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Section A

Subject Structural Analysis-1

Date 26/06/2020

# Question No 1

Sol:-

Given data:-

$E = 29000\ ksi = 29(10^3)$

$I = 600\ in^4$

Required data:-

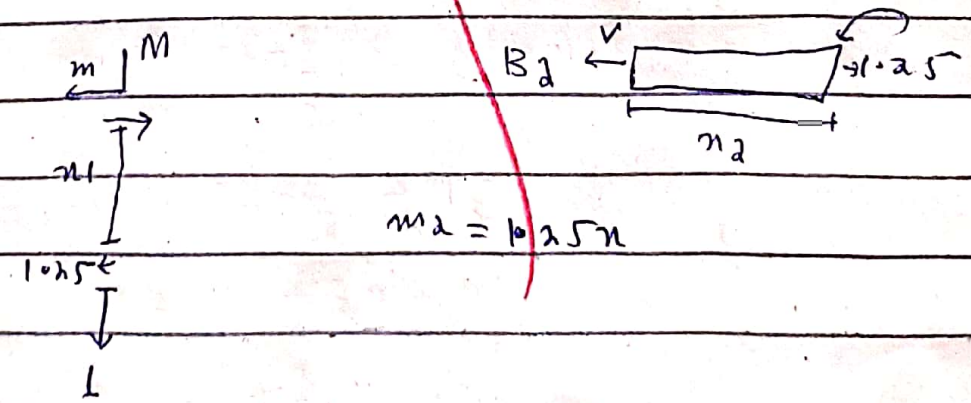
Vertical displaced = ?

Sol:-

As we know that

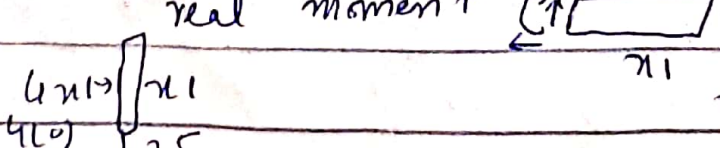
$$1 \cdot \Delta = \sum \int \frac{M\,M}{EI}\,de + \int \frac{K\,N\,V}{G \cdot A}\,de + \int \frac{n\,N\,dl}{AE} + \int \frac{E\,I}{dG \cdot J}\,de$$

Now Vertual displacement




$m_2 = 1.25x$

real moment




$m_2 = 25\ x_2$

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

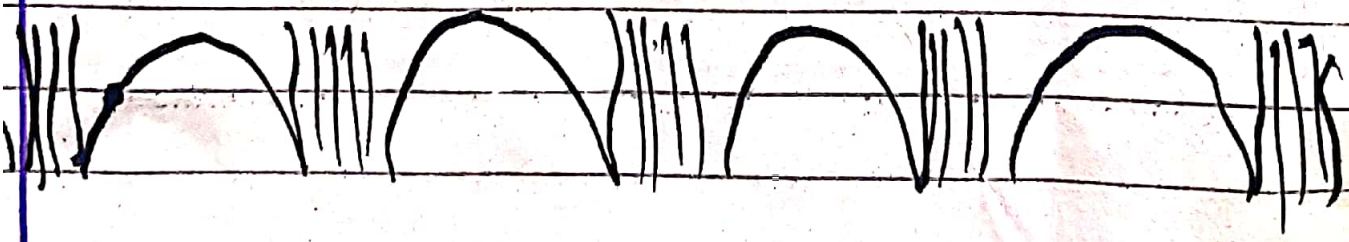
Now By virtual work equation

$$\Delta DL = \int_0^L \frac{m M dx}{\xi}$$

$$\Delta L = \int_0^{10} (1x_1)\left(\frac{40x_2 - 2x_2^2}{q}\right) dx + \int_0^8 \left(\frac{1.25x_2)(25x_2)}{E_1}\right) dx$$

$$\Delta L = \frac{1}{EI}\left| \frac{42x^3}{3} - \frac{2x^3}{4} \right|_0^{10} + \left| \frac{3.125x^3}{3} \right|_0^8$$

$$\boxed{\Delta L = 10649.60184}$$ Ans



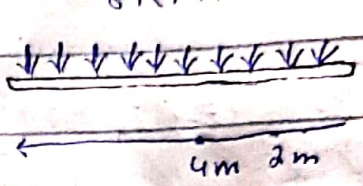
## Question No 2

Sol:-

Given data

$E = 200\ GPa$

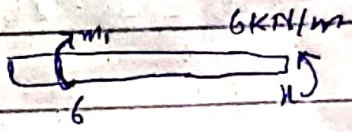
$I = 60 \times 10^6\ mm^4$




Required:-

slope and displacement = ?

As we know that




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

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

$$m = m' + 3x^2 + x_1^2/2$$

taking potential derivative with respect to m.

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

$$DB = \int \frac{m(2m)}{dp}\frac{dl}{E}$$

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

$$DB = \frac{-3x^2}{4EI_0}\Big|_0^6 + \frac{-3x^4}{4EI}\Big|_0^4$$

Put the value of EI and I

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

$$DB = \frac{-216\ KN ft^3}{4.8\times10^6} + \frac{-614.4\ Kft^3}{4.8\times10^{10}}$$

$$DB = -4.5\times10^{-9} + (1.28\times10^{-8})$$

$$\Rightarrow DB = 5.76\times10^{-9}\ inch \quad \text{displacement.}$$

Slope:-

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

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

So, $\frac{2m_1}{2m_1} = 0$

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

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

$$m = m' + 3x^2 + x^2 1/2$$

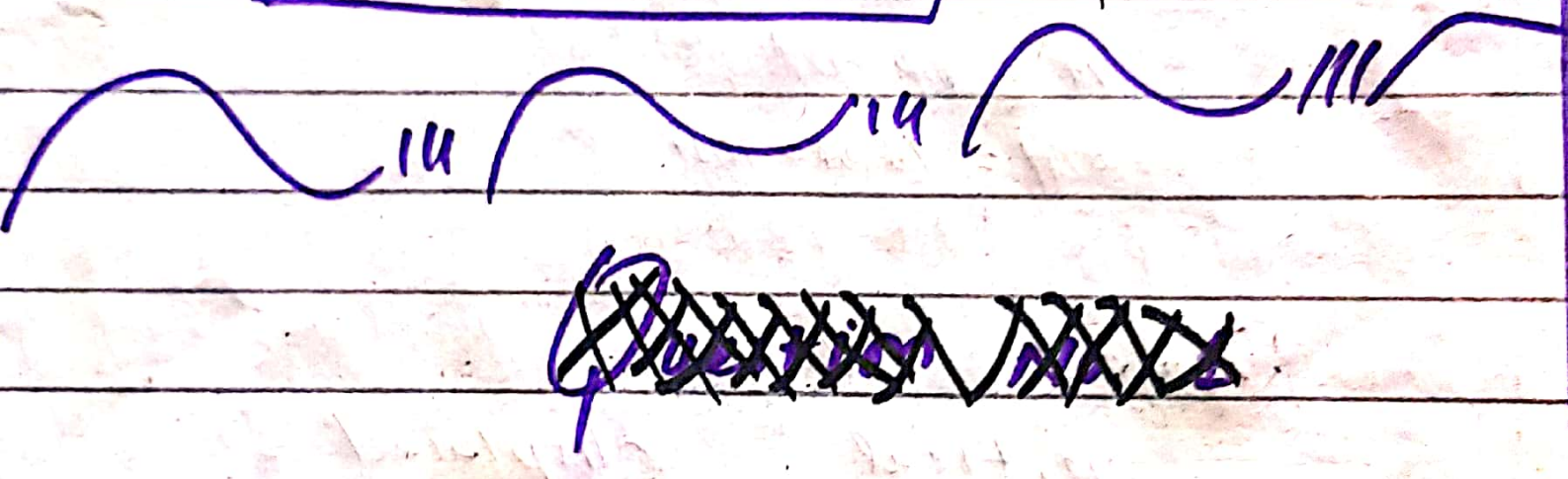
$$\frac{2m_2}{2m_1} = -1$$

$$= \int_0^6 -3x^2\,dx + \int_0^{10}\left(-2 + 6x^2 + \frac{x^2}{2}\right)dx$$

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

$$= \frac{1}{200(60\times10^6)} \left(-x + \frac{6x^3}{3} + \frac{x^3}{6}\right)\Big|_0$$

$$\Rightarrow \boxed{Q = 4.125 \times 10^{-7} \text{ rad}} \quad \text{Slope}$$



## Question no # 3

ANSWER:-

1 -: Solution:

**Given data:-**

$\omega_o$ = uniform load = 400 Lb/ft

h = 10 ft

L = 15 ft

**Required data:-**

Equation of curve and force in Cable = ?

**Solution:-**

As we know that

From equation 5-9

$$y = \frac{h}{L^2} x^2 \rightarrow (1)$$

putting value

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

$$y = 0.046 x^2$$

⇒ From equation 5-8

$$T_0 = FH = \frac{w_0 l^2}{2h}$$

putting value

$$\Rightarrow \frac{400(15)^2}{2(10)} \Rightarrow 4500 \text{ Lb} = \boxed{4.5K} \quad \because \frac{4500}{1000} = 4.5$$

⇒ From equation 5-10

$$T_B = T_{maxi} = \sqrt{(FH)^2 + (w_0 l)^2}$$

putting value.

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

$$\Rightarrow 7500 \text{ Lb} = \boxed{7.5K}$$

⇒ From Equation 5-11

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

putting value

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

$$\Rightarrow 7500 \text{ Lb} = 7.5K.$$

# Question No 4

## ANSWER:-

## Solution:-

**Given data:-**

uniform load = 30 KN/m

**Required data:-**

Internal movement: at D=?

**Solution:-**

As we know that

Dividing into two members AB and BC

AB

$\hookrightarrow + \Sigma M_A = 0 \quad B_x(5) + B_y(8) - 240(4) = 0 \rightarrow (a)$

BC

$\hookrightarrow + \Sigma M_C = 0 \quad -B_x(5) + B_y(8) + 240(4) = 0 \rightarrow (b)$

Adding equ (a) and (b)

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

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

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

$$\Sigma B_y(8) = 0$$

$$\Rightarrow \quad B_y = 0 \cdot KN$$

putting the value of "By" in eq (b)

$$\text{eq(b)} \Rightarrow -B_x(5) + 0(8) + 960 = 0$$

$$B_x(5) = 960$$

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

$$B_x = 192\,KN$$

Now at segment "DB"

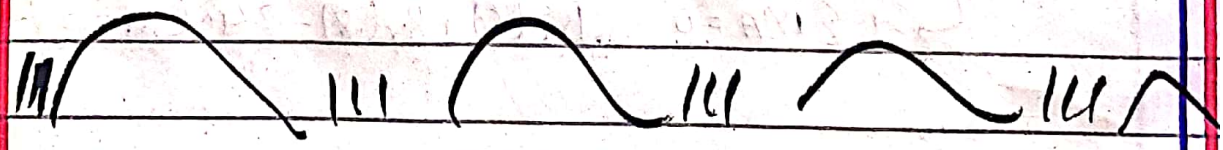
$$C_1 + \Sigma M_D = 0$$

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

$$384 - 375 - M_D = 0$$

$$9 - M_D = 0$$

$$\Rightarrow M_D = 9\,KN \cdot m$$



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