Final paper

NAME Shaheryar Khan

ID 7891

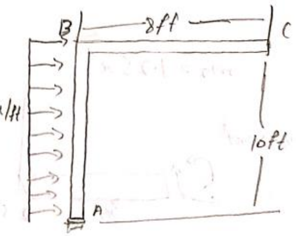
Section A

Date 27/6/20

Subject Structural Analysis-I

Q2

Determine the vertical displacement of free end point C on the frame shown in figure. Take $E = 29(10^3)$ ksi and $I = 600 in^4$ for both members. Use method of virtual work.



Given Data:

uniform load = 4K/ft

$E = 29 \times 10^3$ ksi

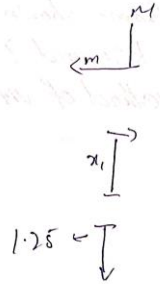
$I = 600 in^4$

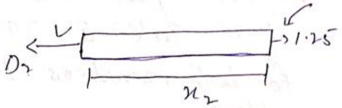
Required:

vertical Displacement.

Solutions:

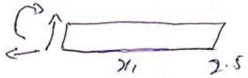
Now vertical moment



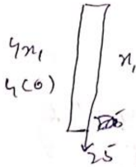


$m_2 = 1.25x$

real moment



$m_2 = 25x_r$



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

$$40x_1 - 2x_1^2$$

Now by Nrtual wosk eluation

$$ADC = \int_0^L \frac{mMdx}{E}$$

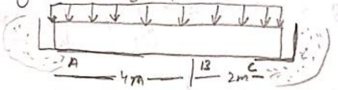
$$\Delta L = \int_0^{10} (1x_1) \left(\frac{40x_2 - 2x^2}{\xi} \right) d + \int_0^{8} \frac{(1.25x2)(25x2)}{E_1} dx$$

$$\Delta L = \frac{1}{EI} \left| \frac{42x^3}{3} - \frac{2x^3}{4} \right|_0^{10} + \left| \frac{(31.25 x^3)}{3} \right|_0^{8}$$

$$\Delta L = 10649.6018 .$$

Q(2)

Determine the slope and displacement at point B. Assume the support at A is a pin and C is a roller. Take $E = 200$ GPa, $I = 60(10)^6\ mm^4$. Use Castigliano's Theorem.



Given

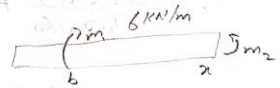
$E = 200$ GPa

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

Required:

Slope and displacement = ?

Solution



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

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

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

taking partial derivation with respect to m

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

$$\Delta B = \int_0^2 \frac{m(\partial m)}{\partial P} \frac{d_4}{E}$$

$$\Delta B = -3x^2(-x)\frac{dx}{E_1} + \int_0^4 \frac{-3x^2(-x)dx}{EI}$$

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

Put the value of EI and I

$$= \frac{-3x^2}{2(280)(60\times10^6)}\Big|_6^6 + \frac{-3x^4}{4(200)(60\times10^6)}\Big|_6^4$$

$$= \frac{-216\,kN.ft^3}{4.8\times160} + -\frac{614.4\,kN.ft^3}{4.8\times10^{10}}$$

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

$$\boxed{\Delta B = 5.76\times10^{-10}\,inch}$$

Displacement

Slope :-

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

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

So,

$$\frac{\partial m_1}{\partial m_1'} = 0$$

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

~~$m_2 m_2 \frac{1}{6}$~~

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

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

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

$$= \int_0^5 \frac{-3x^2(4x)}{E \cdot I} + \int_0^{10} (-2 + 6x^2 + \frac{x^2}{2}\, dx$$

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

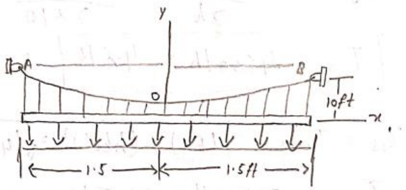
$$= \frac{1}{200 \times (60 \times 10^6} \left(-x + \frac{6x^3}{3} + x^3/6 \right|_6^{10}$$

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

Ans.

Q3

The cable is subjected to the uniform loading. If the slope of the cable at point O is zero, determine the equation of the curve and the force in the cable at O at B



Given Data

$w =$ Uniform load $= 400 lb/ft$

$h = 10ft$

$l = 15ft$

Required

equation of curve and force in cable = ?

Solutions:

we know that

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

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

Putting the values

$$y = \frac{10}{(15)^2} x^2 = 0.44x^2$$

$$T_0 = F_H = \frac{W_0 L^2}{2h} = \frac{400(15)^2}{2 \times 10}$$

$$\boxed{T_0 = 4500 lb = 4.5K}$$

$$T_B = T_{max} = \sqrt{(F_H)^2 + (Wol)^2} = \sqrt{(4500)^2 + (400 \times 15)^2}$$

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

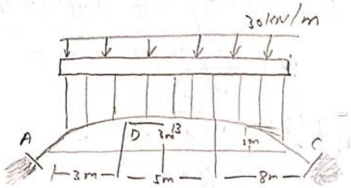
NOW "T_{max}" By another equation

$$T_B = T_{max} = W_0 L \sqrt{1 + \left(\frac{L}{2h}\right)^2} = 400 \times 15 \sqrt{1 + \left(\frac{15}{2 \times 10}\right)^2}$$

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

① (4)

The three-hinged spandrel arch is subjected to the uniform load of 30 kN/m. Determin the internal moment in the arch at point D.

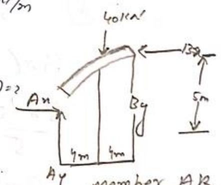


Given Data :

Uniform load = 30 kN/m

Required

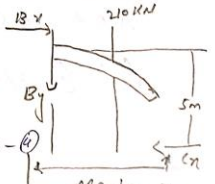
Internal moment at D = ?



Member AB

Solution

Dividing into two members AB and BC.



Member BC

AB

$\circlearrowleft + \Sigma M_A = 0$

$B_x(5) + B_y(8) - 240(4) = 0$ — (i)

BC

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

Adding eq (a) and (b)

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

$2By(8) = 0$

$= By = 0\ KN$

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

eq (b) $\quad -Bx(5) + 0(8) + 960 = 0$

$Bx(a) = 960$

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

$Bx = 192\ KN$

Now at segment DB

$\circlearrowleft^+ \Sigma M_D = 0$

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

$$384 - 375 - M_D = 0$$

$$9 - M_D = 0$$

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