Structural Analysis - I

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I. ① * 7902

Section = A

① Date = 26-6-2020

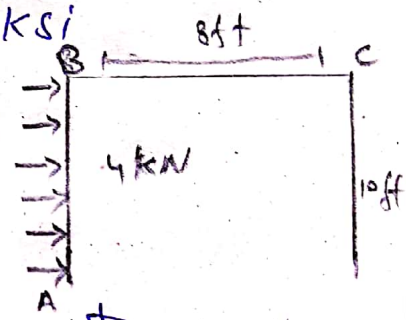
Q No 1

Given Data:-

uniform load = 4 k/ft

E = 29×10^3 KSi

I = 600 in^4

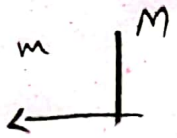


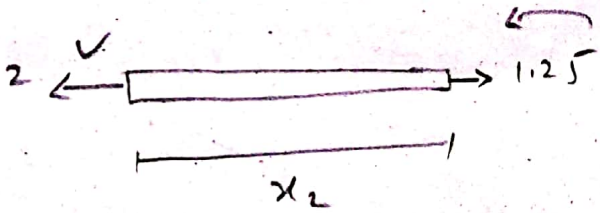
Required :-

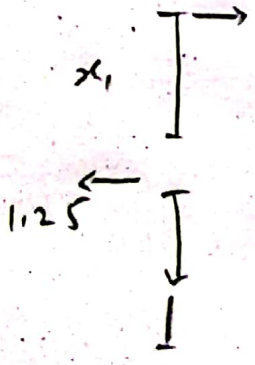
vertical ① displacement.

Sol :-

Now vertical moment.

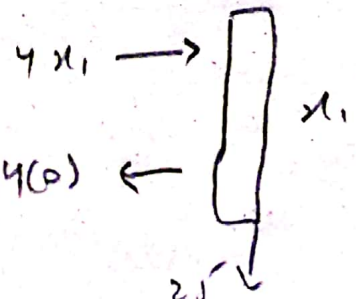


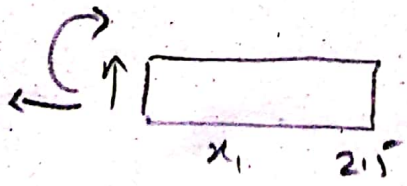




$m_2 = 1.25x$

real moment





$m_2 = 2.5x_2$

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

Now By virtual work equation.

$$\Delta \cdot 1I = \int_0^L \frac{m\,M\,dx}{E}$$

$$\Delta I = \int_0^{10} (1x_1)\left(\frac{40x_2 - 2x^2}{E}\right)dx + \int_0^8 \frac{(1.25V_2)(25x_2)}{E_1}dx$$

$$\Delta I = \frac{1}{EI}\left|\frac{42x^3}{3} - \frac{2x^3}{4}\right|_0^{10} + \left|\frac{(31.25x_2^3)}{3}\right|_0$$

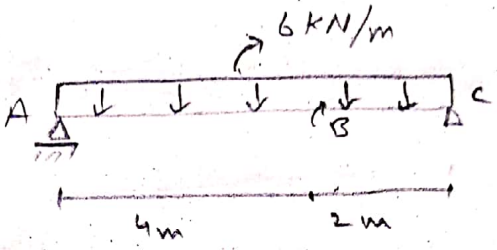
~~$\Delta I = 1064.60184$~~

$$\Delta I = \frac{33999.99}{(200)(60\times10^6)}$$ ~~Ans.~~

$\Delta I = 2.833 \times 10^{-6}$ in → Ans.

Q No 2

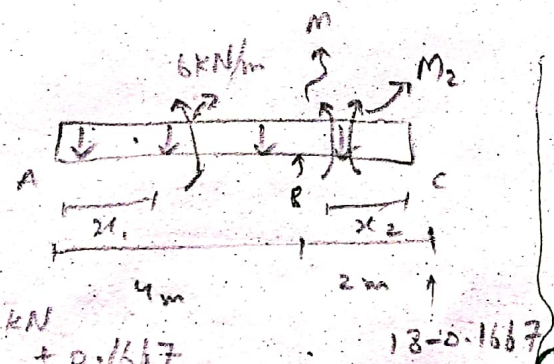
Given Data :-



Required :-

slope and displacement at Point B.

Sol :-



(a)

$$R_1 + R_2 = 0 \longrightarrow (1)$$

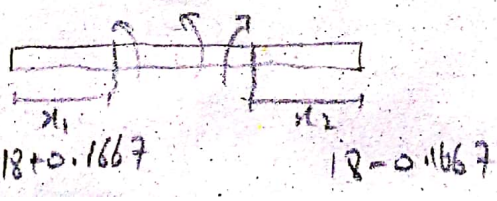
$$\Sigma M_A = 0 \quad \circlearrowleft +$$

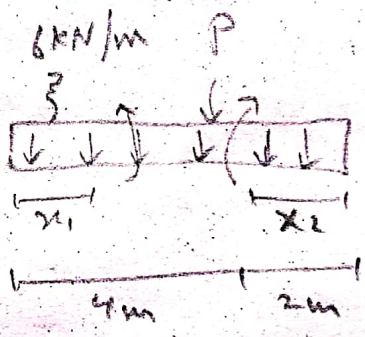
$$1 + R_2 (6) = 0$$

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

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

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





(b)

$$R_1 + R_2 = 1$$

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

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

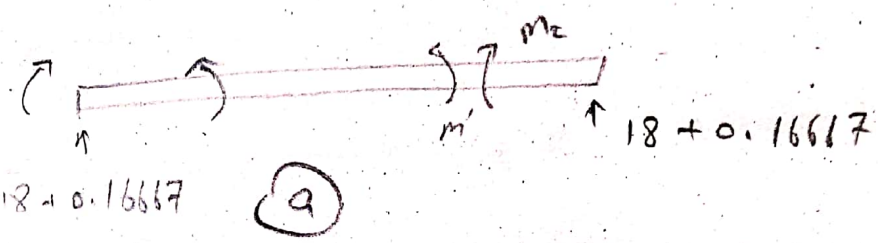
$$R_1 = 0.6667 \text{ kN}$$

$$R_2 = 1 - 0.6667 \text{ kN}$$

$$R_2 = 0.333 \text{ kN}$$

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

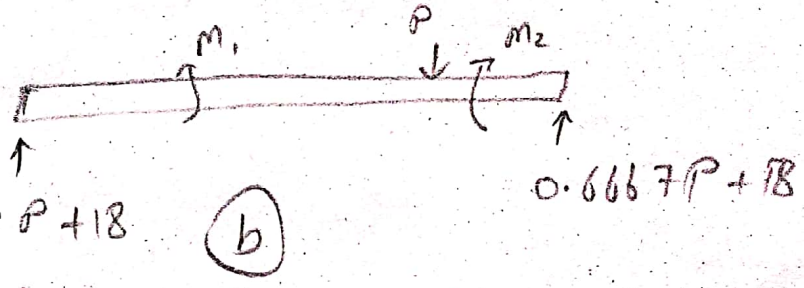
$$M_2 = (18 - 0.1667\,M')\,X_2 - 2x_2^2$$



(a)

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

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



(b)

The displacement function shown in the figure "a" above

$$\frac{\partial M_1}{\partial M'} = 0.16667x_1 \quad \text{and} \quad \frac{\partial M_2}{\partial M'} = 0.16667x_2$$

Set $M' = 0$. hence

$$M_1 = (18 + 0.16667(0))\,x_1 - 2x_1^2$$

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

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

$$B = \int_0^L M\left(\frac{\partial M}{\partial M'}\right)\frac{dx}{E_i} = \int_0^{x'} \frac{(18x_1 - 2x_1^2)(0.16667x_1)}{E_i}\,dx_1 +$$

P-T-O

$$\int_0^2 \frac{(18x_2 - 2x_2^2)(0.1666\,7x_2)\,dx_3}{EI}$$

$$\Phi_B = \frac{48.65}{EI} + \frac{6.66}{EI}$$

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

$$\Phi_B = \frac{49.31}{(200 \times 10^6)\pi (0.0006)} =$$

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

→ For the displacement function are shown in figure. "6".

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

also set $P = 0$

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

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

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

$$\Delta B = \int_0^4 \frac{(30 \times x_1 - 2x_1^2)(0.333x_1)}{EI} dx + \int_0^2 \frac{(30x_2 - 2x_2^2)(0.6667x_2)}{EI} dx$$

$$\Delta B = \frac{218.5}{EI} \Rightarrow \frac{218.5}{(200 \times 10^6)(\pi \cdot 0.0006)} = 0.018\text{m} = 18\text{mm}$$

Ans.

Q No 3

Given Data :-

Ans:-

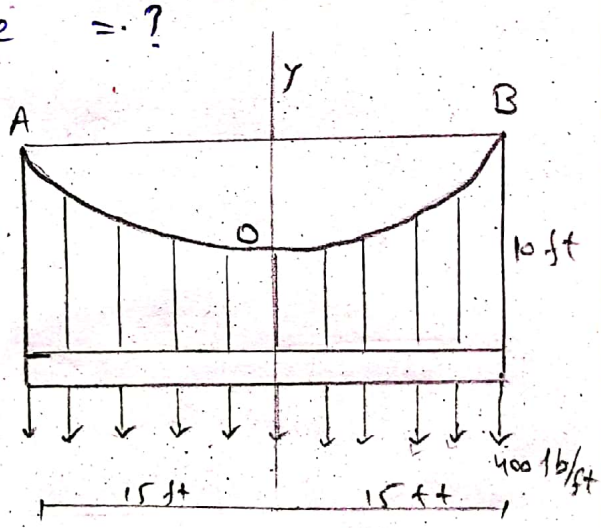
Uniform load = w_o = 400 lb/ft.

h = 10 ft

L = 15 ft

Required :-

Equation of curve and force in cable = ?



Solⁿ-

we know that

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

Putting the values.

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

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

$$T_o = 4500 \text{ lb} = 4.5 \text{ k}.$$

$$T_B = T_{max} = \sqrt{(F_H)^2 + (w_o L)^2} = \sqrt{(4500)^2 + (400 \times 15)^2}$$

$$\boxed{T_{max} = 7500 \text{ lb} = 7.5 \text{ k}}$$

Now "Tmax" By another equation

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

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

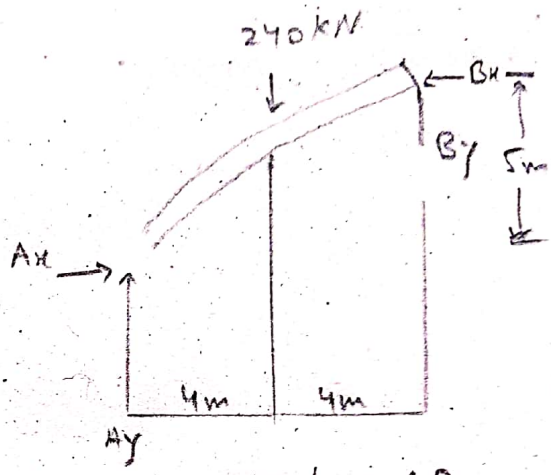
$$\boxed{T_{max} = 7500\ lb = 7.5\ K}$$

Q No 4

Given Data :-

Ans:-

uniform load = 30 KN/m



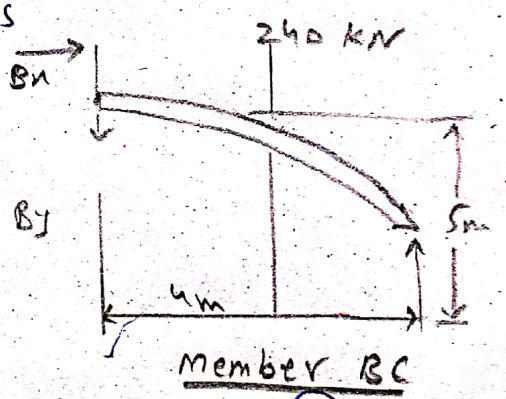
Required :-

internal moment at D = ?

Sol :-

① Dividing into two members AB and BC.

Member AB



Member BC

AB :-

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

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

BC :-

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

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

Adding eq (a) and (b)

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

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

$2B_y(8) = 0$

$$2 B_y (8) = 0$$

$$\Rightarrow \quad \Rightarrow \quad \boxed{B_y = 0 \cdot kN}$$

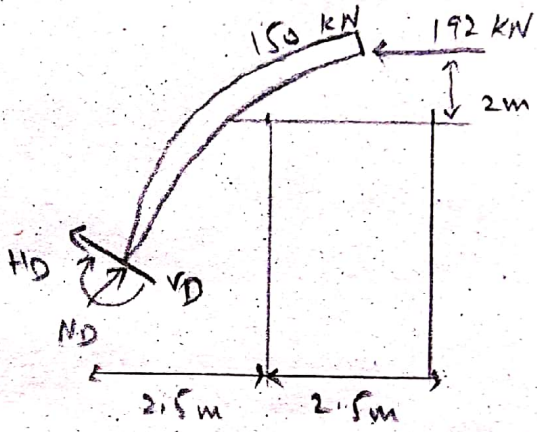
Putting the value of 'By' in eq (b)

eq (b) $\Rightarrow$ $-B_x (5) + 0(8) + 960 = 0$

$$B_x (5) = 960$$

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

$$\boxed{B_x = 192 \ k.N}$$



∴ Now at segment ① B ∴ Member DB

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

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

$$384 - 375 - M_D = 0$$

$$9 - M_D = 0$$

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