Name:

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GD#

7911

Section:

A

Subject:

Structural Analysis (I)

Date:

26-6-2020

# Answer No 1

**Given:**

Uniform load = 4k/ft

E = 29 x 10³ ksi

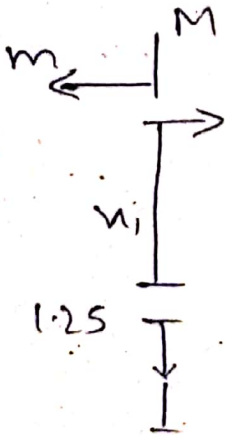
I = 600 in⁴

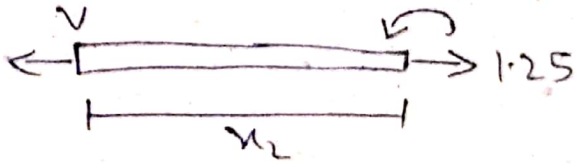
**Required:**

Vertical displacement = ?

**Solution:**

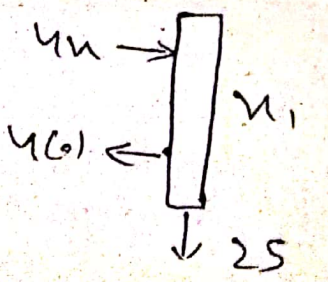
Now virtual moment

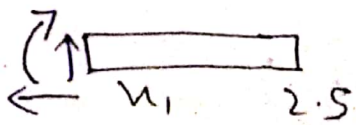



$m_2 = 1.25x$

real moment




$m_2 = 2.5x_1$

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

By virtual work equation

$$\Delta_{DC} = \int_0^L \frac{mM\,dx}{EI}$$

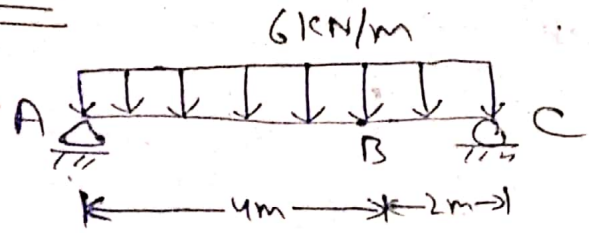
$$\Delta L = \int_0^{10} (1x_1)\frac{(40x_1 - 2x^2)}{EI}dx + \int_0^{8} \frac{(1.25x_2)(25x_2}{EI}dx$$

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

$$\boxed{\Delta L = 10649.6018\,4}$$

# Answer No 2

## Given




## Required:

Slope and displacement =?

## Solution:

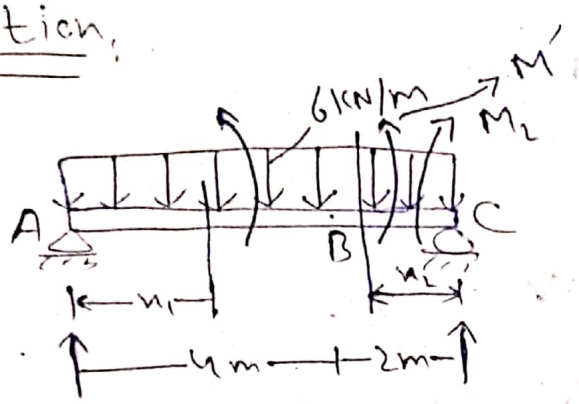



Figure a

18 KN + 0.1667 18 - 0.1667

$$R_1 + R_2 = 0 \quad \text{—} \ (1)$$

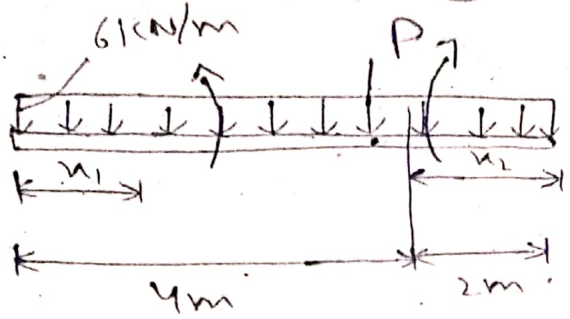
$$\Sigma M_A = 0 \ (\circlearrowright +)$$

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

$\Rightarrow -0.1667$ put in (1)

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

$$\boxed{R_1 = 0.16667 \text{ KN}}$$




$$R_1 + R_2 = 1$$

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

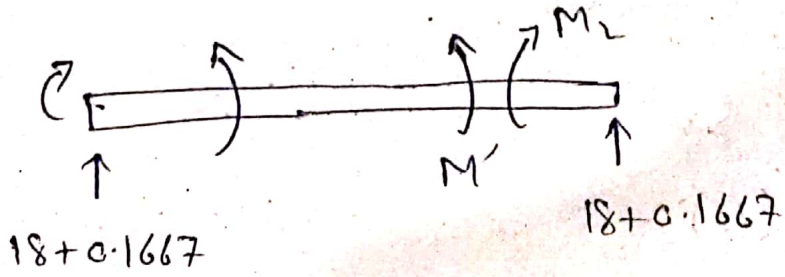
$$-(1)(4) + R_2(6) = 0$$

$$R_2 = 1 - 0.6671 \text{ kN}$$

$$\boxed{R_2 = 0.3331 \text{ kN}}$$

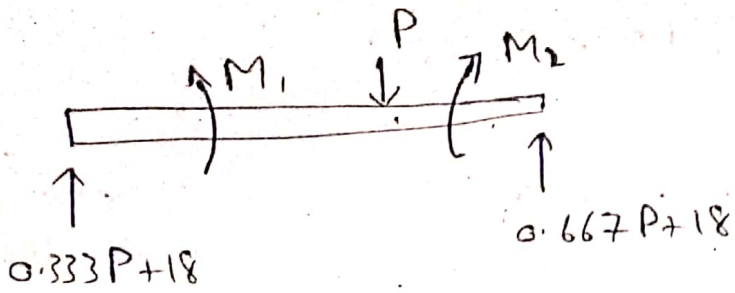
$$M_1 = (18 + 0.1667M')x_1 - 2x_1^2$$

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




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

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




The displacement functions shown in the figure "a" above

$$\frac{\partial M_1}{\partial M'} = 0.16667x_1 \text{ and } \frac{\partial M_2}{\partial M'} = 0.1667x_2$$

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

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

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

$$\theta_B = \int_0^2 M\left(\frac{\partial M}{\partial M'}\right)\frac{dx}{EI} = \int_0^4 \frac{(18x_1 - 2x_1^2)(0.1667x_1)\,dx_1}{EI}$$

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

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

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

$$\theta_B = \frac{49.31}{(200\times10^6\,kPa)(0.0006)}$$

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

For displacement functions are shown in fig (b)

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

Also put $P = 0$

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

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

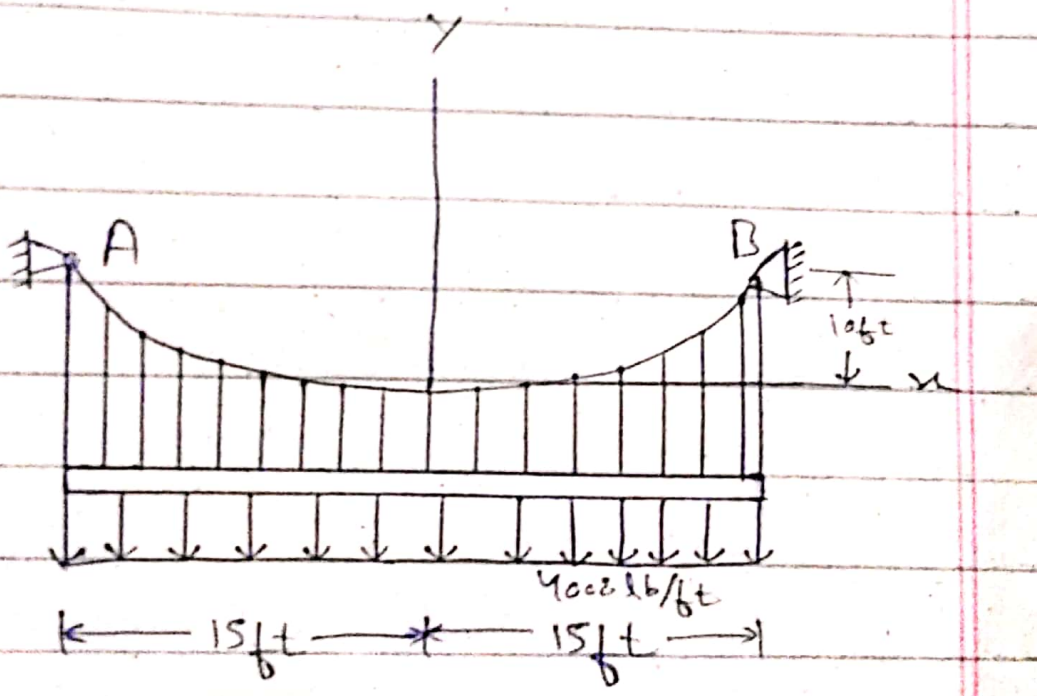
$$\Delta_D = \int_0^L M\left(\frac{\partial M}{\partial P}\right)\frac{dx}{EI}$$

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

$$\Delta_B = \frac{218.5}{EI} = \frac{218.5}{(200\times10^6)(0.0006)}$$

$$\boxed{\Delta_B = 0.018\ m}$$

Q3 The cable is subjected to the uniform loading. If the slope of the cable at point O is zero. Determine the equations of the curve and force in the cable at O and B



# Answer 3

Given

$w$ = 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

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

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

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

$$T_b = T_{max} = \sqrt{(F_H)^2 + (WL)^2}$$

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

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

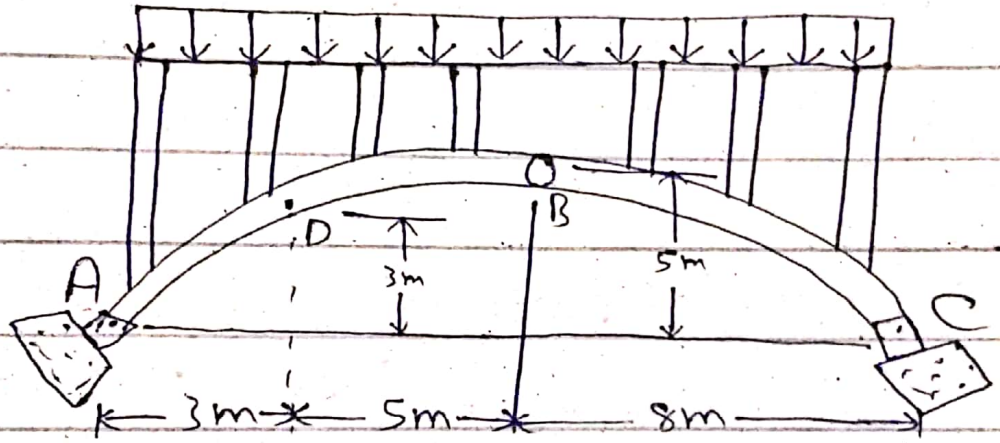
Now $T_{max}$ by another equation

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

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

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

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



# Answer No 4

Given:

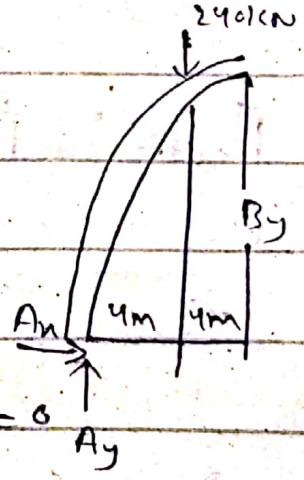
Uniform load = 30 kN/m

Required:

Internal moment at D = ?

Solution:

Dividing into two members AB and BC




**AB**

$\circlearrowleft + \Sigma M_A = 0$

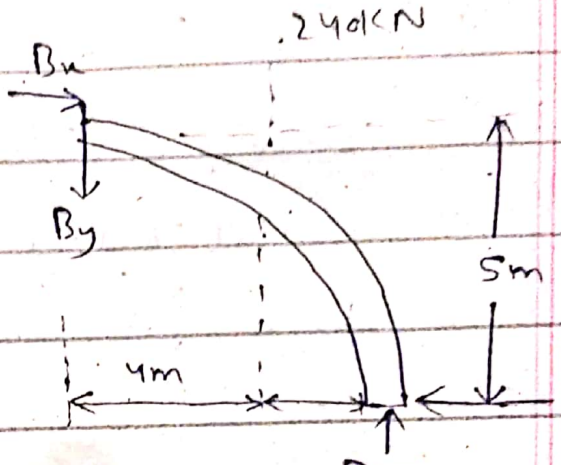
$B_x(5) + B_y(8) - 240(4) = 0$ ← (A)

Member AB

BC:

$\circlearrowleft + \Sigma M_c = 0$

$-B_x(5) + B_y(8) + 240(4) = 0$ — (B)




Adding eq (A) and (B)

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

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

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

$2B_y(8) = 0$

$\Rightarrow B_y = 0$ kN

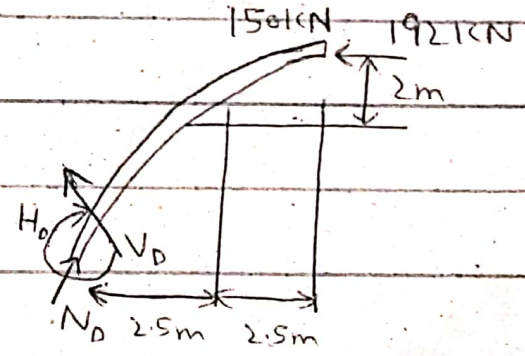
Putting the value of $B_y$ in eq (B)

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

$$B_x(5) = 960$$

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

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




Member DB

At segment DB

$$\left(+\right. \Sigma M_D = 0$$

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

$$384 - 375 - M_D = 0$$

$$9 - M_D = 0 \Rightarrow M_D = 9\text{KNm}$$