Structure Analysis

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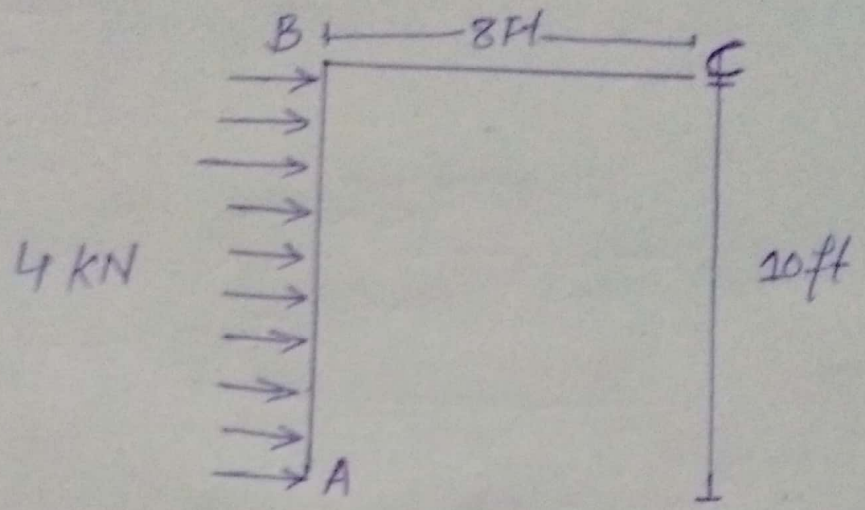
Sec :- A

Date = 26/6/2020

Q No 01

Ans:

Given data



$E = 29 \times 10^3$ KSI

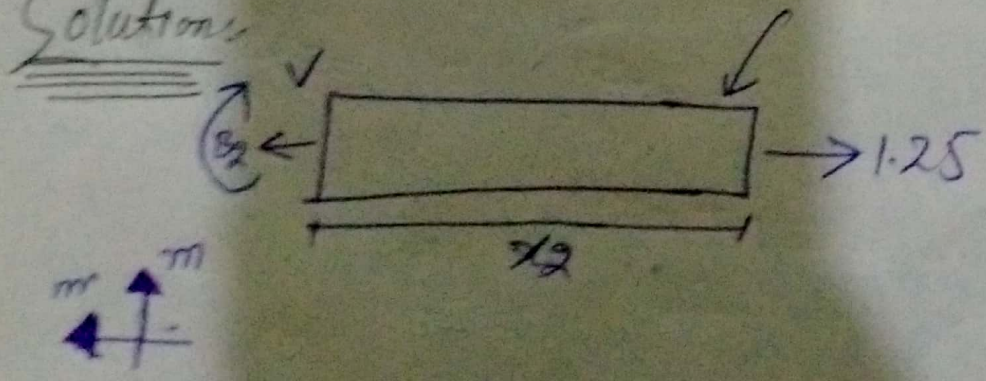
$I = 600$ In^4

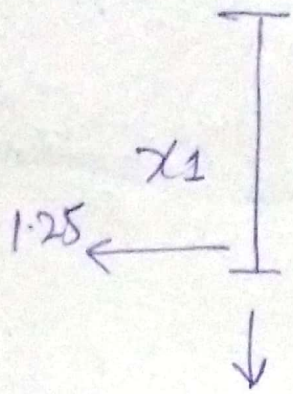
Required data :

Vertical displacement = ?

Vertical moment = ?

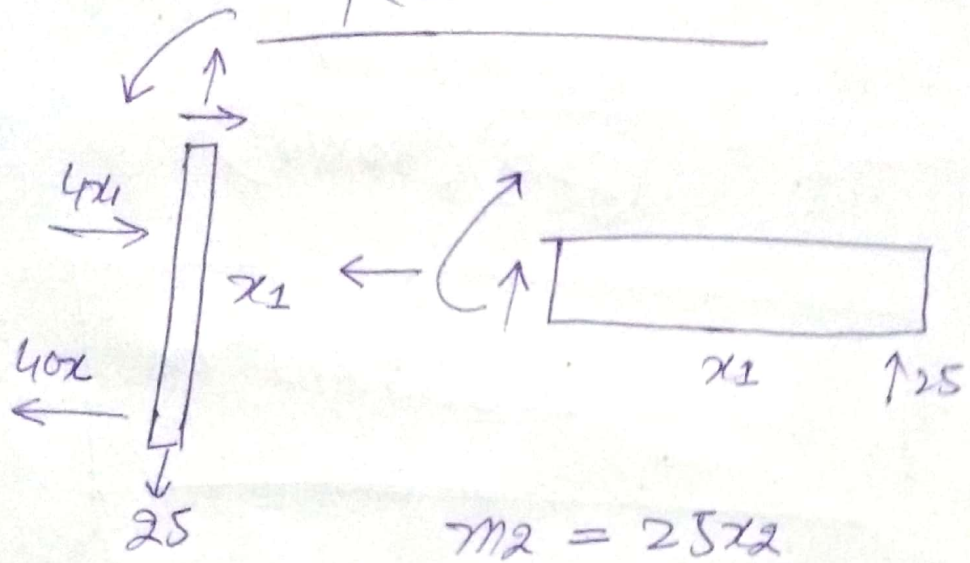
Solution:





$m_2 = 1.25x$

Real moment



$m_2 = 25x_2$

$$M = 40x_1 - 2x\frac{1}{2}(x_1)$$

$$= 40x_1 - 2x_3^2$$

Now put virtual work

$$1 \cdot \Delta C = \int_0^2 m\frac{M}{E}\,dx$$

$$= \int_0^{10} 1x_1\left(\frac{4x_2 - 2x^2}{E}\right)dx + \int_0^8 \frac{(1.25x_1)(25x_1)}{EI}\,dx$$

(3)

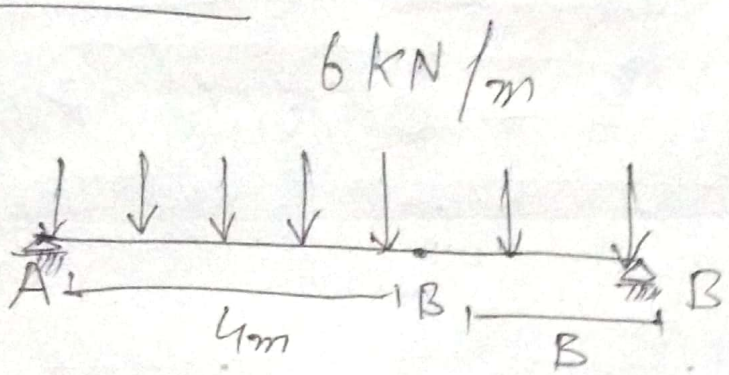
$$\Delta I = \frac{1}{EI}\left(\frac{40x^3}{3} - \frac{2x^4}{4}\right)\Bigg|_0^{10} + \left(\frac{31.25}{3}x_2^3\right)\Bigg|_0^8$$

$$\Delta I = \frac{1}{EI}\left(2.3333 + 10666.66\right)$$

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

$$\boxed{\Delta I = 2.833\times10^{-6}\ m}$$

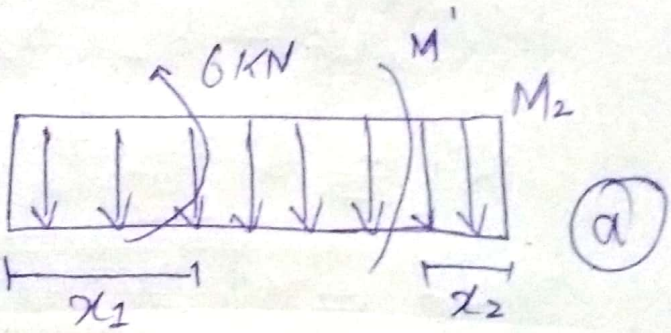
Q No 2



Required:

Slope & Displacement at point B.

Solution



(a)

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

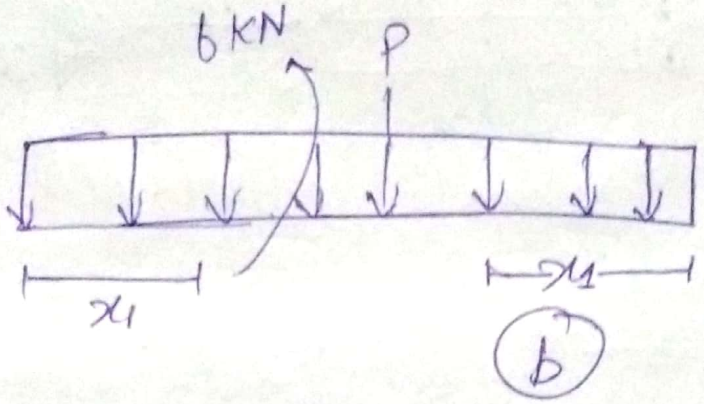
$$\Sigma M_A = 0 \quad \curvearrowright +$$

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

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

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

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



$$R_1 + R_2 = 1$$

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

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

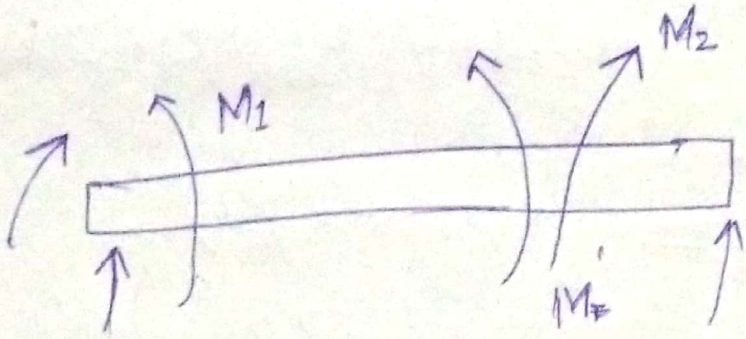
$$R_1 = 0.6667\ kN$$

$$R_2 = 1 - 0.6667\ kN$$

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

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

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

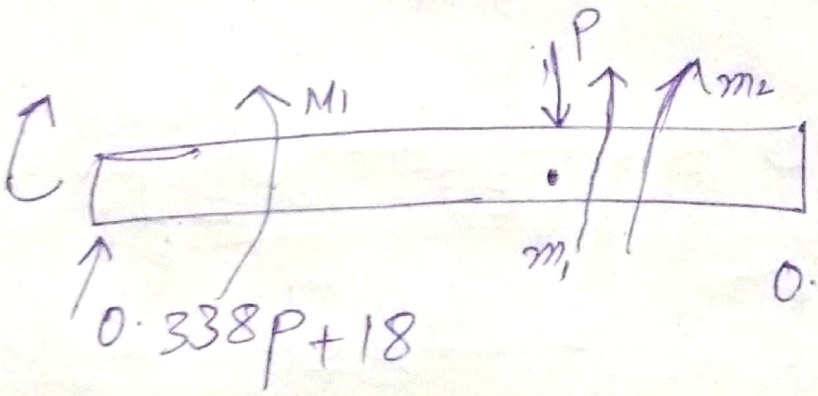


18+0.1667

18+0.1667

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

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



0.667P + 18

0.338P + 18

The displacement function show in the figure "a" above

$$\frac{\delta m_1}{\delta m'} = 0.01667x_1 \quad \text{and} \quad \frac{\delta M_2}{\delta M_1} = 0.1667x_2$$

Set $M' = 0$

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

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

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

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

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

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

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

$$\theta_B = \frac{49.31}{(200 \times 10^6)(0.00008)}$$

$$\boxed{\theta_B = 0.444 \text{ rad}}$$ (Slope)

→ For displacement function are shown in fig (b)

$$\frac{\partial M_1}{\partial M_p} = 0.333x_1 \text{ and } \frac{\partial M_2}{\partial P}$$

$$= 0.6667x_2$$

then $M_1 = (16x_1 - 2x_1^2)$ kN-m

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

Thus

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

$$\Delta B = \int_3^4 \frac{(30x_1 - 2x_1^2)(0.333x_1)}{EI}dx$$

$$+ \int_0^2 \frac{(30x_2 - 2x_2^2)(0.6667x_2)}{EI}dx$$

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

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

$\Delta B = 16mm$ Ans (Displacement)

Q NO3

Ans:

Given data

Uniform Load "Wo" = 400 lb/ft

h = 10 ft

L = 15 ft

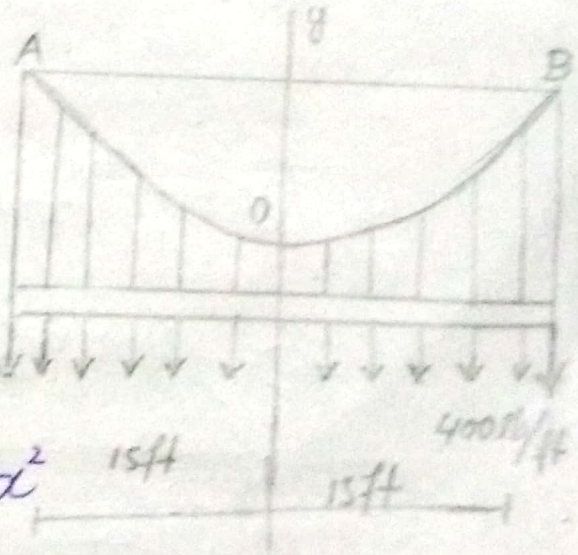
Required data

Equation of Curve and force in Cable = ?.

Solution:

We know that

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



putting the values

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

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$$T_O = F_H = \frac{W_O L^2}{2h} \Rightarrow \frac{400 \times (15)^2}{2 \times 10}$$

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

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

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

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

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

Now "T_{max}" By another equation

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

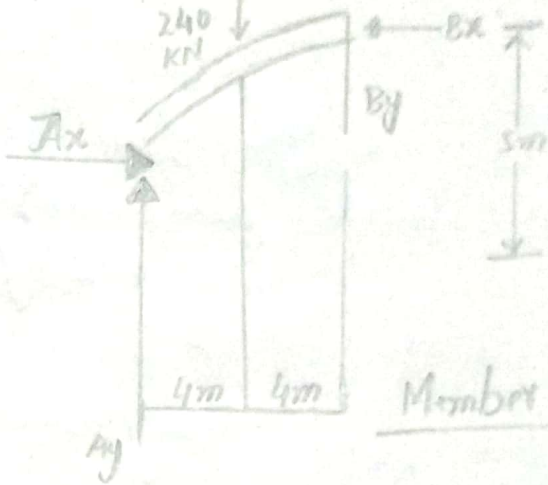
$$\Rightarrow 400 \times 15 \sqrt{1 + \left(\frac{15}{2 \times 10}\right)^2}$$

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

Q No 4

Ans: Given data :-

Uniform Load = 30 KN/m

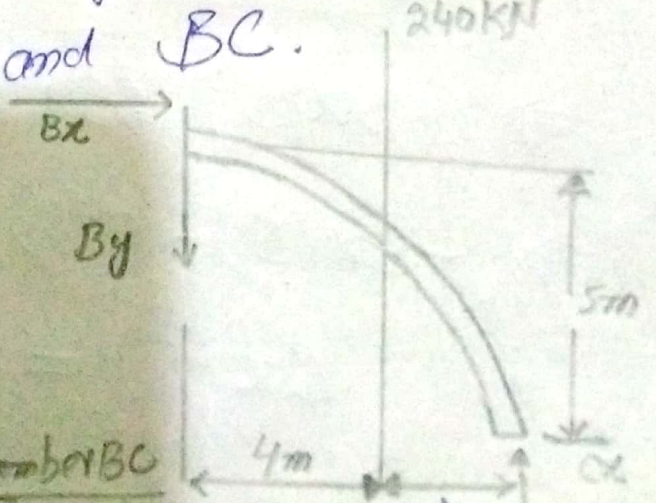


Required data :-

Internal Moment at D = ?

Solution :-

Dividing into two members AB and BC.



AB : Member BC

$\curvearrowright + \Sigma M_A = 0$

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

BC :

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

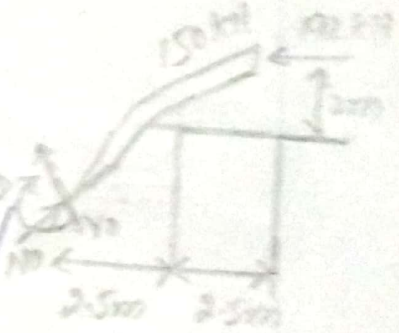
$$-B_x(5) + B_y(8) + 240(4) = 0 \longrightarrow (b)$$

Adding eq (a) and (b)

$$B_x(5) + B_y(8) - 240(4) = 0$$
$$-B_x(5) + B_y(8) + 240(4) = 0$$
$$0 + 2B_y(8) + 0 = 0$$

$$2B_y(8) = 0$$

$$\Rightarrow B_y = 0 \text{ kN}$$



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

$$\Rightarrow -B_x(5) + B_y(8) + 240(4) = 0$$
$$\Rightarrow -B_x(5) - 0(8) + 960 = 0$$
$$B_x(5) = 960 \longrightarrow (1)$$

Dividing eq (1) both sides by 5.

$$\frac{Bx(8)}{8} = \frac{960}{5}$$

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

"At Segment DB"

↳ $\Sigma M_D = 0$

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

$$384 - 375 = MD$$

$$\boxed{MD = 9\ kN \cdot m}$$

Ans