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SECTION: B
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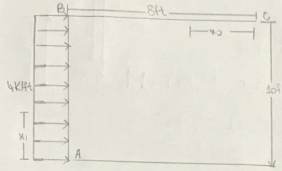
SEMESTER: 4th Spring
DEPARTMENT: B.E (civil)
EXAM: Final

"STRUCTURE ANALYSIS"

Question No 1

Determine the ----- Virtual work



Given Data:

$E = 29(10^3)$ ksi

$I = 600 in^4$

Required Data:

Virtual work, $\Delta_{C_h} = ?$

For Reaction:

$\Sigma M_A = 0$

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

$C_y = 25$ Kips

$\Sigma F_y = 0 \uparrow^+$

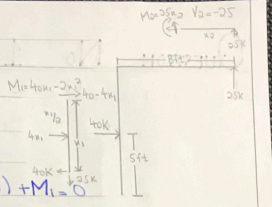
$25 + A_y = 0$

$A_y = -25$ kips

$\Sigma F_x = 0 \rightarrow +$

$40 - A_x = 0$

$A_x = +40 \text{ kips}$



REAL MOMENTS:

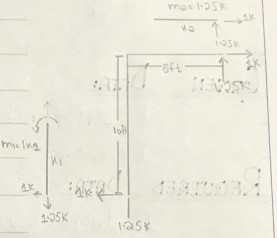
$\Sigma M_1 = 0$

$-40(x_1) + 4x_1(x_1/2) + M_1 = 0$

$M_1 = 40x_1 - 2x_1^2$

$-25x_2 + M_2 = 0$

$M_2 = 25x_2$



Virtual moments:

$\Sigma m_1 = 0$

$-1(x_1) + m_1 = 0$

$m_1 = 1x_1$

$-m_2 + 1.25x_2 = 0$

$m_2 = 1.25x_2$

Now from virtual work equation

$$1K \cdot \Delta_{ch} = \int_0^{\ell} mM\,dx / EI$$

$$1K \cdot \Delta_{ch} = \int_0^{18} \frac{(40x_1 - 2x_1^2)(1x_1)\,dx}{EI}$$

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

$$\Delta_{ch} = \frac{13666.7}{EI} \quad K\text{-}ft^3$$

$$\Delta_{cn} = \frac{13666.7\ k^2 \cdot ft\ (12^3\ in^3/1\ ft^3)}{[29 \times 10^3\ K/in^2](600)}$$

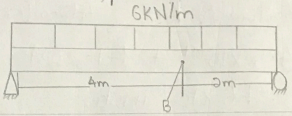
$$\Delta_{cn} = 1.357\ in$$

RESULT:

$$\Delta_{cn} = 1.357\ in.$$

QUESTION NO 2

Determine the slope ---- Theorem.



GIVEN DATA:

$E = 200\ GPa$

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

REQUIRED:

Slope, $\theta_B = ?$

displacement, $\Delta_B = ?$

SOLUTION:

$$m' - m_2 = \tfrac{1}{2}(x_2)(6 + x_1)$$

$$m' = m' + 6x^2 + x_1^2$$

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

Pratial derivative

$$\frac{\partial M_2}{\partial P} = -x$$

displacement:

$$\Delta_B = \int_0^{} M \frac{\partial M}{\partial P} \frac{dx}{IE}$$

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

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

$$\Delta_B = \frac{-3x^2}{2(200)(60\times10^6)}\Big|_0^6 + \frac{-3x^4}{4(200)(60\times10^6)}\Big|_0^6$$

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

$$\Delta_B = 5.76\times10^{-6} \text{ inch}$$

Slope:

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

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

So $\frac{\partial M}{\partial M} = 0$

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

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

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

$$\frac{\partial M_2}{\partial M_1} = -1$$

$$= \int_0^{8} -3x^2 \frac{dx}{EI} + \int_0^{10} (-2 + 6x^2 + x^2/2)\,dx$$

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

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

$\theta_B = 4.125 \times 10^{-7}$ radians.

QUESTION No 3

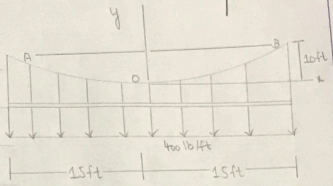
The cable ---------- O & B

GIVEN:

$h = 10\,ft$

$w_o = 400\,lb/ft$

$l = 15\,ft$



REQUIRED:

equation of curve and force in cable.

SOLUTION:

As we know

$$Y = \frac{h}{l^2} x^2 = \frac{10}{15} x^2$$

$$Y = 0.6667\, x^2$$

As $T_O = F_H = \frac{w_o l^2}{2h} = \frac{400 \times 15^2}{2 \times 10} = 4500.00\,lb = 4.500\,K$

Now $T_B = T_{MAX} = \sqrt{(F_H)^2 + (w_o l^2)^2} = \sqrt{(4500)^2 + (400 \times 15)^2}$

$$T_B = 7500\,lb = 7.500\,K$$

Next $T_B = T_{MAX} = w_o l \sqrt{1 + \left(\frac{l}{2h}\right)^2} = (400 \times 15)\sqrt{1 + \left(\frac{15}{2 \times 10}\right)}$

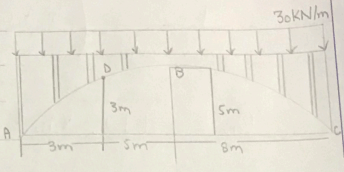
$$T_B = 7937.2 = 7.937\,K.$$

Question No 4

The three ——— Point D.

Given Data:

load = 30KN/m



Required:

Internal moment in arch at D.

Solution:

Member AB: ↻+

$\Sigma M_A = 0$

$B_x(5) + B_y(8) - 240(4) = 0$ —(i)

Member BC: ↻+

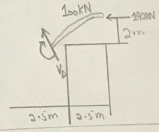
$\Sigma M_C = 0$

$-B_x(5) + B_y(8) + 240(4) = 0$ —(ii)

By solving both equations

$B_x = 192\,KN$, $B_y = 0$

Segment BD:- ↻+



$\Sigma M_D = 0$

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

$M_D = 9\,KN.m$

Result:

$M_D = 9\,KN.m$.