Name:

Hassan Zaib Khattak

ID:

7958

Section:

B

Deptt:

BE(C)

Subject:

Strutuve Analysis

Submitted to:

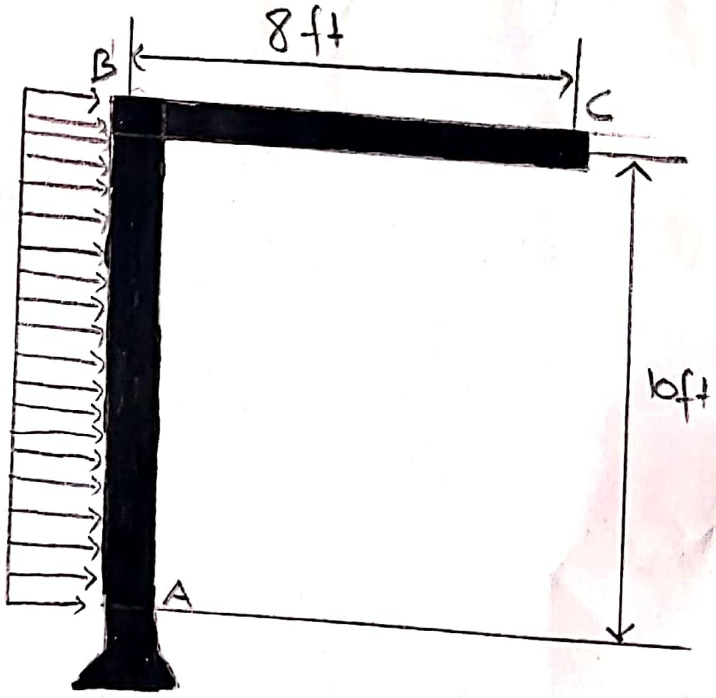
Engr Amjid Islam

Iqra National University

Question No 01:

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

Given Data:



$E = 29(10^3)$ ksi

$I = 600 in^4$

Required:

Verticle displacement = ?

Solution:

Now verticl moment

For reaction:

$\Sigma M_A = 0$

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

$C_y = 25$ Kips

$\Sigma F_y = 0 \uparrow +$

$25 + A_y = 0$

$A_y = -25$ kip

$\Sigma F_x = 0 \longrightarrow +$

$40 - A_x = 0$

$A_x = +40$

Real moment;

$\Sigma M_1 = 0$

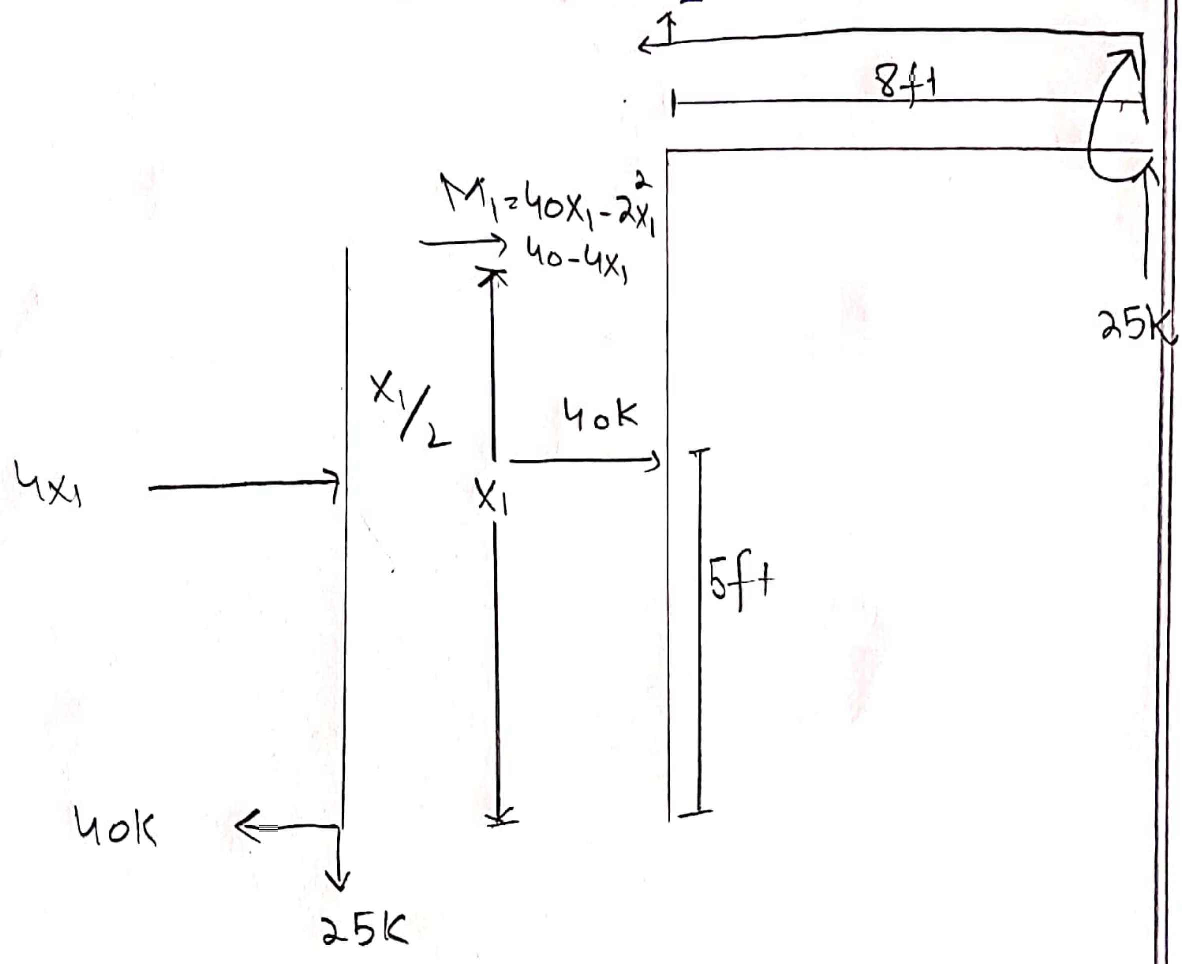
$-40(x_1) + 4x_1(x_1/2) + M_1 = 0$

$M_1 = 40x_1 - 2x_1^2$

$$-25X_2 + M_2 = 0$$

$M_2 = 25X_i, V_2 = -25$

$$M_2 = 25X_2$$



Virtual Moments:

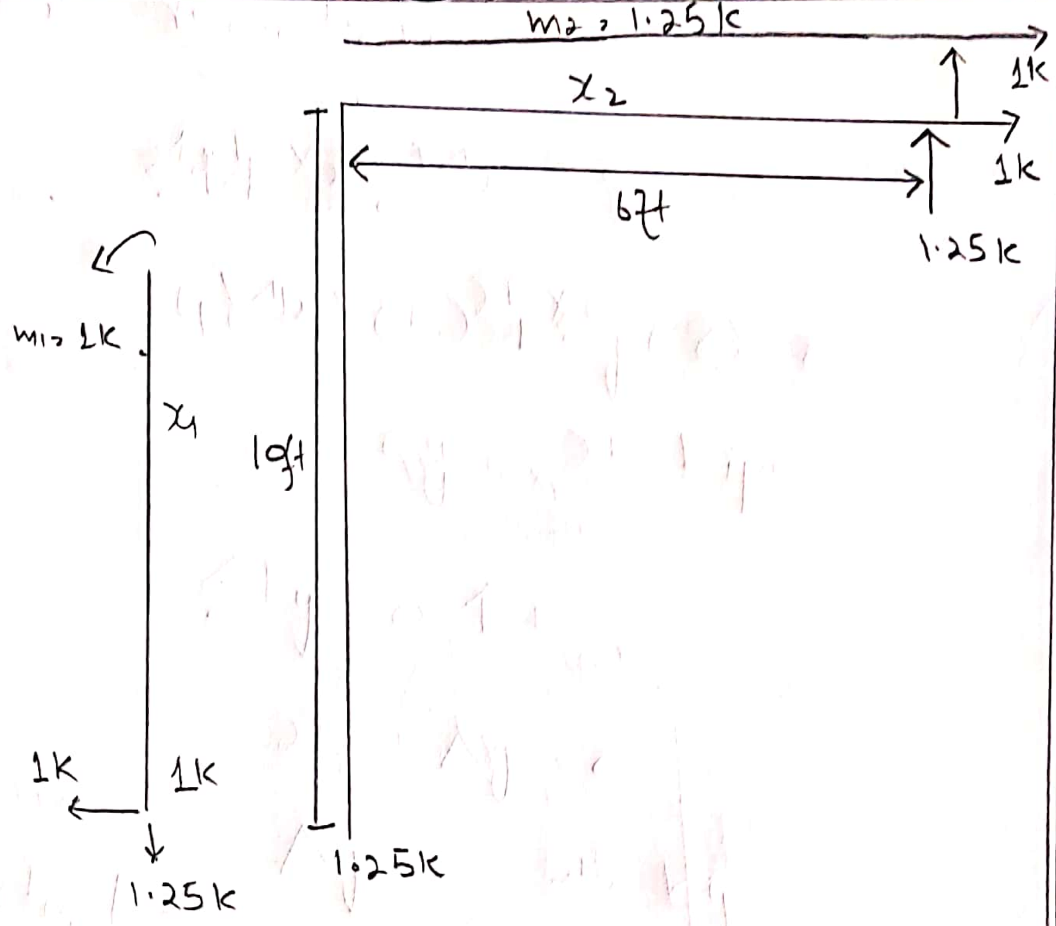
$$\Sigma m_1 = 0$$

$$-1(X_1) + m_1 = 0$$

$$m_1 = 1X_1$$

$$-m_2 + 1.25X_2 = 0$$

$$m_2 = 1.25X_2$$



Now from virtual work eqn

$$1k \cdot \Delta_{ch} = \int_0^x m \frac{M\,dx}{EI}$$

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

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

$$\Delta_{ch} = \frac{13666.7}{EI} \; k^3 . ft^3$$

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

Result

$$\boxed{\Delta_{ch} = 1.357 \text{ in}}$$

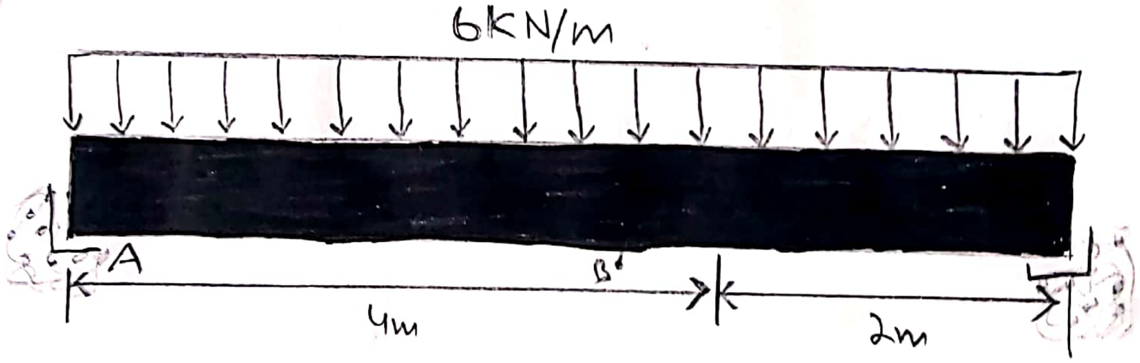
Question No 02:

Determine the slope and displac-ement 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 Data:

$E = 200 GPa$

$I = 60 (10)^6 mm^4$

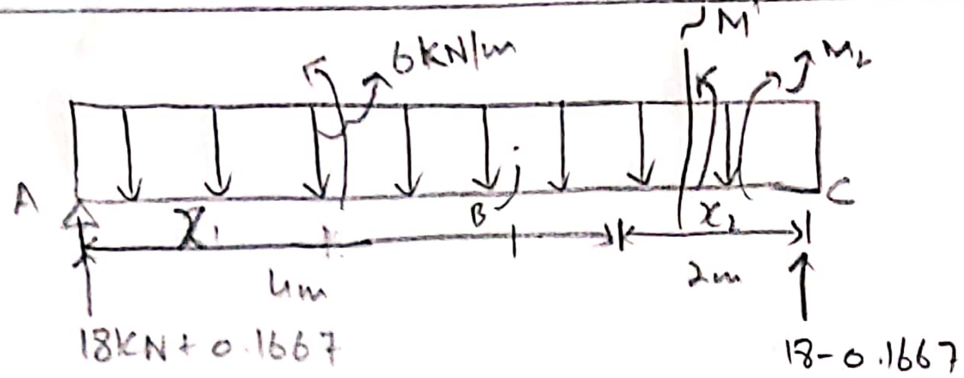


Required:

Slope and displacement at B = ?

Solution:

③



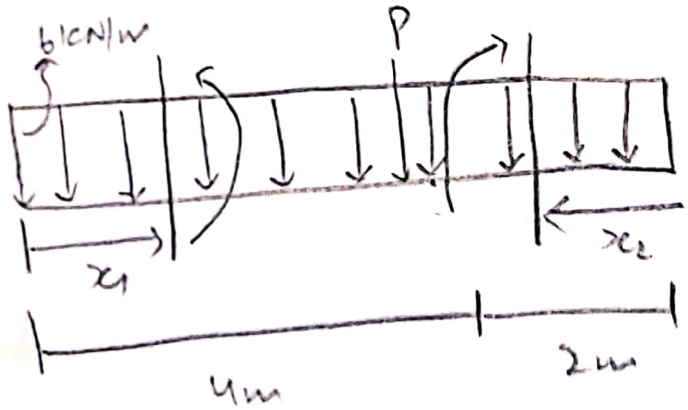
$R_1 + R_2 = 0$

$\Sigma M_A = 0 \circlearrowleft +$

$1 + R_2(6) = 0$

$R_1 + (-0.1667) = 0$

$R_1 = 0.16667\ KN$



$R_1 + R_2 = 1$

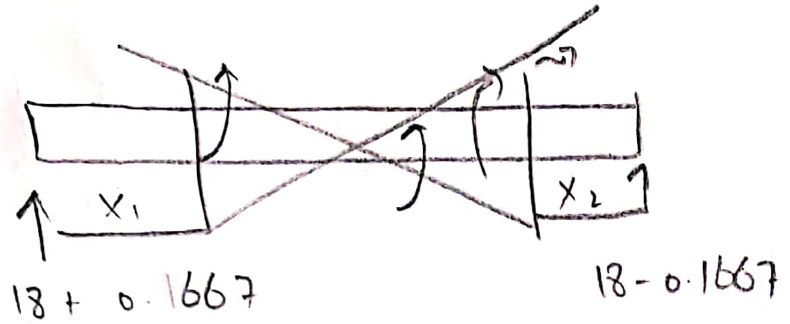
$\circlearrowleft + \Sigma M_A = 0$

$-(1)(4) + R_2(6) = 0$

$R_1 = 0.16667\ KN$

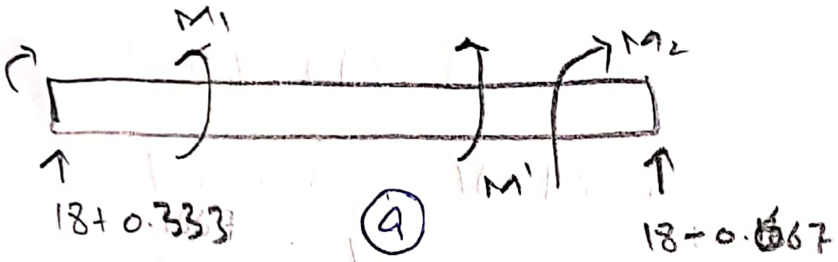
$R_2 = 1 - 0.1667\ KN$

$R_2 = 0.0333 \, kN$



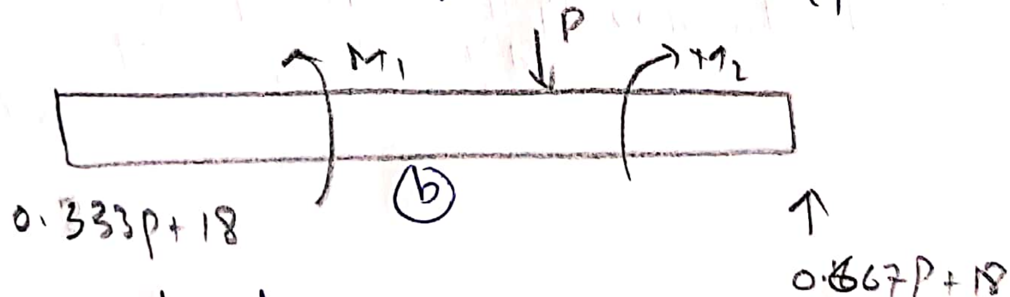
$$M_1 = (18 + 0.1667M')x_1 - 2x_1^2$$

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



$$M_1 = (0.0333p + 18)x_1 - 2x_1^2$$

$$M_2 = (0.1667p + 18)x_2 - 2x_1^2$$



The displacement function shown in the fig "a" above

$$\frac{\partial M_1}{\partial M'} = 0.1667x \quad \text{and} \quad \frac{\partial M_2}{\partial M'} = 0.1667x^2$$

Set $M' = 0$ then

$\Rightarrow M_1 = (18 + 0.1667(0))x_1 - 2x_1^2$

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

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

$$\theta_B = \int_0^L M\left(\frac{\partial M}{\partial M'}\right)\frac{dx}{EI} = \int_0^4 \frac{(18x_1 - 2x_1^2)(0.1667x_1)dx}{EI}$$

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

$$\theta_B = \frac{42.65}{EI} + \frac{6.66}{EI}$$

$$\theta_B = \frac{49.31}{EI}$$

$$\theta_B = \frac{49.31}{(200 \times 10^6)(0.00006)}$$

$\theta_B = 0.4411$ Rad

for the displacement function are shown in figure 'b"

$\frac{\partial M_1}{\partial M_p} = 0.8333x_1$ and $\frac{\partial M_2}{\partial p} = 0.1667X_2$

also set $P = 0$

Then $M_1 = (18x_1 - 2X_1^2)$ KN·m

$M_2 = (18X_2 - 2X_2^2)$ KN·m

Thus;

$$\Delta_B = \int_0^2 M\left(\frac{\partial M}{\partial p}\right)\frac{dx}{EI}$$

$$\Delta_B = \int_0^4 \frac{(30x_1 - 2x_1^2)(0.333X_1)dx}{EI}$$

$$\int_0^2 \frac{(30X_2 - 2X_2^2)(0.667X_2)dx}{EI}$$

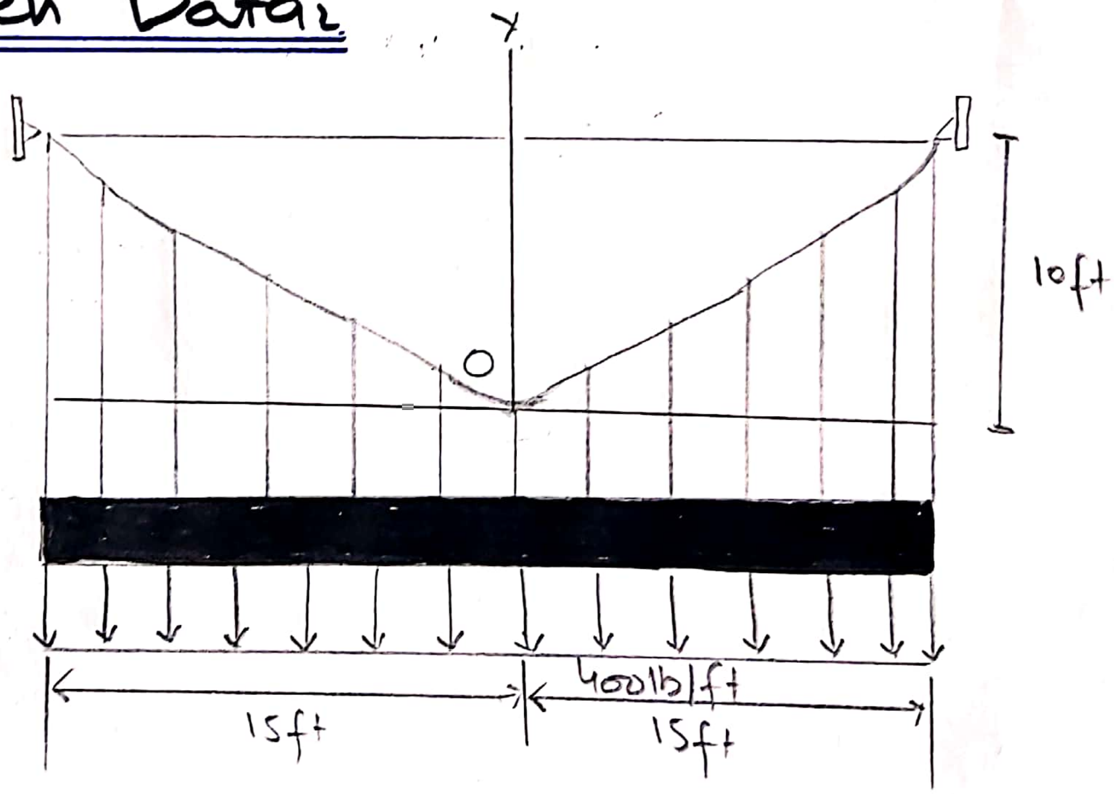
$$\Delta B = \frac{218.5}{EI} = \frac{218.5}{(200\times10^6)(0.00006)}$$

$\Delta B = 0.018m$ or $18mm$

Question No 03:

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 and B

Given Data:



Length of origin to top = 10ft
Length of origin to left = 15ft
Length of origin to right = 15ft
Load = 400lb/ft

Required:

equation of curve & force:?

Solution:

As we know that

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

$$= \frac{10}{15^2} x^2$$

$$\boxed{y = 0.0444 x^2}$$

Now,

$$T_o = F_U = \frac{W_o L^2}{2h} = \frac{400(15)^2}{2(10)}$$

$$T_o = 4500 \text{ lb}$$

by ÷ by 1000

$$\boxed{T_o = 4.5k}$$

We Know that

$$T_B = T_{max} = \sqrt{F_0^2 + (w_0 L)^2}$$

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

$$= 7500$$

÷ by 1000

$$\boxed{T_B = T_{max} = 7.5k}$$

Now,

$$T_B = T_{max} = w_0 L \sqrt{1 + \left(\frac{L}{2h}\right)^2}$$

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

$$= 7500 \, lb$$

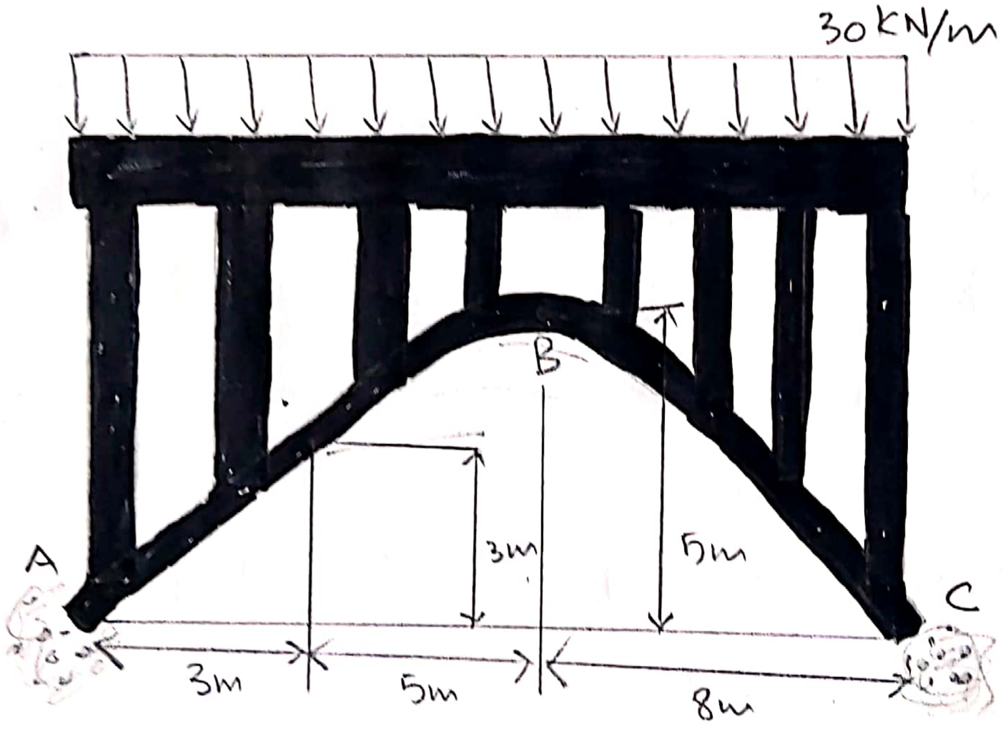
÷ by by 1000

$$\boxed{T_B = T_{max} = 7.500 \, k}$$

Question No 04

The Three-hinged Spandrel arch is subject to the uniform load of 30 kN/m. Determine the internal moment in the arch at Point D.

Given Data:



Required:

Interval moment at point D

Solution:

Member AB;

$\circlearrowleft + \sum M_A = 0$

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

Member BC;

$\circlearrowleft + \sum M_C = 0$

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

Solving

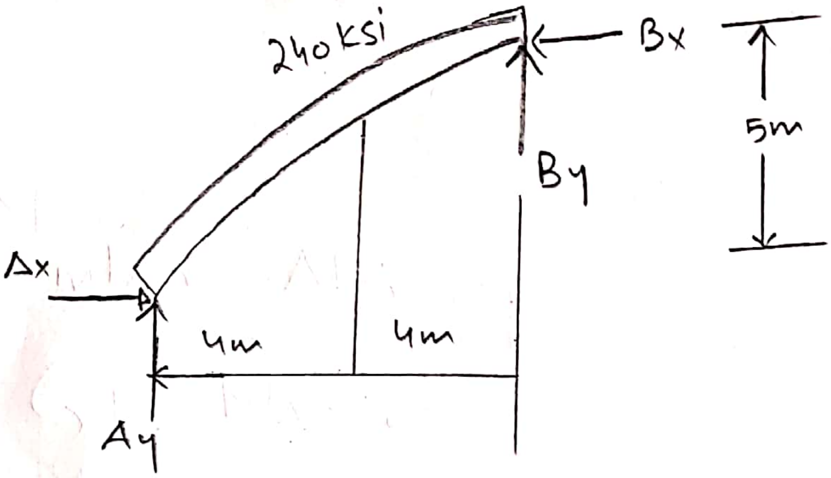
$B_x = 192\,KN \quad , \quad B_y = 0$

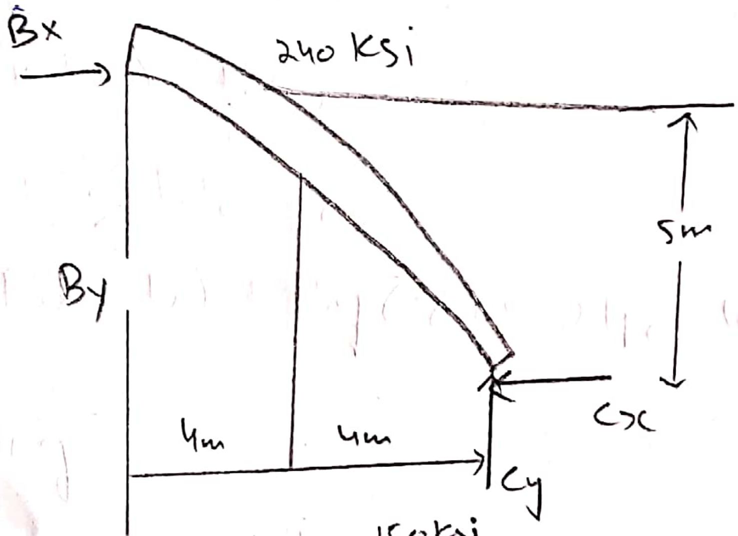
Segment BD;

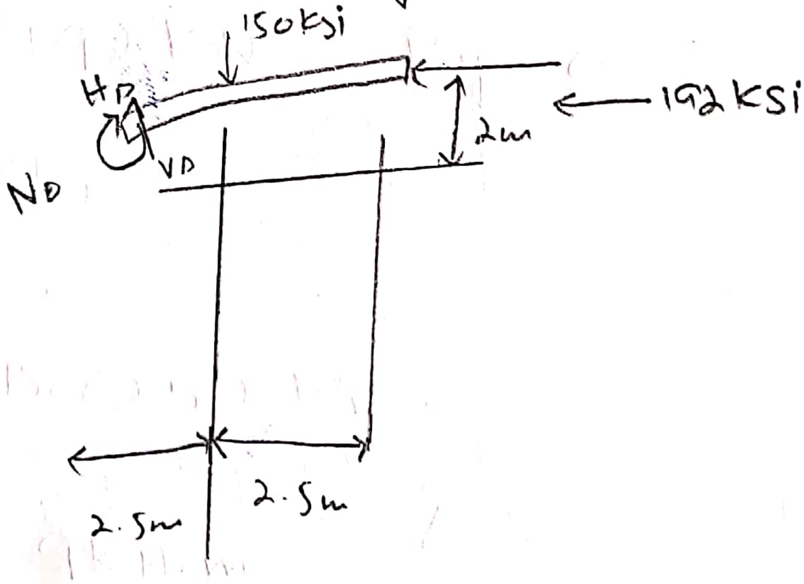
$\circlearrowleft + \sum M_D = 0$

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

$M_D = 9\,KN.m$ Ans


240 ksi
Bx
By
5m
Ax
4m
4m
Ay


Bx
240 ksi
5m
By
Cx
4m
4m
Cy


150 ksi
HD
192 ksi
2m
VD
ND
2.5m
2.5m