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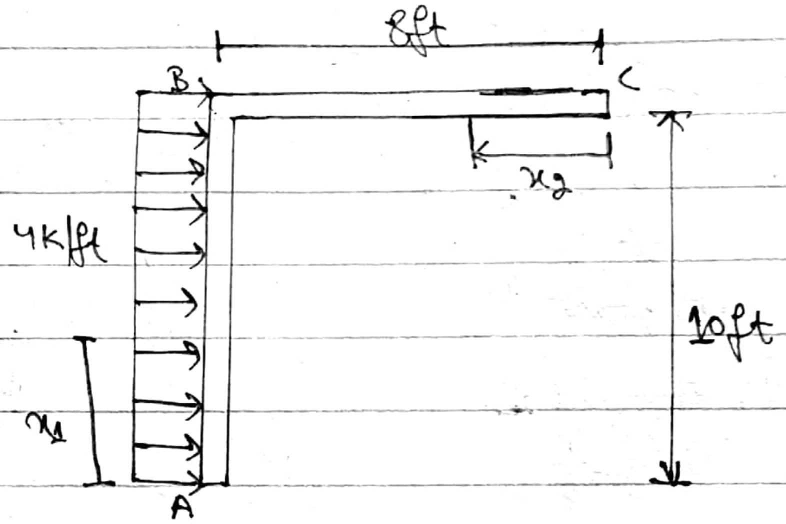
Subject structure 1

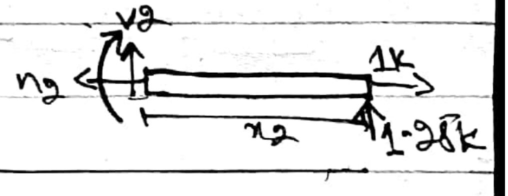
Date 26/06/2020

Q No1 Determine the horizontal displacement of point C on the frame shown. Take $E = 29(10^3)$ and $I = 600\ in^4$ for both members.

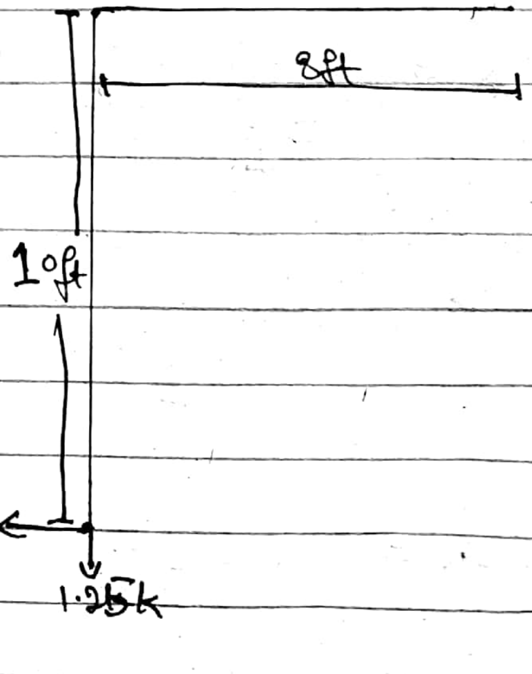


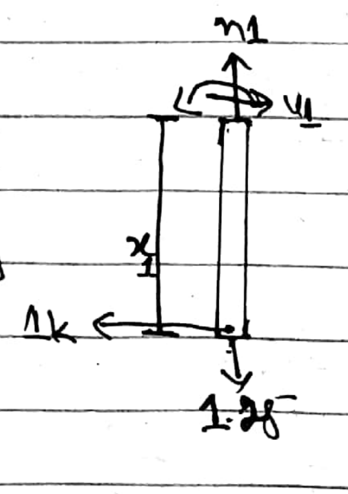
Solution:-

Virtual moment m:-



$$\boxed{m_2 = 1.25x_2}$$

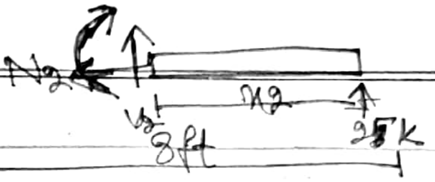


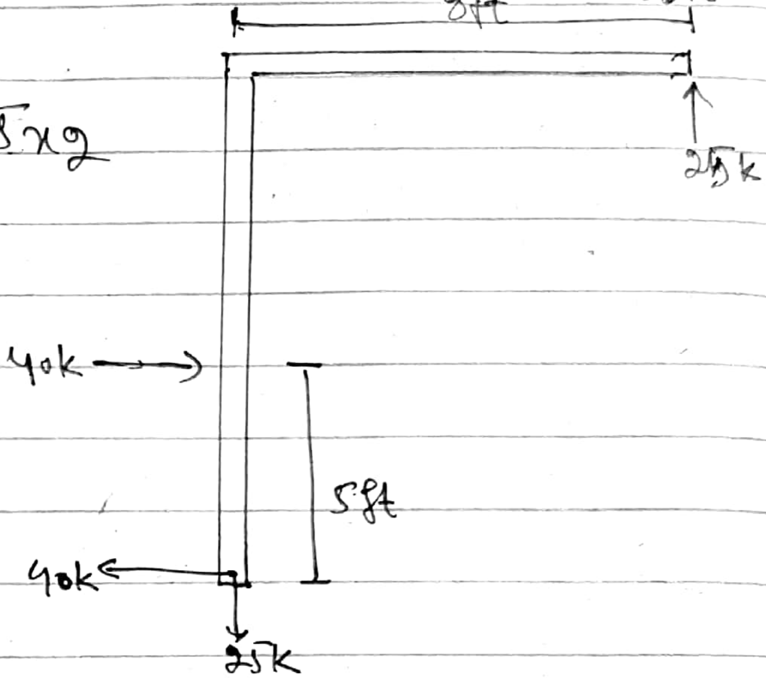


$$\boxed{m_1 = 1x_1}$$

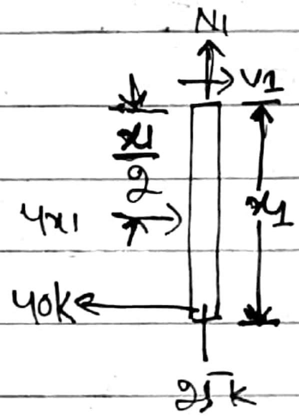
Scanned with CamScanner

Real moment M :-





$$M_2 = 25x_2$$



$$M_1 = 40x_1 - 2x_1^2$$

Virtual work equation

$$\Delta C_h = \int_0^L \frac{mM}{EI}\,dx$$

$$= \int_0^{10} \frac{(1x_1)(40x_1 - 2x_1^2)}{EI}\,dx_1 + \int_0^8 \frac{(1.25x_2)(25x_2)\,dx_2}{EI}$$

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

$$= 1366.7 \text{ k}\cdot\text{ft}^3$$

There fore

$$\int mM\,dx = 13666.7\ k^2.ft^3$$

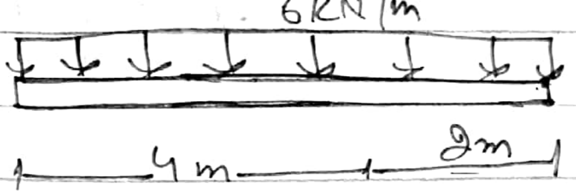
$$\Delta_{ch} = \frac{13666.7}{[29(10)^3)\ k/in^2((12)^2 in^2/ft^2)][600\ in^4(ft^4/(12)^4 in^4)]}$$

$\Delta ch = 0.113\ ft$

$\boxed{\Delta ch = 1.36\ in}$ Ans

Q No 2

Given data

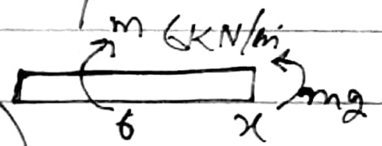


$E = 200\ GPa$

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

Required:

slope and displacement=?



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

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

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

taking partial derivative with respect to m

$$\frac{\partial m_2}{\partial P_2} = -x$$

$$\Delta B = \int_6^2 m \frac{(\partial m)}{\partial P} \frac{dx}{E}$$

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

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

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

Put the value of EI and I.

$$= \frac{-3x^2}{2(280)(60\times10^6)}\Big|_0^6 + \frac{-3x^4}{(4000)(60\times10^6)}\Big|_0^4$$

$$= \frac{-216\,kN\,ft^3}{4.8\times10^{10}} + -\frac{614.4\,kN\cdot ft^3}{4.8\times10^{10}}$$

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

$$\boxed{DB = 5.76\times10^{-10}\ \text{inch}}$$

Displacement

Slope:-

$$m + 1/2 \times (6x1) = 0$$

$$m = -1/2 x (6x2) = 3x^2$$

So;
$$\frac{\partial m_1}{\partial m_1} = 0$$

$$m_1' - m_2 - 1/2 (x_2)(6 + x_2)$$

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

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

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

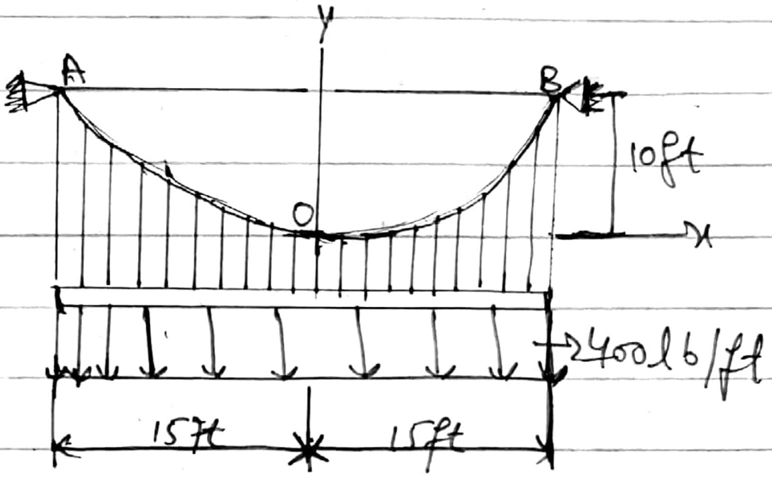
$$= \int_0^6 \frac{-3x^2 (0dx)}{E.I} + \int_0^{10} \left(-2 + 6x^2 + \frac{x^2}{2}\right) dx$$

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

$$= \frac{1}{200 \times (60 \times 10^6)} \left| -x + \frac{6x^3}{3} + \frac{x^3}{6} \right|_6^{10}$$

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

QNo3:-



Solution:-

$$y = \frac{h}{L^2} x^2 = \frac{10}{15} x^2$$

$$y = 0.666 x^2 \text{ Ans}$$

As we know that

$$T_o = F_B = \frac{w_o L^2}{2h}$$

$$= \frac{400(15)^2}{2(10)}$$

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

Now

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

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

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

Now

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

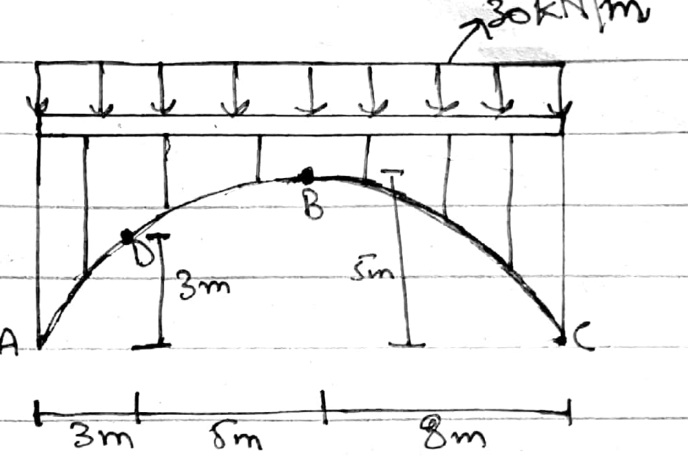
$= 400(15)\sqrt{1 + \left(\frac{15}{2(10)}\right)^2}$

$= 7500 \text{ lb}$

$= 7.5\text{k}$ Ans

Q No 4

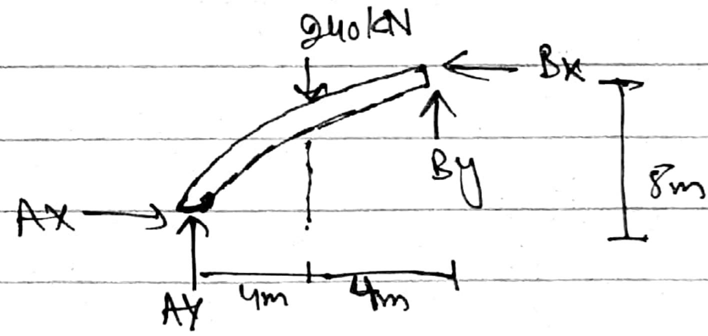
Given data



Required

internal moment in the arch at point D?

Solution:-



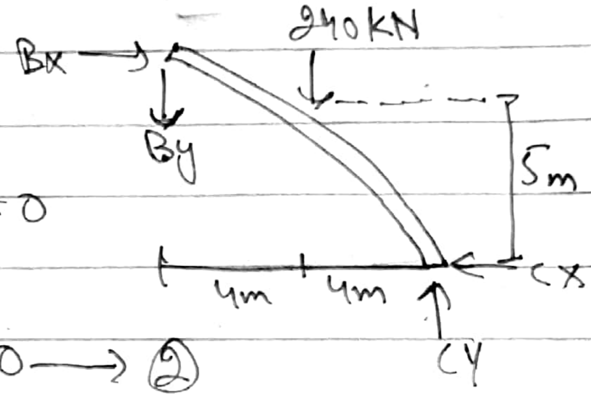
member AB:-

$$\curvearrowleft + \sum M_A = 0$$

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

$$\Rightarrow 5Bx + 8By - 960 = 0 \longrightarrow (A)$$

Member BC:



$\circlearrowleft +\ \Sigma M_C = 0$

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

$\Rightarrow -5Bx + 8By + 960 = 0 \longrightarrow (2)$

Solving equation (1) and (2) for Bx & By

$$\cancel{5Bx} + 8By - \cancel{960} = 0$$
$$+ \quad -\cancel{5Bx} + 8By + \cancel{960} = 0$$

$$16By = 0$$

$$By = 0$$

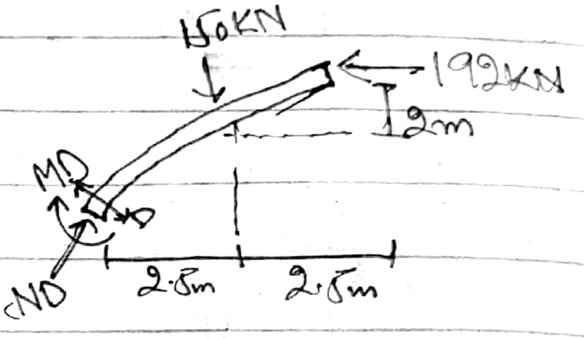
Put By in eq (1)

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

$$5Bx = 960$$

$$Bx = 192\text{kN}$$

Segment DB



$\circlearrowleft + \sum M_D = 0$

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

$\Rightarrow 384 - 375 = M_D$

$\boxed{M_D = 9\,kN\text{-}m}$

internal moment at "D"