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Subject Structure I

Section A

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Question no 1

Given Data

uniform load = $4k/ft$

$E = 29 \times 10^3$ ksi

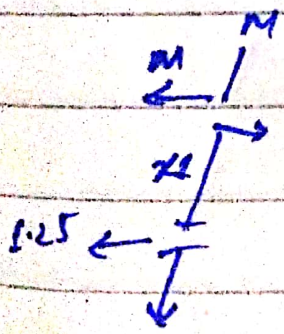
$I = 000 \, in^4$

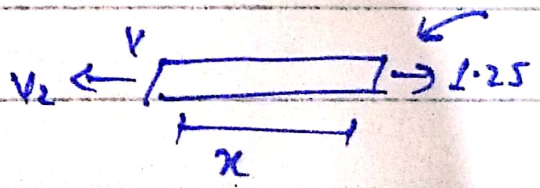
Required

vertical Displacement

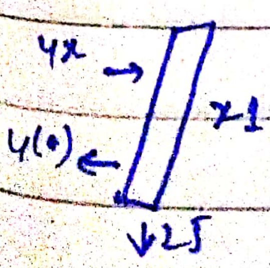
Solution

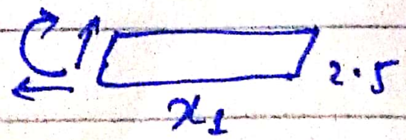
Now vertical moment





$m_2 = 1.25x$





$m_2 = 25x_2$

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

Now By virtual work equation

$$\Delta D^L = \int_0^L \frac{mM\,dx}{E}$$

$$\Delta C = \int_0^{10} (1x_1)\left(\frac{40x_2 - 2x^2}{E}\right)dx + \int_0 \frac{(1 \cdot 25x_2)}{EI}$$

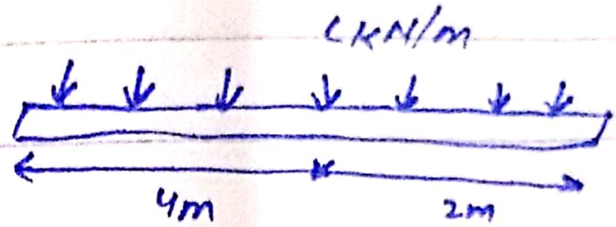
$$\Delta C = \frac{1}{EI}\left|\frac{42x^3}{3} - \frac{2x^3}{4}\right|_0^{10} + \left|\frac{31 \cdot 25\,x^{3/2}}{3}\right|_0^8$$

$$\Delta C = 10649.60184$$

Question No 2

Solution

Given Data



Required

Slope and displacement =?

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

$m' = m - 1 \quad \frac{6x_2 + x_1^2}{2}$ $\quad {}^{1}x$

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

taking partial derivative with respect to m.

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

$$\Delta B \int_0^2 \frac{m\,(\partial m)}{\partial P}\,\frac{dy}{E}$$

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

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

put the value of EI and I.

$$\frac{-3x^2}{2(250)(60\times10^6)}\Big|_0^6 + \frac{-3x^4}{4(250)(60\times10^6}\Big|_0^4$$

$$\frac{-216\,kNH^3}{4.8N6^6} + \frac{-614.4\,kNH^3}{4.8\times10^{10}}$$

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

$$\boxed{\Delta 5 = 5.76\times10^{-10}\ \text{inch}}$$ Displacement

Scanned with CamScanner

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Slope

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

$$m = -1/2 x \; (6x_1) = 3x^2$$

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

$$m_1 - m_2 = 1/2\,(x_1)(6 + x_2)$$

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

$$m = -m^1 + 3x^2 + x_1^2/2$$

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

$$= \int_0^6 \frac{-3x^2 (0)dx}{EI} + \int_0^{10} \left(-2 + 6x^2 + \frac{x^2}{2}\right) dx$$

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

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

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

QNo3

Given data

w_0 = uniform load = 400 lb/ft

h = 10 ft

l = 15 ft

Required

Equation of curve and force cable = ?

Solution

we know that

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

putting the values

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

$$T_0 = F_H = \frac{w_0 l^2}{2h} = \frac{400 \times (15)^2}{2 \times 10}$$

$T_O = 4500 lb = 4.5k$

$T_B = T_{max} \sqrt{(F_H)^2 + (W_{O}l)^2} =$

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

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

Now "T_{max}" By another equation.

$T_B = T_{max} = W_{O}l \sqrt{1 + \left(\frac{L}{2h}\right)^2} = \cancel{400 \times 15 \sqrt{\frac{15}{100}}}$

$= 400 \times 15 \sqrt{\left(1 + \frac{15}{100}\right)^2}$

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

Question No 4

Given Data

uniform Load = 30kN/m

Required

Internal moment at = D = ?

Solution

Dividing in to two members AB and BC

AB

$\circlearrowleft + \Sigma M_c = 0 \quad Bx(5) + By(8) - 240(4) = 0$ (a)

BC = $\circlearrowleft + \Sigma M_c = 0 \quad -Bx(5) + By(8) + 240(4) = 0$ (b)

Addig eq (a) and (b)

$$B_x(\cancel{5}) + B_y(8) - 240(4) = 0$$
$$\underline{-\cancel{B_x}(5) + B_y(8) + 240(4) = 0}$$
$$0 + 2B_y(8) + 0 = 0$$

$$2B_y(8) = 0$$
$$\rightarrow \quad B_y = 0 \cdot kN$$

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

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

$$B_x(5) = 960$$
$$\frac{B_x(5)}{5} = \frac{960}{5}$$
$$\boxed{B_x = 192 kN}$$

"NOW at Segment DB"

$\circlearrowleft + \sum M_B = 0$

$192(3) - 150(2.5) - M_D = 0$

$384 - 375 - M_D = 0$

$9 - M_D = 0$

$\Rightarrow M_D = 9\,kN.m$