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Subject: Structure Analysis I

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# FINAL EXAM.

Q3: 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.

## Given Data:-

$W_o$ = Uniform load = 400 lb/ft

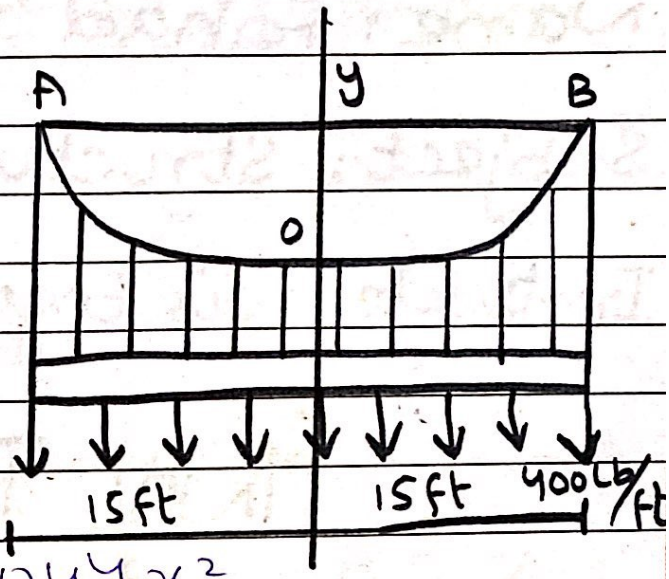
$h$ = 10 ft

$l$ = 15 ft

## Required:

equation of curve and force in cable = ?

# Solution:




We know that

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

Putting the values

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

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

$$T_O = 4500 lbz\ 4.5K.$$

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

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

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

Now "Tmax" By another equation

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

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

$T_{max} = 7500 lb = 75K.$

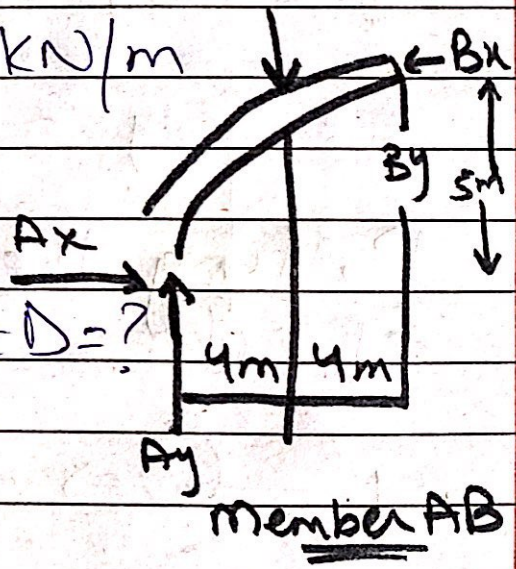
**Q4:** The three-hinged spandrel arch is subjected to the uniform load of 30 KN/m. Determine the internal moment in the arch at point D.

## Given Data:

Uniform load = 30 KN/m

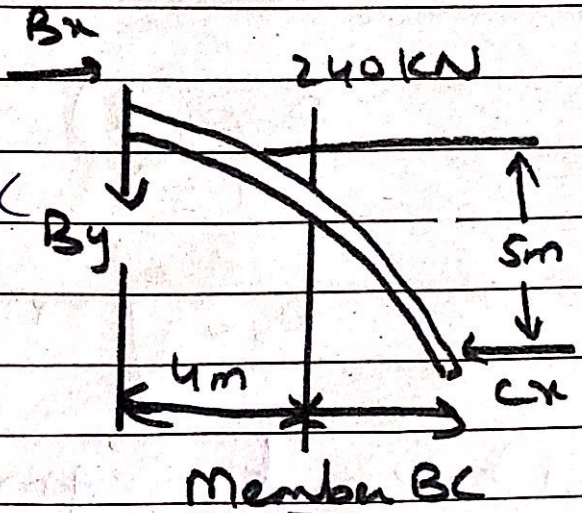
## Required:

Internal moment at D = ?




## Solution:

Dividing into two members AB & BC




AB:-

$+\Sigma M_A = 0 \quad Bx(5) + By(8) - 240(4) = 0$ — (1)

BC :-

$(+\circlearrowleft) \sum M_c = 0 - Bx(5) + By(8) + 240(4) = 0 \rightarrow (b)$

Adding eq (a) and (b)

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

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

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

$2By(8) = 0$

$\Rightarrow By = 0.\ KN$

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

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

$Bx(5) = 960$

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

$Bx = 192\ KN$

"Now at segment DB"

$\circlearrowleft + \sum M_D = 0$

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

$$384 - 375 - M_D = 0$$

$$9 - M_D = 0$$

$$\Rightarrow M_D = 9 \text{ KN.m.}$$

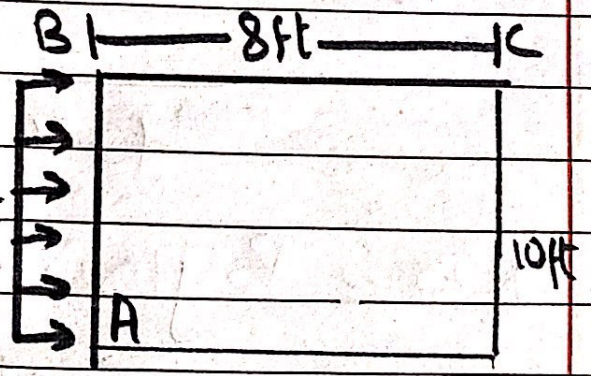
**Q1:** Determine the vertical displacement of free end point C on the frame shown in figure. Take $E = 29 \times 10^3$ Ksi and $I = 600 \text{ in}^4$ for both members. Use method of virtual work.

## Given Data:

Uniform load = 4 K/ft

$E = 29 \times 10^3$ Ksi

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

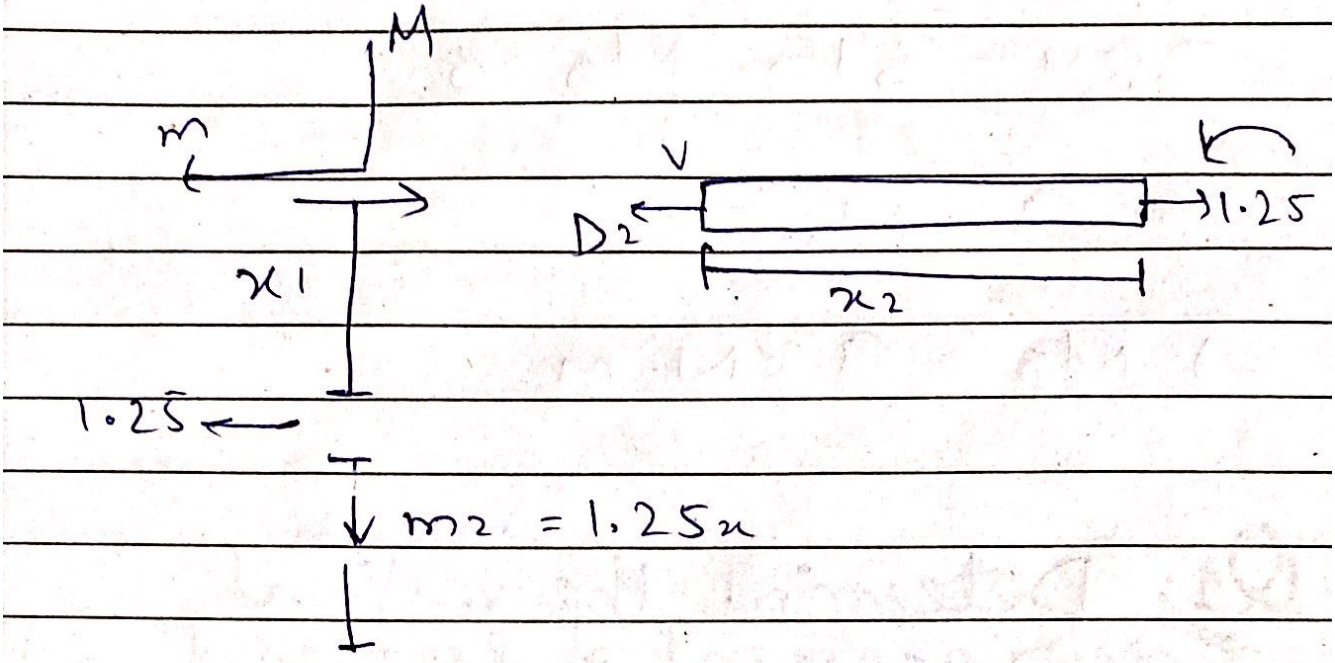



## Required:

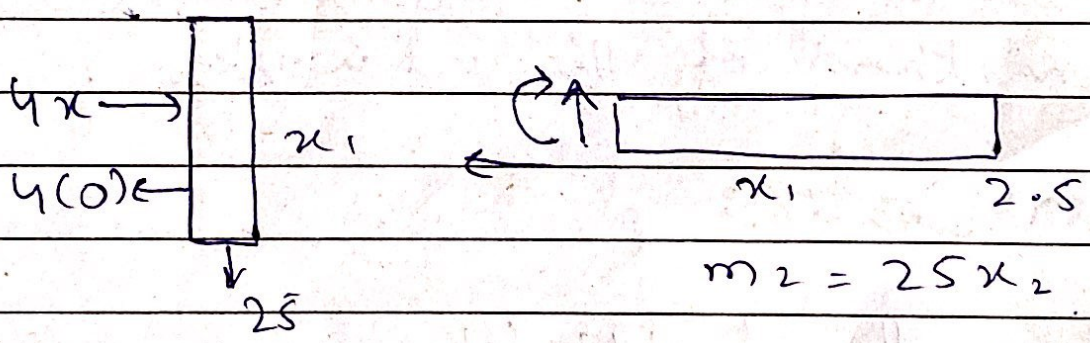
Vertical Displacement.

## Solution:

Now virtual moment.




real moment




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

Now By virtual work equation

$$0.DL = \int_0^L \frac{mM\,dx}{E}$$

$$\Delta L = \int_0^{10} \frac{(1x_1)(40x_2 - 2x^2)}{E} dx + \int_0^{8} \frac{(1.25v_2)(25x2)}{E_1} dx$$

$$\Delta L = \frac{1}{EI}\left| \frac{42x^3}{3} - \frac{2x3}{4} \right|_0^{10} + \int (31.25x^3)_0^{8}$$

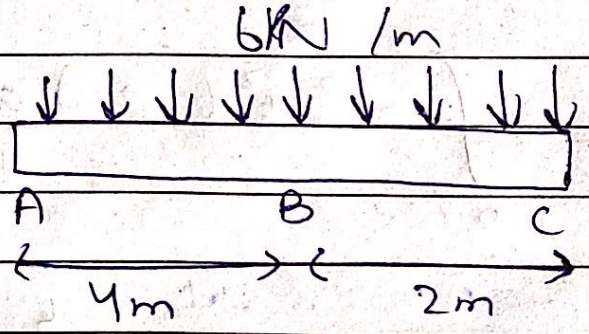
$$\Delta L = 10649.60184$$

**Q2//** 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 Castigliano's Theorem.

## Given Data:

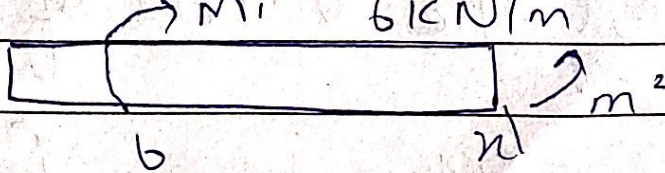
E = 200GPa

I = 60 x 10$^6$ mm$^4$




## Required:-

slope and displacement = ?



$$m' - m^2 = 1/2 (x_2)(6 + x_1)$$

$$m' = m' + \frac{6x_2 + x_2^2}{2}$$

$$m = -m' + 3x^2 + \frac{x_2^2}{2}$$

taking partial derivative with respect to m.

$$\frac{2m_2}{2p} = -x \longrightarrow$$

$$DB = \int_0^2 m \frac{(2m)}{2p} \frac{dv}{E}$$

$$\int_0^6 \frac{-3x^2(-x)\,dx}{EI} + \int_0^4 \frac{-3x^2(-x)\,dx}{EI}$$

$$DB = \frac{-3x^2}{4EI}\Big|_0^6 + \frac{-3x^4}{4EI}\Big|_0^4$$

Put the value of EI and I:

$$\frac{-3x^2}{2(260)(60\times10^6)}\Big|_0^6 + \frac{-3x^4}{(4000)(60\times10^6)}\Big|_0^4$$

$$= \frac{-216\ KN ft^3}{4.8 \times 10^6} + \frac{-614.4 KN \cdot ft^3}{4.8 \times 10^{10}}$$

$$= -4.5 \times 10^{-9} + (-1.28 \times 10^{-8})$$

**DB = $5.76 \times 10^{-10}$ inch displacement.**

**Slope:**

$$m + \frac{1}{2} x(6x_1) = 0$$

$$m = \frac{-1}{2} x (6x_2) = -3x^2$$

So; $\frac{2m_1}{2m_i} = 0$

$$m_1' - m_2 - \frac{1}{2}(x_2)(6+x_2)$$

$$m = -m' + 6x_2 + x^2$$

$$m = -m' + 3x^2 + x^2/2$$

$$\frac{2m^2}{2m_1} = -1$$

$$\int_0^6 \frac{-3x^2 \Delta f x}{E \cdot I} + \int_0^{10} \frac{(-2 + 6x^2 + x^2}{2} dx$$

$$= 0 + \left(\frac{-x + 6x^3 + x^3}{3 \quad 6}\right)\Big|_0^{10} \left(\frac{1}{EI}\right)$$

$$= \frac{1}{200 \times (60 \times 10^6)} \left(\frac{-x + 6x^3 + x^3}{3 \quad 6}\right)\Big|_0^{10}$$

$$\Rightarrow \Phi = 4.125 \times 10^{-7} \text{ inch}$$

Ans.

THE END.