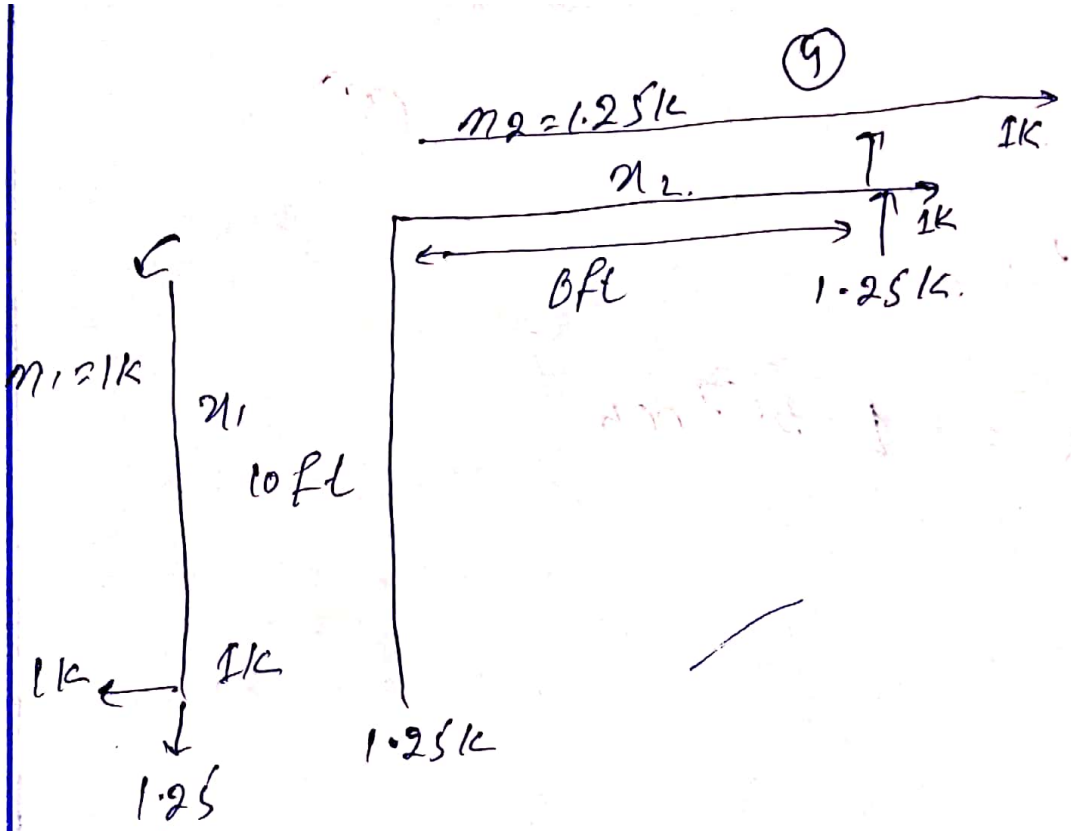
$$\sum M_1 = 0$$

$$-1(X_1) + m_1 = 0$$

$$m_1 = 1X_1$$

$$-m_2 + 1.25X_2 = 0$$

$$m_2 = 1.25X_2$$



Now from virtual work eq

$$1k \cdot \Delta ch = \int_0^{u} m \frac{M\,dx}{EI}$$

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

$$\Delta ch = \frac{8333.3}{EI} + \frac{5'333.3}{EI}$$

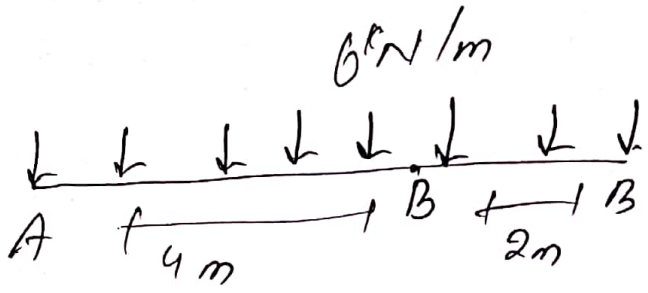
$$\Delta ch = \frac{13866.7}{EI}\ k^3.ft^3$$

$$\Delta ch = \frac{1\ 3366.7 k^2 ft\,(12^3 \cdot 11a^3)/1ft^3)}{(29 \times 10^3 k/in^2)(600)}$$

Result :-

$$D_{ch} = 1.357 \text{ inch}$$

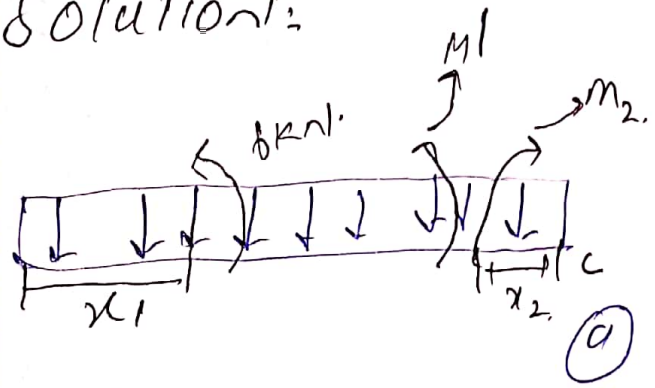
Question #02.



Required:-

Slope and displacement at point B

Solution:-



(a)

$R_1 + R_2 = 0$ — (1)

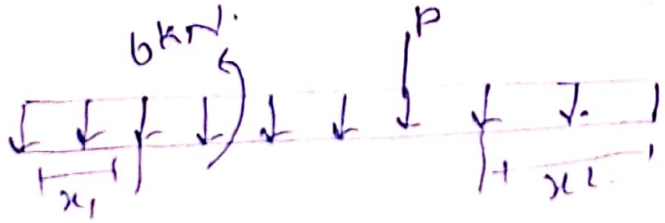
$\Sigma M_A = 0$ (+

$+R_2(6) = 0$

$\Rightarrow -0.16667$ put in eq (1)

$R_1 + (-0.1667) = 0$

$R_1 = 0.16667\ kN$



(b)

$R_1 + R_2 = 1$

$\circlearrowleft + \Sigma M_A = 0$

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

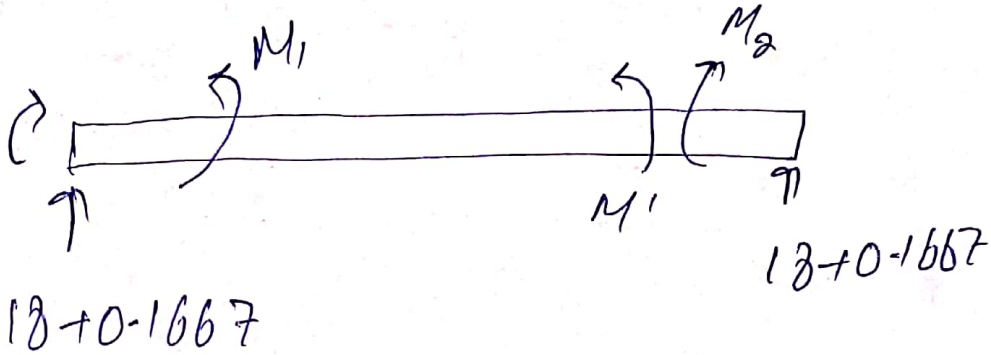
$R_1 = 0.6667\ kN$

$R_2 = 1 - 0.6667\ kN$

$R_2 = 0.333\ kN$

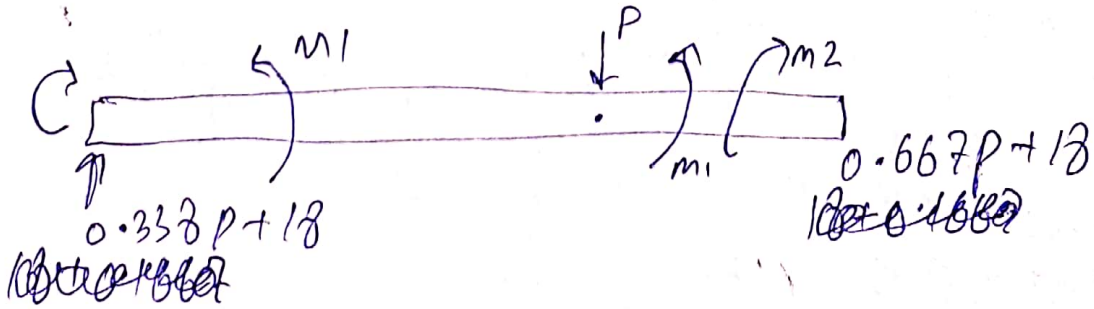
$$M_1 = (18 + 0.1667M') x_1 - 2x_1^2$$

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



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

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



Where
The displacement function shown in the figure "a" above.

$\frac{\delta M_1}{\delta m'} = 0.1667 x_1$ and $\frac{\partial M_2}{\partial M1} = 0.1667 x_2$.

Set $M' = 0$

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

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

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

$$\theta_B = \int_0^L M\left(\frac{\partial M}{\partial M_1}\right)\frac{dx}{EI} = \int_0^4 \frac{(18x_1 - 2x_1^2)(0.1667)dx_1}{E_1}$$

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

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

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

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

$$\boxed{\theta_B = 0.444 \text{ rad}}$$

→ For the displacement function are shown in figure "b"

$$\frac{\partial M_1}{\partial M_P} = 0.333x_1 \text{ and } \frac{\partial M_2}{\partial P} = 0.6667x_2$$

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

$$M_2 = (18x_2 - 2x_2^2) \text{ KN.m}$$

Thus

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

$$\Delta_B = \int_3^7 \frac{(30x_1 - 2x_1^2)(0.333x_1)dx}{EI} + \int_0^2 \frac{(30x_2 - 2x_2^2)(0.6667x_2)dx}{EI}$$

(7b)

$$\Delta B = \frac{2\,18.5'}{EI}$$

$$\Delta B = \frac{218.5'}{(200\times10^{6})(0.0006)} = 0.018m$$

$$\boxed{\Delta B = 18mm}$$

Ans

Q.No #03

Given data:-

w_0 = uniform load = 400 lb/ft

h = 10ft , L = 15'ft

Required:-

Equation of curve and force in Cable = ?

Solution:-

we know that

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

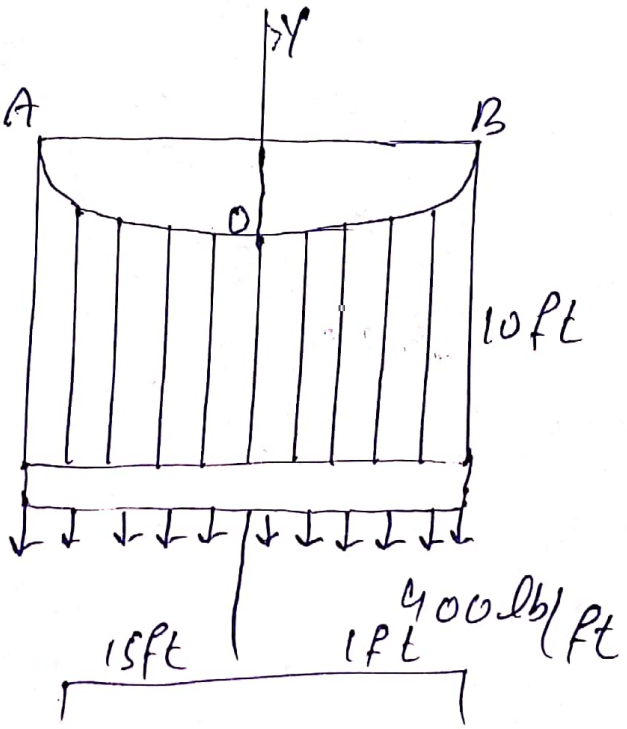
putting the value

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

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

$$T_0 = F_H = \frac{w_0 L^2}{2h} = \frac{400 \times (15)^2}{2 \times 10}$$

$$T_0 = 4500 \text{ lb} = 4.5 \text{ K}$$



$$T_B = T_{max} = \sqrt{(F_H)^2 + (w_0 L)^2}$$

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

$$T_{max} = 7500 \text{ lb} = 7.5 \text{ K}.$$

No 6

"T_{max}" by another equation

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

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

$$T_{max} = 7500 lb = 7.5 k$$

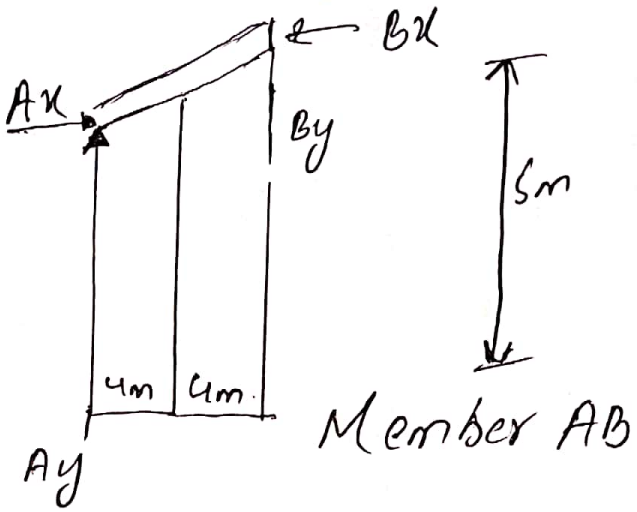
Ans

Question No#04

Answer:-

Given data:-

uniform load = 30 kN/m

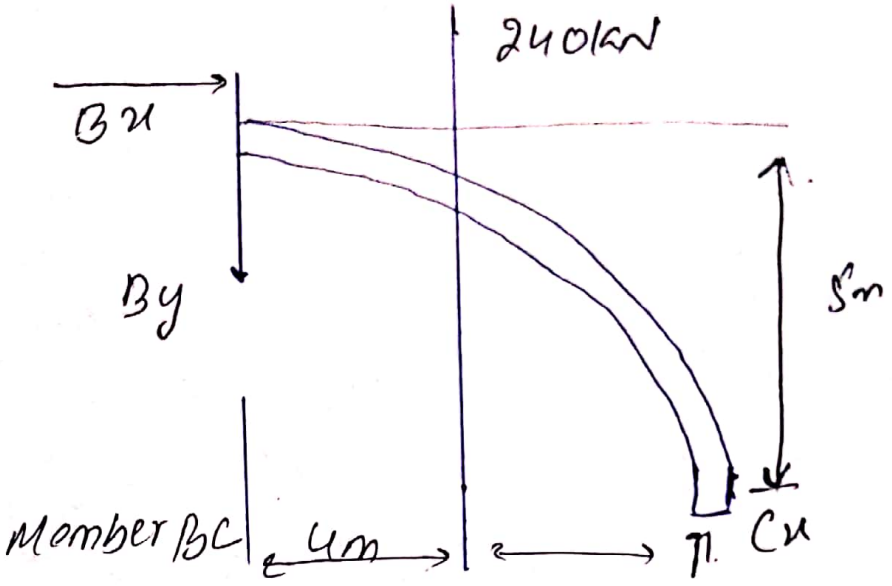


Required data:-

Internal moment at D = ?

Solution:-

Dividing into two members AB and BC



AB:-

$$\circlearrowleft + \Sigma M_A = 0 \quad Bx(5) + By(8) - 240(4) = 0$$

— (a)

BC:-

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

$$-Bx(5) + By(8) + 240(4) = 0$$

→ (b)

Adding eq (a) and (b)

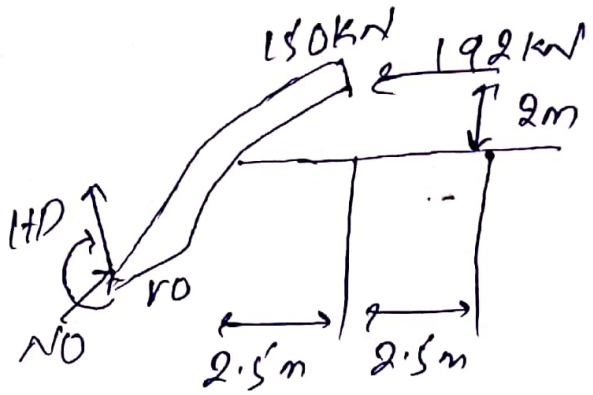
$$Bx(5) + By(8) - 240(4) = 0$$

$$-Bx(5) + By(8) + 240(4) = 0$$

$$0 + 2By(8) + 0 = 0$$

$$2By(3) = 0$$

$$By = 0\ kN$$



Putting the value of "By" in eq (b)

$$\Rightarrow -Bx(5) + By(3) + 240(4) = 0$$

$$\Rightarrow -Bx(5) + 0(3) + 960 = 0$$

$$Bx(5) = 960$$

Dividing eq (i) both sides by 5

$$\frac{Bx(5)}{5} = \frac{960}{5}$$

$$\boxed{Bx = 192\ kN}$$

At segment DB"

↳ $\Sigma M_D = 0$

$$C92(2) - 150(2.5) - M_D = 0$$

$$384 - 375 = M_D$$

$$\boxed{M_D = 9\ kN.m}$$

Ans.