UMAR HADI

ID # 7974

Section # B

Subject # Structural Analysis-I

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Date # 26-06-2020

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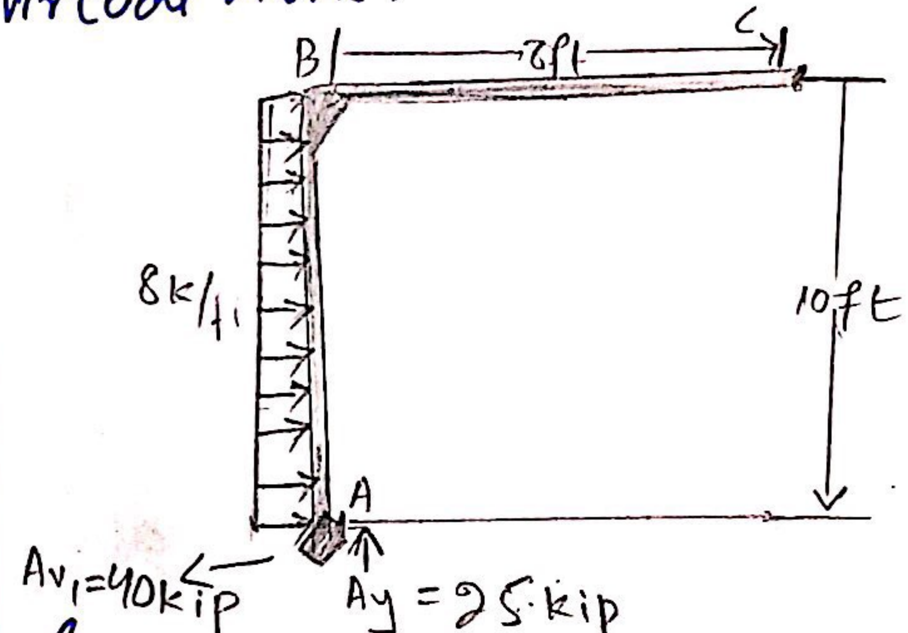
QUESTION # 02

Determine the vertical displacement of free end point C on the frame shown in figure Take $E = 29(10^3)$ ksi .... Use Method of Virtual Work.



Solution :-

Given Data :→

$\Delta y = ?$

$E = 29 \times 10^3$ ksi

$I = 600 \text{ in}^4$

Finding Reaction:

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

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

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$C_y = 25 \text{ kip}$

$\sum F_y = 0 \uparrow^+$

$25 + A_y = 0$

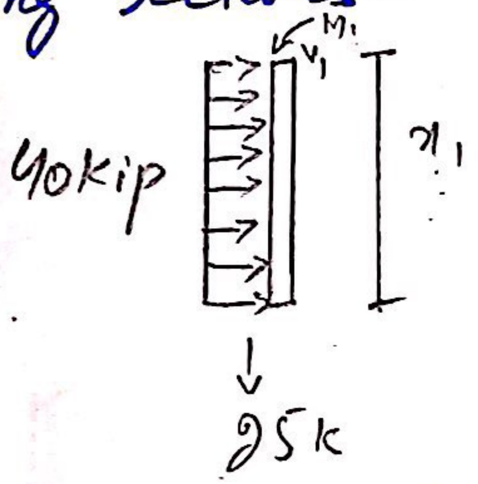
$A_y = -25 \text{ kips}$

$\sum F_x = 0 \rightarrow^+$

$40 - A_x = 0$

$A_x = 40k$

⇒ **Taking Sections-**



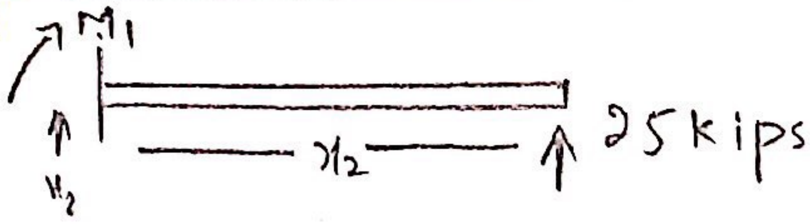
⇒ **Real moment:**

$\circlearrowright^+ \sum M_1 = 0$

$-40(x_1) + 4x_1\left(\frac{x_1}{2}\right) + x_1 = 0$

$M_1 = 40x_1 - 2x_1$

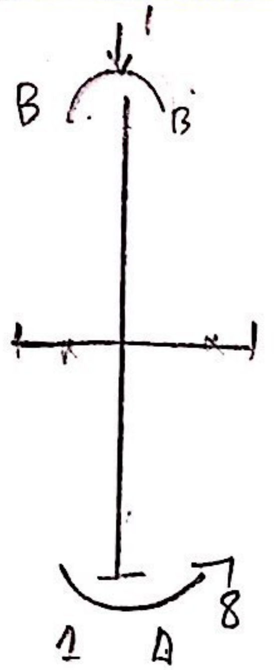
(3)

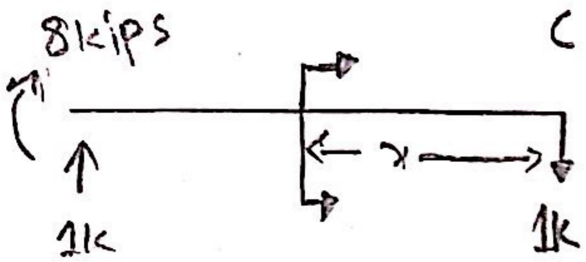


$$-25(x_2)+M_2 = 0$$

$$M_2 = 25x_2 \text{ kips}$$

⇒ **Now Vertical Moments:.**





Members	BA	CB
Origin	B	C
Limit	0-10	0-8
M	$2x^2$	0
m	8	x

(4)

: By vertical work Method:

$$1 \cdot \Delta_1 = \int_0^{10} \frac{(2x^2)(8)}{EI}\,dx + \int_0^{8} \frac{(0)(x)}{EI}$$

$$= \frac{16x^3}{3}\Big|_0^{10} + 0$$

$$= \frac{16 \times 1000}{3} / EI$$

$$= \frac{5333.33}{EI} = \frac{533.33}{29 \times 10^3 \times 600}$$

$$\boxed{1 \cdot \Delta_1 = 3.06 \times 10^{-4} \text{ in}}$$

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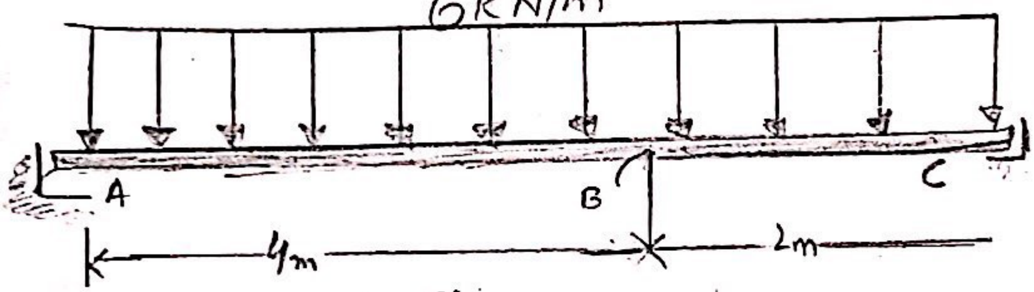
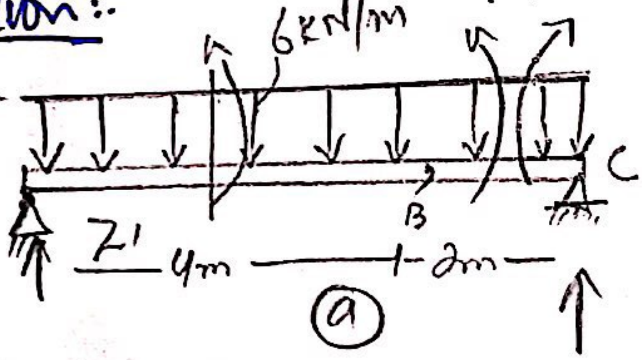
QUESTION #03

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 castigliono's Theorum.



a

Solution:



(a)

18 KN + 0.1667

18 − 0.1667

$R_1 + R_2 = 0$

$\sum M_A = 0$ ↻+

$1 + R_2(6) = 0$

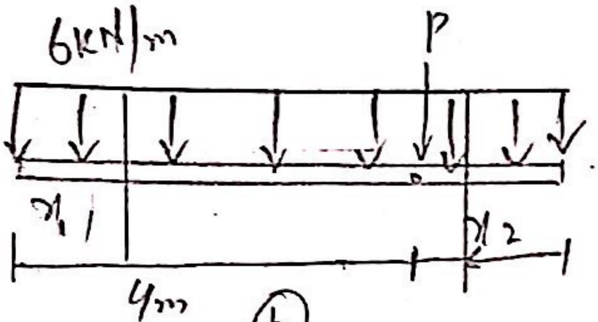
$\Rightarrow -0.16667$ Put in ①

(6)

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

$$R_1 \mp (0.1667) = 0$$

$$R_1 = 0.16667\,kN$$



(b)

$$R_1 + R_2 = 1$$

$$\circlearrowright + \sum M_A = 0$$

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

$$R_1 = 0.667\,kN$$

$$R_2 = 1 - 0.6667\,kN$$

$$R_2 = 0.333\,kN$$

$$M_1 = (18 + 0.1667M')x_1 - 9x_1^2$$

$$M_2 = (18 - 0.1667M')x_2 - 9x_2^2$$

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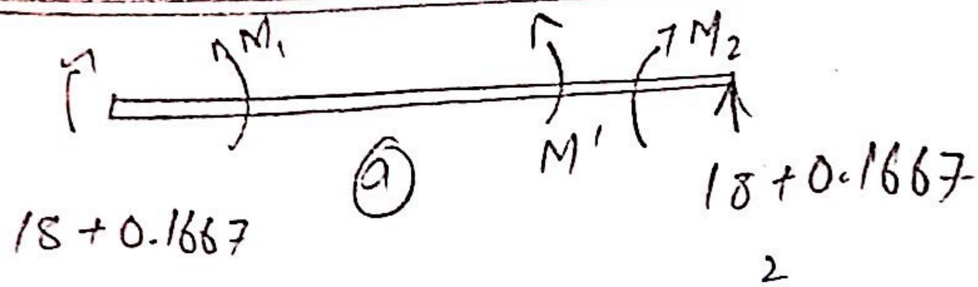
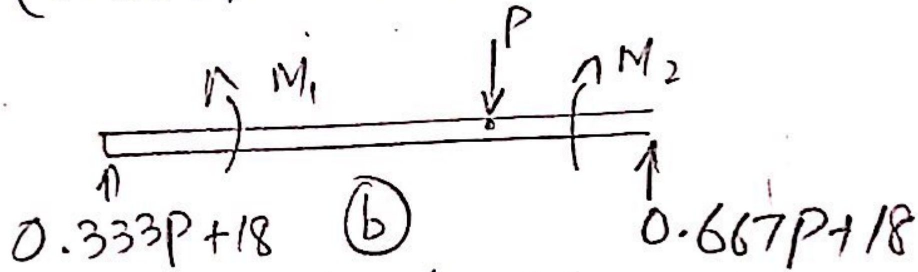


$$M_1 = (0.333P + 18)x_1 - 2x_1^2$$

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



The displacement function shown in the figure "a" above

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

set $M' = 0$. then

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

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

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

$$\theta_B = \int_0^2 M \left(\frac{\partial M}{\partial M_1}\right)\frac{dx}{EI}$$

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

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

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

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

$$\theta_B = \frac{49.31}{(200 \times 10^6\ kPa)(0.00006)}$$

$$\theta_B = 0.441\ \text{rad}$$

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

$$\frac{\partial M_1}{\partial M_p} = 0.333x_1 \quad \text{and} \quad \frac{\partial M_2}{\partial P} = 0.667x_2$$

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(a) also set $p = 0$

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

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

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

$$\Delta_B = \int_0^4 \frac{(30xx_1 - 2x_1^2)(0.333x_1)\,dx}{Ei}$$

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

$$\Delta_B = \frac{218.5}{Ei} \Rightarrow \frac{218.5}{(200 \times 10^6)(0.00006}$$

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

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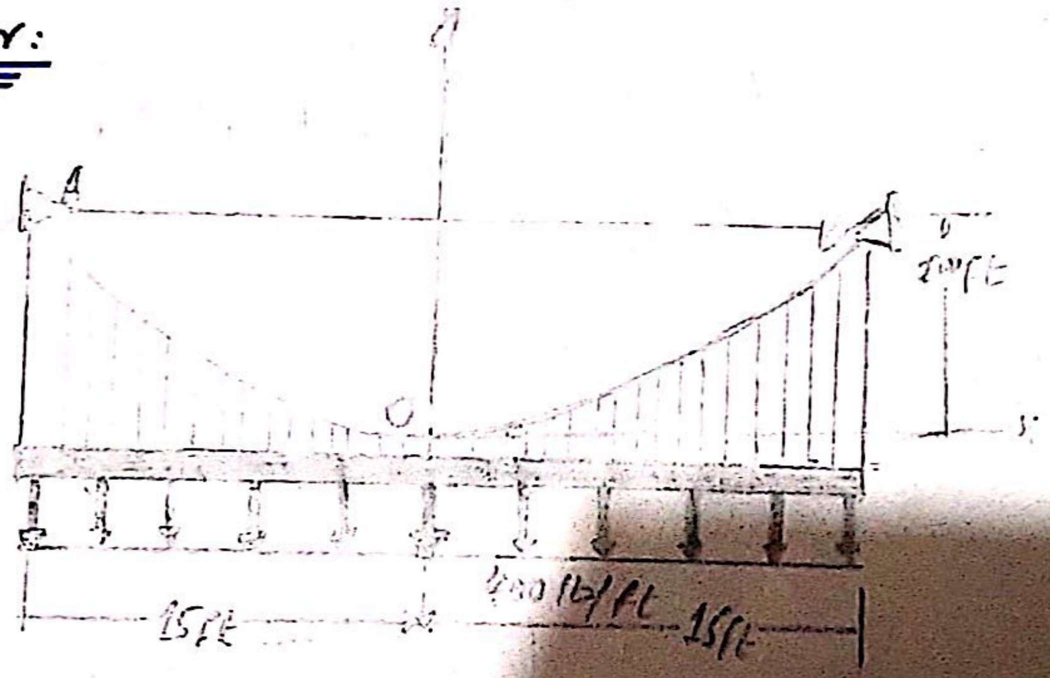
Question # 04:

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

Answer:



⇒ As we know that

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

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

$$y = 0.0444x^2$$

Now

$$T_0 = F_u = \frac{w_0 L^2}{2h}$$

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

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

∴ Divide by 1000

$$T_0 = 4.5K$$

Now

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

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

$$T_{max} = \sqrt{20250000 +}$$

$$T_{max} = 7500 \text{ lb}$$

∴ Divide by 1000

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

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(iv) Also

$$T_B = T_{max} = w_0 L \sqrt{1 + \left(\frac{L}{2h}\right)^2}$$

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

$$= 6000\sqrt{1 + \frac{225}{400}}$$

$$= 6000(1.25)$$

$$= 7500\, lb \quad \therefore \text{Divide by } 1000$$

$$\boxed{T_B = T_{max} = 7.5\, k}$$

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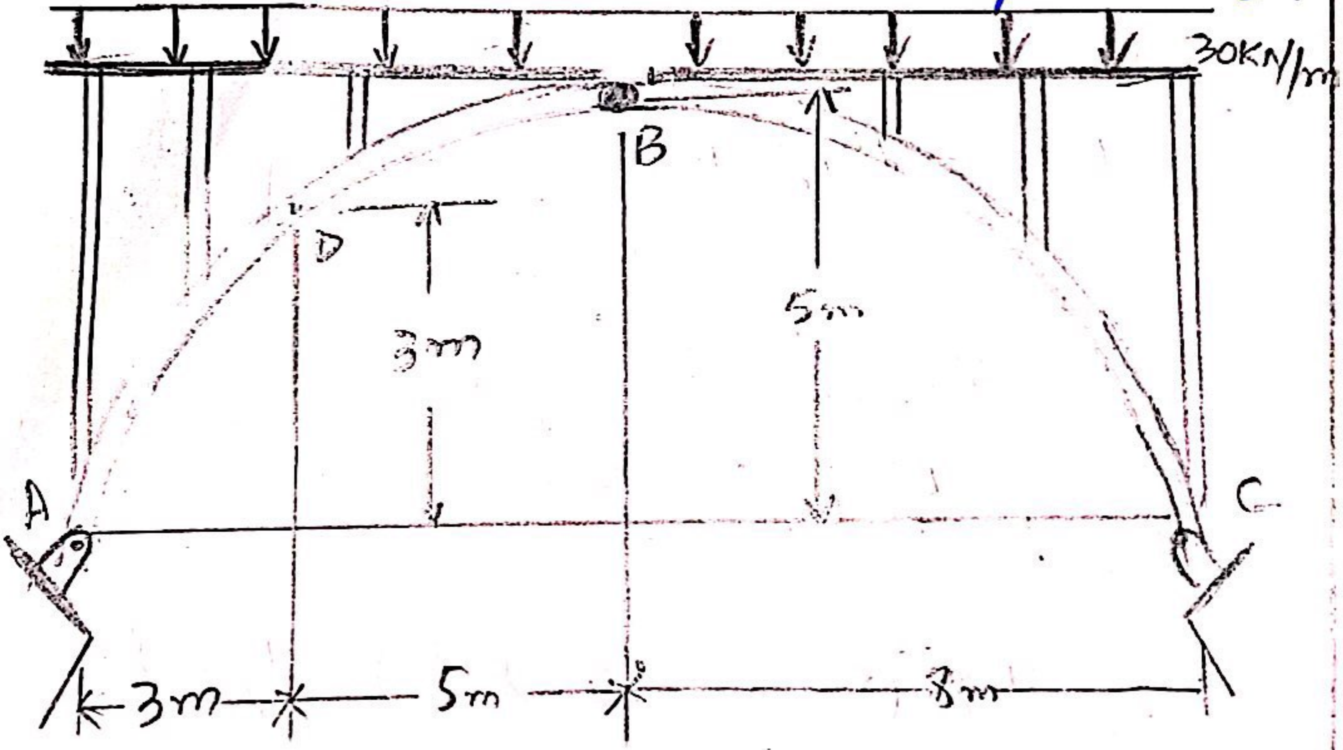
(13) QUESTION # 05

The three-hinged spandrel arch is subjected to the uniform load of 30KN/m. Determine the internal moment in the arch at point D.



Solution :-

Member ~~AB~~ AB.

$$\circlearrowleft + \sum M_A = 0$$

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

(14)

Member BC :-

$\circlearrowleft + \sum M_C = 0$

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

Now

$B_x = 192 \text{ kN} \quad , \quad \therefore B_y = 0$

Segment BD :-

$\circlearrowleft + \sum M_D = 0$

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

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