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Section:- B

Subject:- Structural analysis

Semester:- 4th

Q1:

Given data

Uniform load = 4k/ft

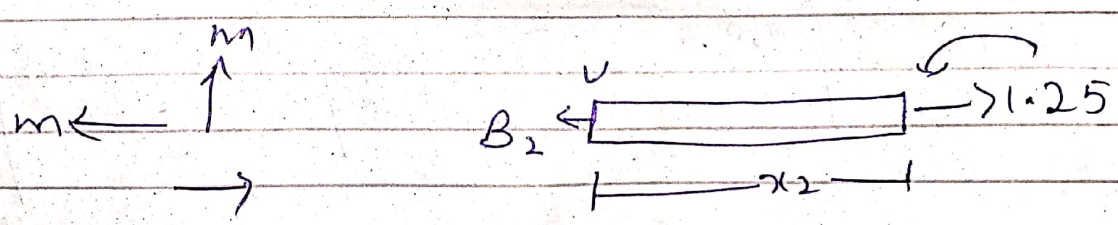
$E = 29 \times 10^3$ ksi

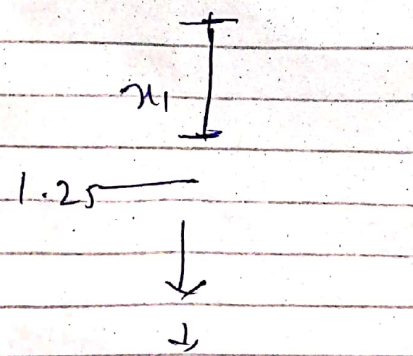
$I = 600\ in^4$

Required = Vertical displacement

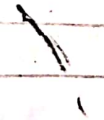
Solution:-

Now vertical movement





$m_2 = 1.25x$



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

Now By virtual work equation

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

$$\Delta L = \int_0^{10} (1x_1)\frac{(40x_2 - 2x^2)}{\xi} dx + \int_0^3 \frac{(1.25\frac{x_2}{2})(2.5\frac{x_2}{2})dx}{EI}$$

$$\Delta L = \frac{8333.3}{EI} + \frac{5333.3}{EI} + \frac{13666.7\ k\,ft^3}{EI}$$

$$\int m M dx = \frac{5}{12}(10)(200)(10) + \frac{1}{3}(10)(200)(8)$$

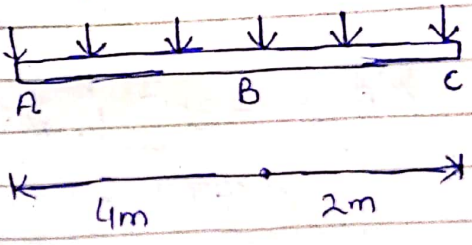
$$= 8333.3 + 5333.3 = 13666.7\ k^2/ft^3$$

$$\Delta C_1 = \frac{13666.7\ k\,ft^3}{[29(10^3)\ k/in^2(12)^2 in^2/ft^2][600 in^4/12^4 in^2]}$$

$$= 0.113\ ft = 1.3\ in$$

Q:- 2

Given that:-



$E = 200 Gpa$

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

Required:-

slope and displacement = ?

$$m_1 - m_2 = \frac{1}{2}(x_2)(6 + x_1)$$

$$m_1 = m' + \frac{6x_2 + x_1^2}{2}$$

$$m = -m' + 3x^2 + \frac{x_1^2}{2}$$

taking partial derivative w.r.t m

$$\frac{\partial m_2}{\partial P} = -x$$

$$\Delta B = \int_0^2 \frac{m(2m)}{2P} \frac{dv}{E}$$

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

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

putt the values of EI and I

$$\frac{-3x^2}{2(200 \times 60 \times 10^6)}\Big|_0^6 + \frac{-3x^4}{4(200)(60\times 10^6)}\Big|_0^4$$

$$= \frac{-216\ kN\,ft^3}{4.8N60} + \frac{-614\ kN\,ft^3}{4.8\times 10^{\circ}}$$

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

$$\boxed{\Delta B = 5.76\times 10^{-10}\ inch}$$

Displacement

Now Slope:-

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

$$m = -\frac{1}{2} x_1 (6x_1) = 3x^2.$$

$$\text{So} \quad \frac{2m_1}{2m_1} = 0$$

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

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

$$m = -m' + 3x^2 + x_2^2$$

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

$$= \int_0^6 -\frac{3x^2(4x)}{E \cdot I} + \int_0^{10} \left(-2 + 6x^2 + \frac{x^2}{2}\right) dx$$

$$= 0 + \left(-x + \frac{6x^3}{3} + \frac{x^3}{6}\right)\Bigg|_0^{10} \left(\frac{1}{E_I}\right).$$

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

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

Q3:-

Given data

Uniform load = 400 lb/ft

$h = 10$ ft

$L = 15$ ft

Required:- equation of corve and force in cable = ?

Solve:- we know that

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

Puting values

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

$$T_o = FH = \frac{w_o L^2}{2h} = \frac{400 \times (15)^2}{2 \times 10}$$

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

$$T_B = T_{max} = \sqrt{(FH)^2 + (hbL)^2} \Rightarrow \sqrt{(4500)^2 + (400 \times 15)^2}$$

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

By another eq:- $w_o L \sqrt{1 + \left(\frac{L}{2h}\right)} = 400 \times 15 \sqrt{1 + \left(\frac{15}{2000}\right)^2}$

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

Q4:-

Solve:-

Given data

Uniform load = 30 kN/m

Required:-

Internal moment at D=?

Solution:-

Dividing into two members

AB and BC

AB =>

$$\left(\circlearrowright + \Sigma M_A = 0 \quad Bx(5) + By(8) - 240(4) = 0 \right) \text{—(A)}$$

BC :- $\left(\circlearrowright + \Sigma M_C = 0 \quad -Bx(5) - By(8) - 240(4) = 0 \right) \rightarrow B$

Adding eq Ⓐ and Ⓑ

$$Bx(8) + By(8) - 240(4) = 0$$
$$-Bx(5) + By(8) + 240(4) = 0$$
$$0 + 2By(8) + 0 = 0$$

$$2By(8) = 0$$
$$\Rightarrow By = 0 \text{ kN}$$

Putting the values of "By" in eq Ⓑ

eq Ⓑ

$$\Rightarrow -Bx(5) + 0(8) + 960 = 0$$
$$Bx(5) = 960$$
$$\frac{Bx(5)}{(5)} = \frac{960}{5}$$
$$\boxed{Bx = 192 \text{ kN}}$$

Now at Segment "BD"

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

$$384 - 375 - MD = 0$$

$$9 - MD = 0$$

$$\Rightarrow MD = 9\,\text{Kg.M}$$