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Semester :- 12th

Subject :- Structure Analysis I

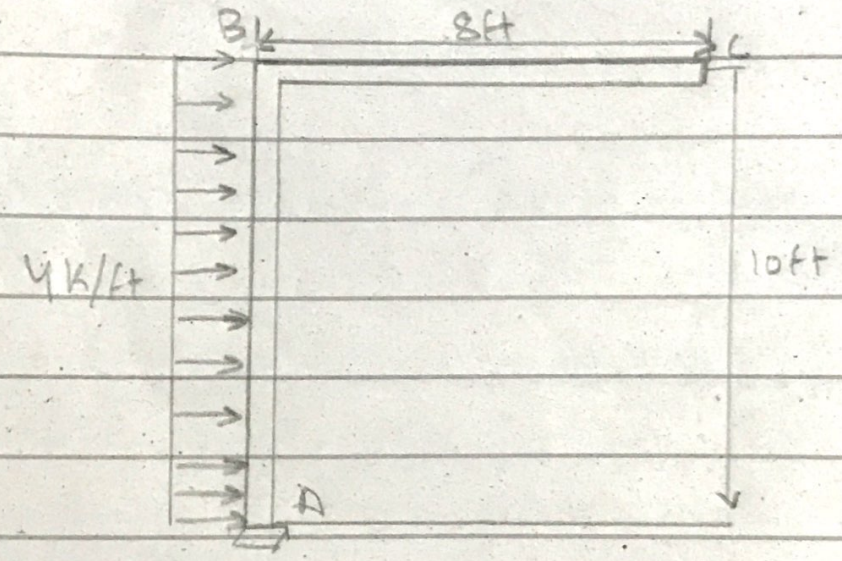
Section :- B

Submitted to :- Engr. Amjad Islam.

Final Term

Qno1 :-

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



=> Given Data:-

Uniform load = 4 K/ft

$E = 29(10)^3$ ksi

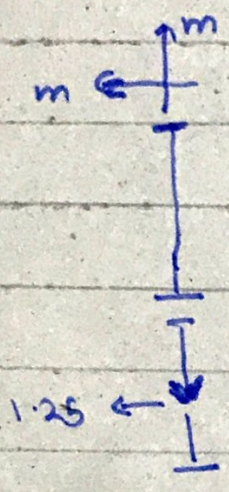
$I = 600\ in^4$

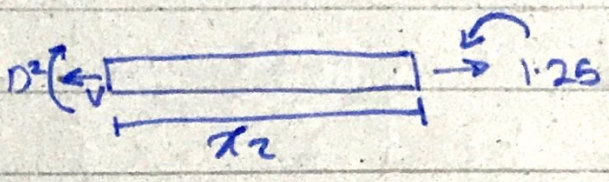
=> Required :- ~~Unit~~

Vertical displacement.

Solution:-

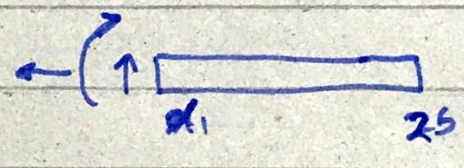
Now virtual moment

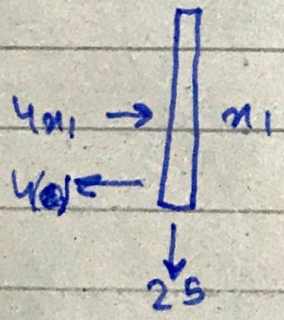




$m_2 = 1.25x$.

Real moment





$m_2 = 25x_2$

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

Now by virtual work Equation

$$\Delta DC = \int_0^L \frac{m\,M\,dx}{E}$$

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

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

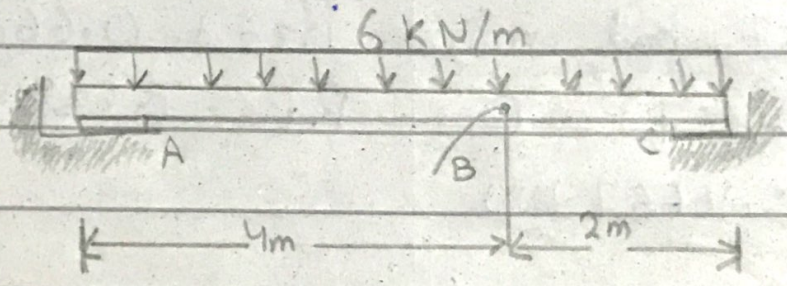
~~[illegible]~~ mm

$\Delta C = 10.64$ mm

Qno 2

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 Castrigliano's Theorm.

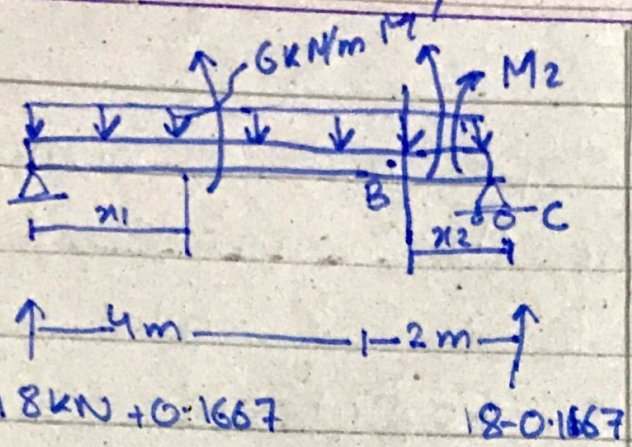
Given Data:-



Required:-

Slope and displacement at Point B

=> Solution:-



(a)

$R_1 + R_2 = 0$ ——— ①

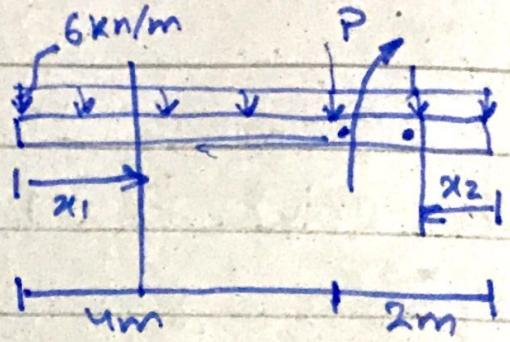
$\Sigma M_A = 0$ ↻ +

$1 + R_2(6) = 0$

$\Rightarrow 0.16667$ put in ①

$R_1 + (0.1667) = 0$

$R_1 = 0.16667$ KN



(b)

$R_1 + R_2 = 1$

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

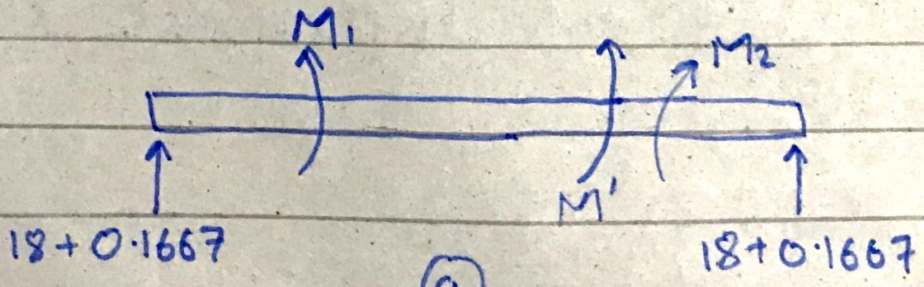
$R_1 = 0.6667$ KN

$R_2 = 1 - 0.6667$ KN

$R_2 = 0.333$ KN

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

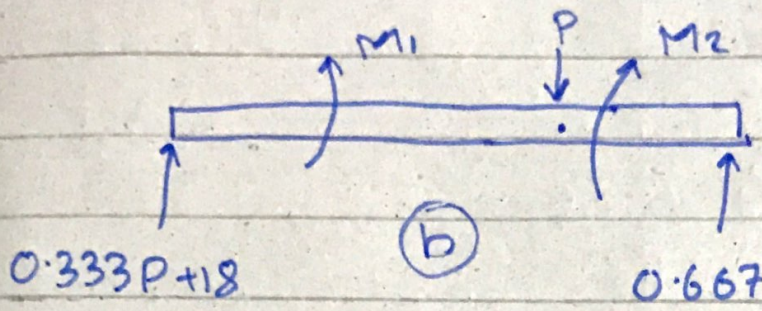
$M_2 = (18 - 0.1667\,M')x_2 - 2x_2^2$



(a)

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

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



The displacement function shown in the figure 'a' above

$$\frac{\partial M_1}{\partial M'} = 0.1667x_1 \quad \text{and} \quad \frac{\partial M_2}{\partial M'} = 0.1667x_2$$

Set $M' = 0$ then

$$\rightarrow M_1 = (18 + 0.1667(0))x_1 - 2x_1^2$$
$$\rightarrow M_1 = (18x_1 - 2x_1^2)$$
$$M_2 = (18x_2 - 2x_2^2)$$

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

$$= \int_0^{4'} \frac{(18x_1 - 2x_1^2)(0.1667x_1)}{Ei}\,dx_1 +$$

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

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

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

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

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

For the displacement function are shown in frgure' b'

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

also $P = 0$

then

$M_1 = (18x_1 - 2x_1^2)\,kN\text{-}m$

$M_2 = (18x_2 - 2x_2^2)\,kN\text{-}m$

thus

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

$$\Delta_B = \int_0^4 \frac{(30x x_1 - 2x_1^2)(0.333x_1)\,dx}{E_1} + \int_0^2 (30x$$

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

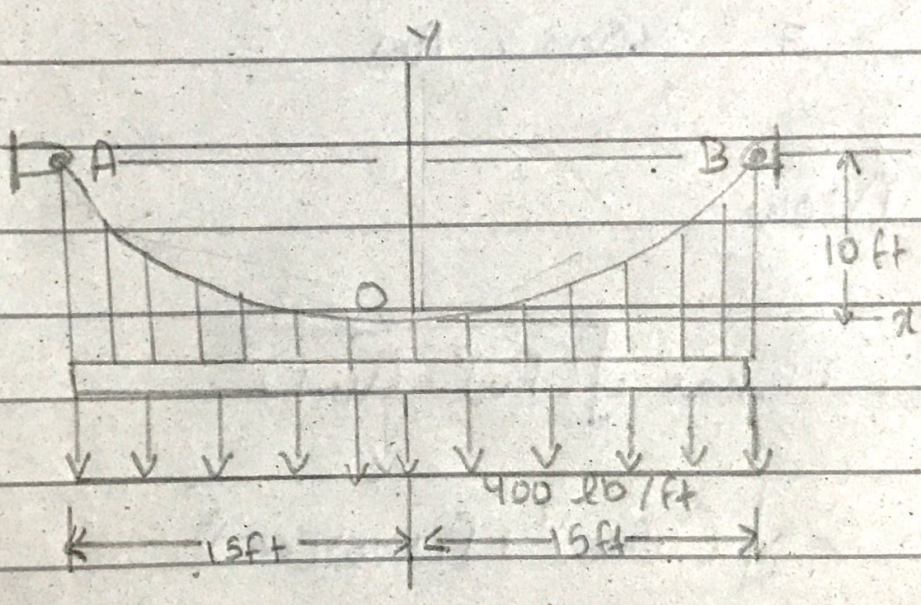
$$\Delta B = \frac{218.5}{EI}$$

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

$$= \boxed{0.018\,m \text{ or } 18\,mm}$$

Qno 3

The cable is subjected to the uniform loading. If the slope of the cable at point O is zero, determine the Equation of curve and the force in the cable at O and B



=> Required (i) Eq of curve ?
(ii) Force at O and B ?

=> Solution :-

$$Y = \frac{h}{L^2} x^2 = \frac{8}{(15)^2} \times x^2$$

$$\boxed{Y = 0.0356\, x^2}$$

Now we know that

$$T_O = f_B = \frac{W_o L^2}{2h}$$

$$= \frac{(400)(15)^2}{2(10)}$$

$$= 4500 \text{ lb}$$

$$= 4.500 \text{ k Ans}$$

Now

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

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

$$= 7500 \text{ lb}$$

$$= \boxed{7.5 \text{ k}}$$

Now

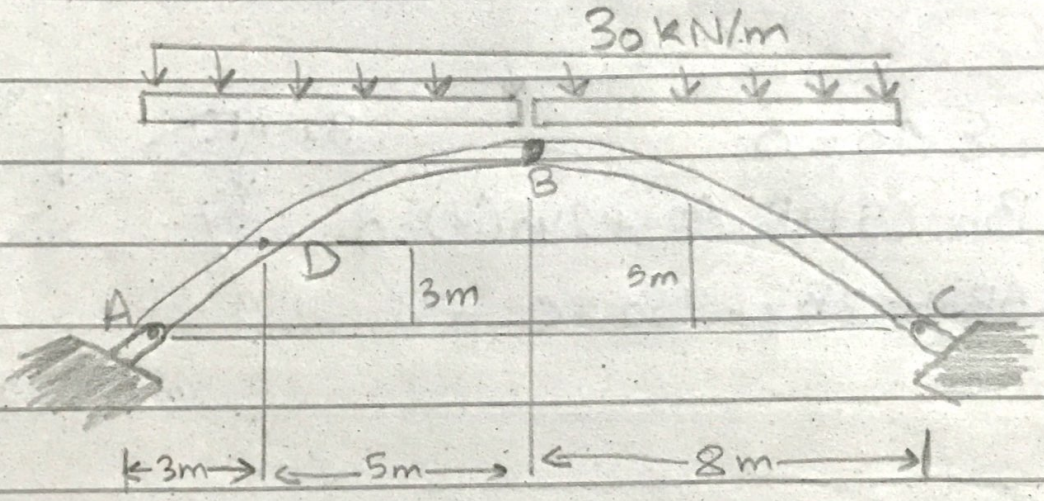
$$T_B = T_{max} = W_o L \sqrt{1 + \left(\frac{L}{2h}\right)^2}$$

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

$$= 7500\ lb = \boxed{7.5\ k\ Ang}$$

Qno 4

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

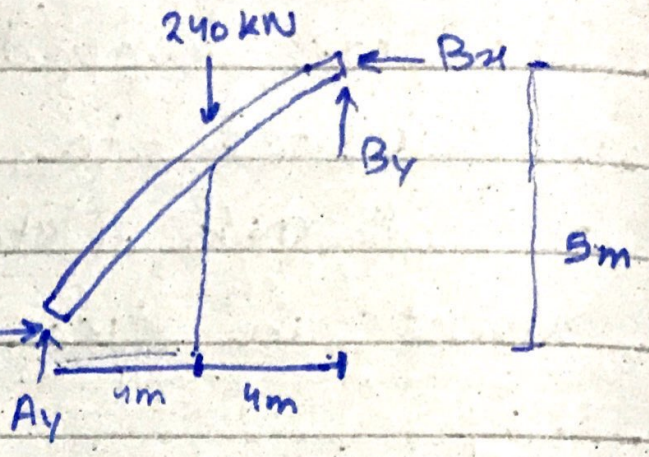


Required:-

Internal moment in the arch at point D ?

Solution:-

Member AB:

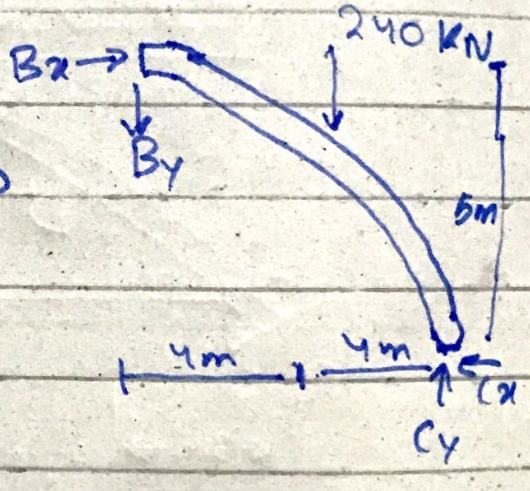


$\zeta^+ \Sigma M_A = 0$

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

$\Rightarrow 5B_x + 8B_y - 960 = 0$ (A)

Member BC



$\zeta^+ \Sigma M_O = 0$

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

$\Rightarrow -5B_x + 8B_y + 960 = 0$ — B

Solving Eq A and B for B_x & B_y

$$5B_x + 8B_y - 960 = 0$$
$$-5B_x + 8B_y + 960 = 0$$
$$16B_y = 0$$

$$B_y = 0$$

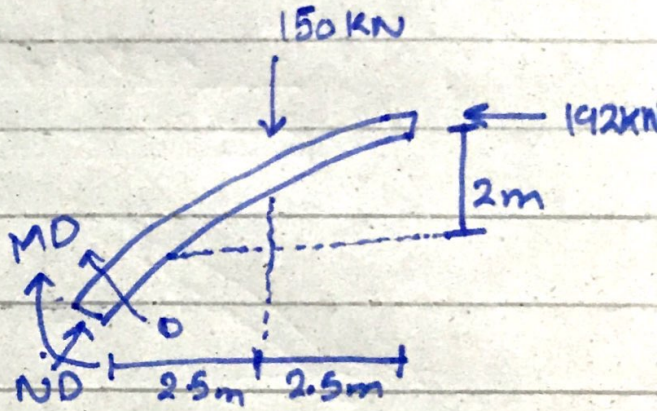
Putting Value in Eq A

$$5B_x + 8(0) - 960 = 0$$

$$5B_x = 960$$

$$\boxed{B_x = 192\ KN}$$

Segment DB



C_D $\Sigma M_D = 0$

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

$$\Rightarrow 384 - 375 = M_D$$

$$\boxed{M_D = 9\ KN\text{-}m}$$

Internal moment at "D"