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Section :~ A

Semester :~ 4th

Sub :~ Structure Analysis

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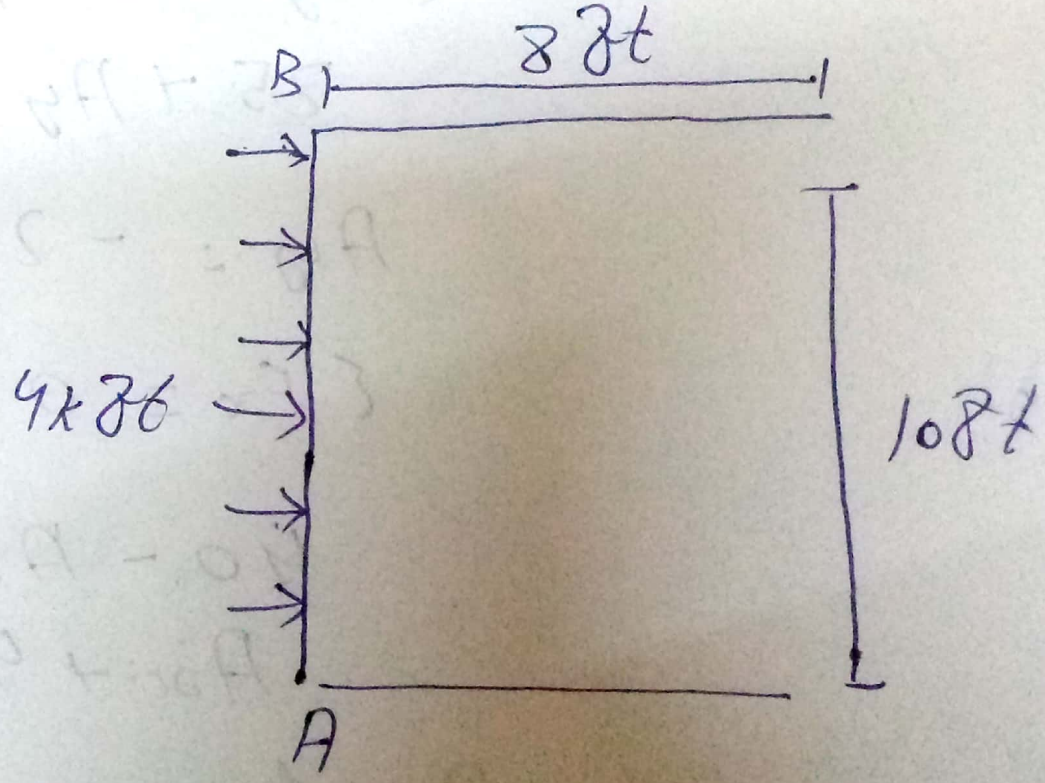
Question No 1

Given data :

$E = 29 (10^3) k/in^2$

$I = 600 in^4$



Req :

Vesticle displacement = ?

Sol :

Now Vertical moment

b)

For reaction:

$\Sigma M_A = 0$

$-4(10)(5) + (y)(8) = 0$

$(y = 25 \text{ kips}$

$\Sigma F_y = 0 \quad \uparrow +$

$25 + A_y = 0$

$A_y = -25 \text{ kip}$

$\Sigma F_x = 0 \rightarrow +$

$40 - A_x = 0$

$A_x = +40$

Real moment:

$\Sigma M_1 = 0$

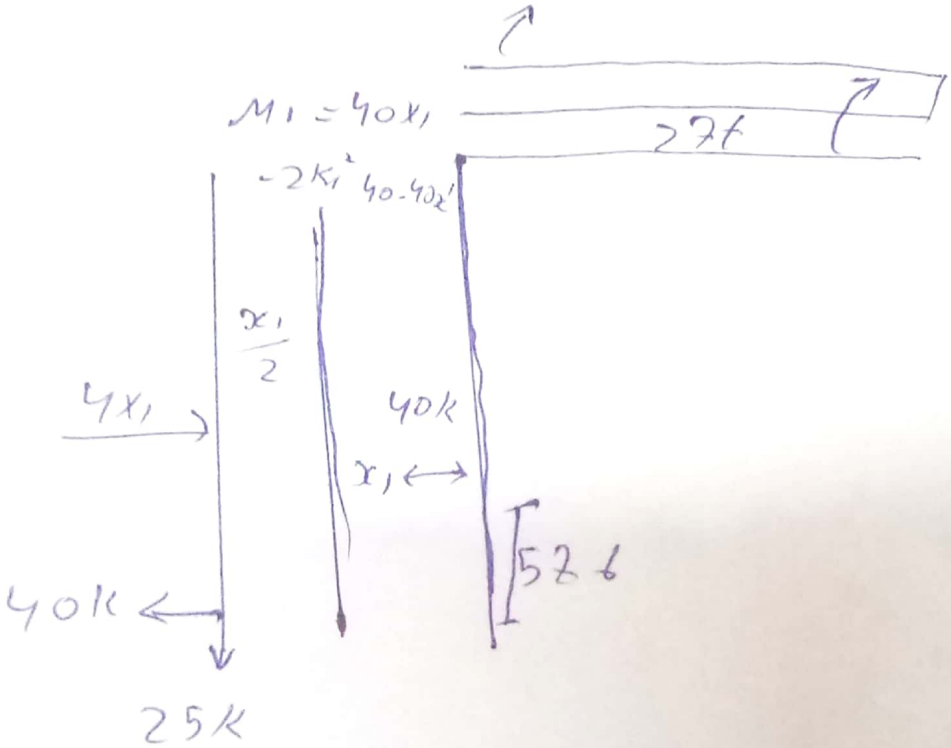
$-40(x_1) + 4\left(\frac{x_1}{2}\right) + M_1 = 0$

$M_1 = 40x_1 - 2x_1^2$

$-25x_2 + M_2 = 0$

$M_2 - 25 \times x_2 = -25$

$M_2 = 25x_2$



Virtual Moments:

$\Sigma m_1 = 0$

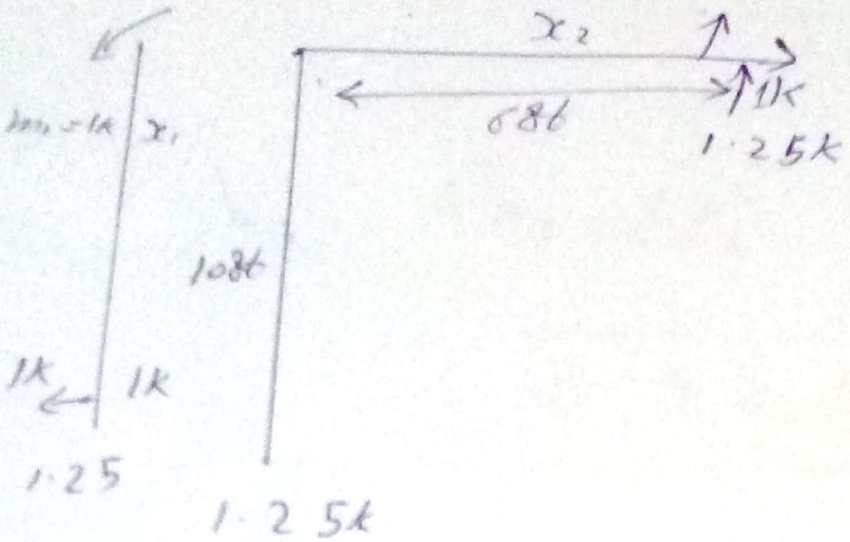
$-1 \ (x_1) + m_1 = 0$

$m_1 = 1x_1$

$-m_2 + 1.25 x x_2 = 0$

$m_2 = 1.25 x_2$

$m_2 = 1.25k$



Now from virtual work eq

$$1k \cdot \Delta ch = \int_0^{w} m \frac{M dx}{EI}$$

$$1k \cdot \Delta c = \int_0^{18} \frac{(40x_1 - 2x_1^2)(1x_1)\,dx}{EI}$$

$$\Delta ch = \frac{8333.3}{EI} + \frac{5333.3}{EI}$$

$$\Delta ch = \frac{13666.2}{EI} k^3 \cdot \delta t^3$$

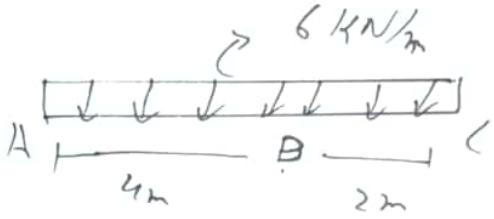
$$\Delta ch = \frac{1366.7 k^2 \delta t (12^3 \cdot 119^3)(18t^3)}{(29 \times 10^6 lb/in^2)(600)}$$

Result

$$\boxed{Dch = 1.357 inch}$$

Question No # 2

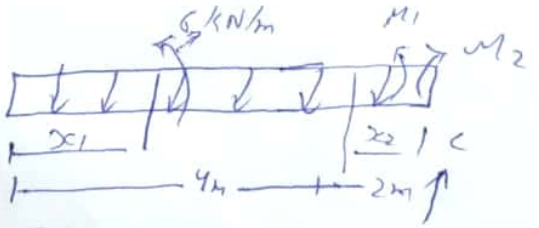
Given data :



Required :

Slope and displacement at point B.

Solution :



18 KN + 0.166 Z 18 - 0.1667

@

$R_1 + R_2 = 0$ —①

$\Sigma M_A = 0$ ↺+

$1 + R_2(6) = 0$

$\Rightarrow -0.1666$ Z Put in ①

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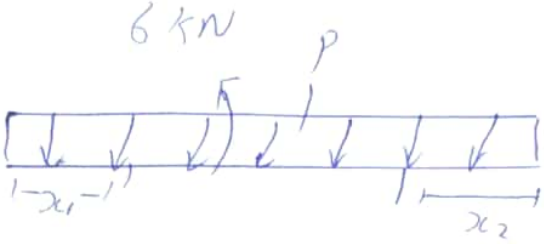
$R_1 + (-0.1667) = 0$

$R_1 = 0.1667\ kN$



(b)

$R_1 + R_2 = 1$

$\hookrightarrow \Sigma M_A = 0$

$-(1)(9) + R_2(6) = 0$

$R_1 = 0.6607\ kN$

$R_2 = 1 - 0.6667\ kN$

$R_2 = 0.333\ kN$

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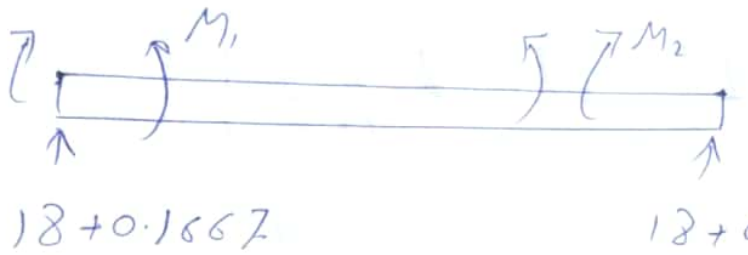
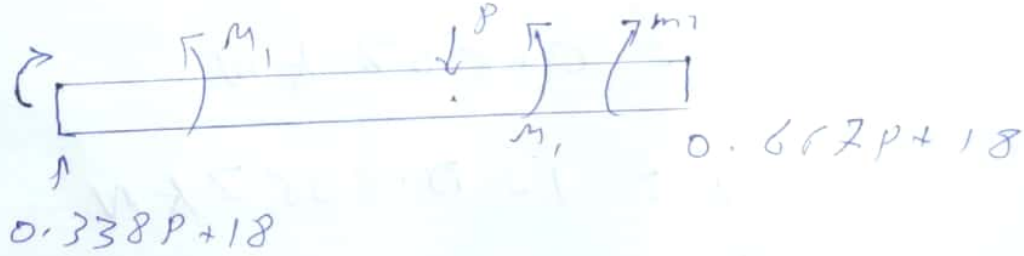
$$M_1 = (18 + 0.1667M')x_1 - 2x_1^2$$

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



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

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



The displacement function shown in the figure "a" above

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2 (4)

5)

$\frac{\delta M'}{\delta m'} = 0.1667x_1$ and $\frac{\partial M_2}{\partial M_1} = 0.1667x_1$ 1d

Set $M' = 0$

$M_1 = (18 + 0.1667(0))x_1 - 2x_1^2$ 1d

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

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

$$\theta B = \int_0^L M\left(\frac{\delta M}{\delta M_1}\right)\frac{dx}{EI} = \int_0^4 \frac{(18x_1 - 2x_1^2)}{EI}(0.1667)dx$$

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

$$\theta B = \frac{42.85}{EI} + \frac{6.66}{EI}$$

$$\theta B = \frac{49.31}{EI}$$

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

$$\theta_B = 0.444 \text{ rad}$$

For the displacement function are shown in figure "b"

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

then $M_1 = (16x_1 - 2x_1^2)$ kN.m

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

Thus

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

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$$\Delta B = \int_3^4 \frac{(300x_1 - 2x_1^2)(0.333x_1)dx}{EI}$$

$$+ \int_0^2 \frac{(300x_2 - 2x_2^2)(0.6667x_1)dx}{EI}$$

$$\Delta B = \frac{213.5}{EI}$$

$$\Delta B = \frac{218.5}{(200\times10^9)(0.0006}$$

$$= 0.018m$$

$$\boxed{\Delta B = 18mm}$$ Ans

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Question No (03)

Solution

Given data:

w_o = Uniform load = 400 lb/ft

h = height = 10 ft

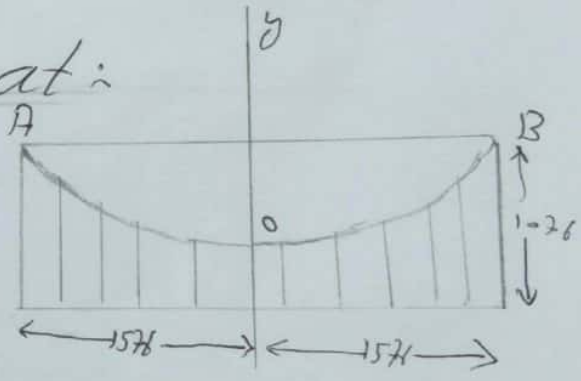
Length (l) = 15 ft

Required:

Equation of curve and forces in cable = ?

We know that:

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



Putting values

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

$$T_o = F_H = \frac{w_o L^2}{2h} = \frac{460 \times (15)^2}{2(10)}$$

$$\boxed{T_o = 4500 \text{ lb} = 4.5 \text{ klb}}$$

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$$T_B = T_{max} = \sqrt{(T_H)^2 + (W_o L)^2}$$

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

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

"T_{max}" By another equation

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

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

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

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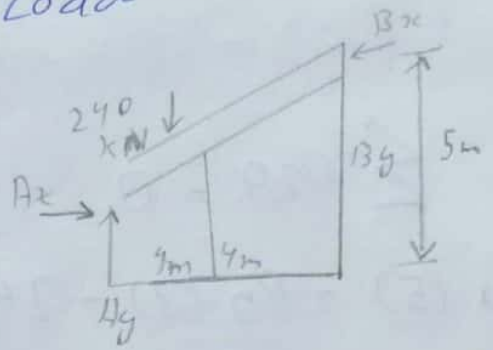
Question No 4

Given data :

Uniform Load = 30 kN/m

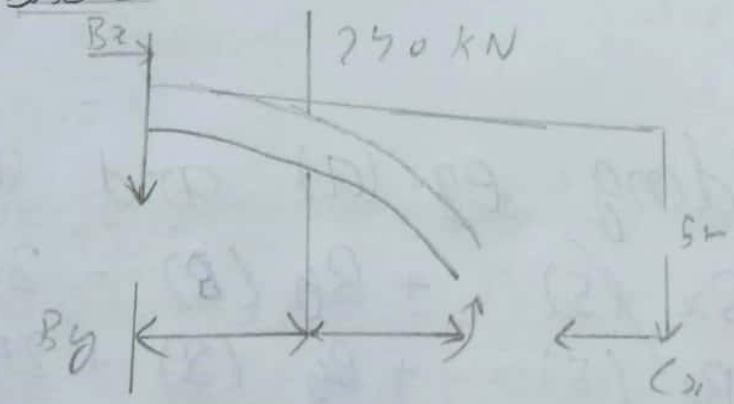


Member AB

Require data

Internal moment at D = ?

Member BC



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Solution:

Dividing into two members AB and BC.

AB:

$$\circlearrowleft + \sum M_A = 0$$

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

$$\rightarrow (a)$$

BC:

$$\circlearrowright + \sum M_C = 0$$

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

$$\rightarrow (b)$$

Adding eq (a) and (b)

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

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

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$\Sigma B_y (8) = 0$

$B_y = 0 \cdot kN$

Putting the values of "By" in eq (b)

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

$B_x (5) = 960$

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

$\boxed{B_x = 192 \, kN}$

Now at Segmant "DB"

$\circlearrowleft^{+} \quad \Sigma M_D = 0$

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

$384 - 375 - M_D = 0$

$9 - M_D = 0$

$\boxed{M_D = 9 \, kNm}$

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