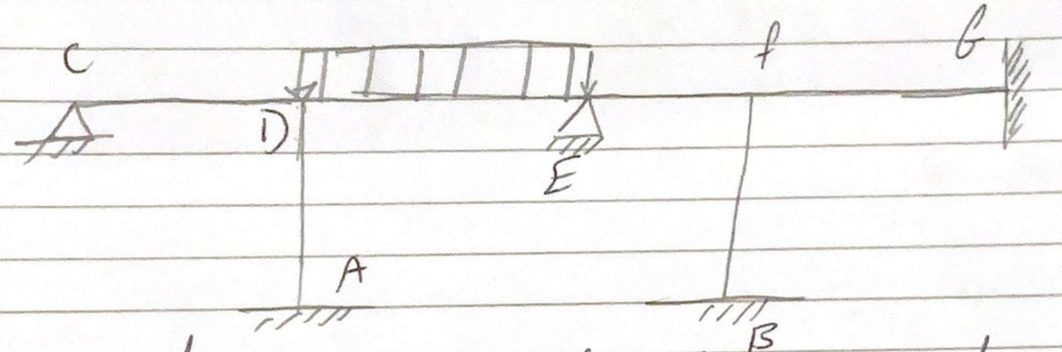
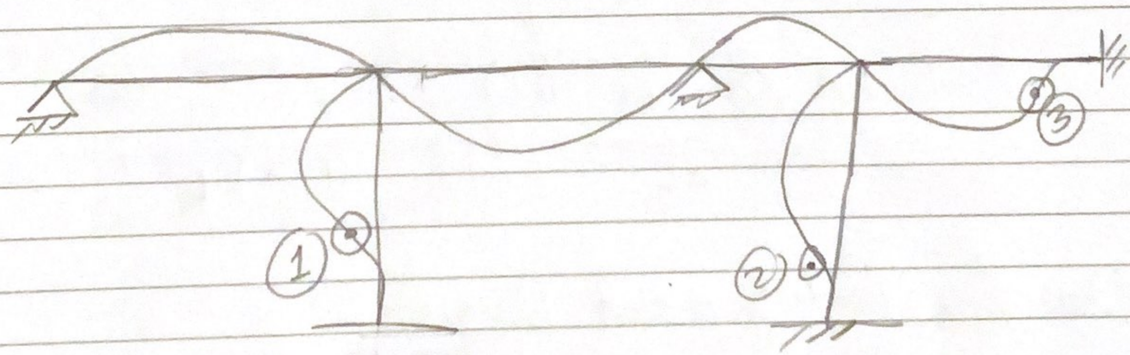
Fall 2022 Assignment '2'

Problem (1)

(a) Sketch the deflected shape marking all locations of inflection points:

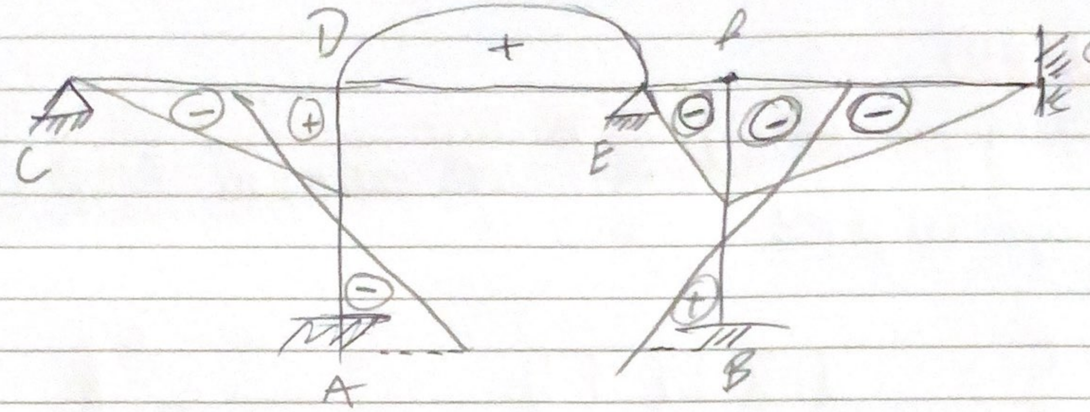


Deflected shape is nothing but elastic curve and is as following:-



Here, ①, ② and ③ Repersent locations of Inflection point

b) moment diagram for all frame members.

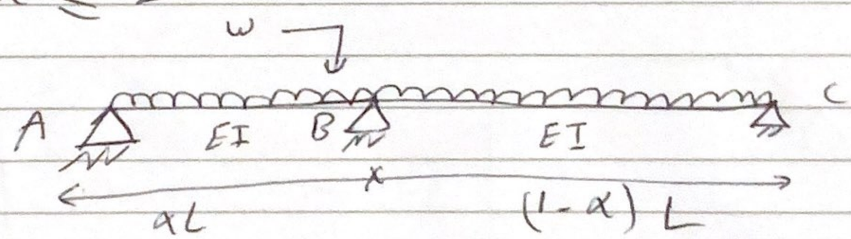


~~Hose~~, ~~(+)~~

Problem(2)

Given :— Total length = L

α for $0 \leq \alpha \leq 1/2$



Draw force Bending moment Diagram :-

for span AB →

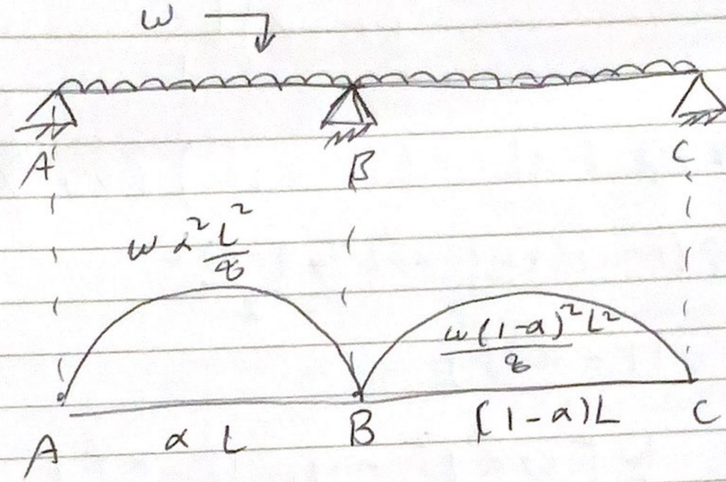
$$\text{B.M at centre} = \frac{wl^2}{8} = \frac{w(\alpha L)^2}{8} = \frac{w\alpha^2 L^2}{8}$$

for span BC →

$$\text{B.M at centre} = \frac{wl^2}{8} = \frac{w(1-\alpha)^2 L^2}{8}$$

$(\because L = (1-\alpha)^{2} L)$

ⓐ calculate the area of Bending moment diagram :-



for AB

$A = \frac{2}{3} \times b \times h$

$A_1 = \frac{2}{3} \alpha L \times \frac{wL^2\alpha^2}{8}$

x_1 = Dist of max^m B.m from the outer support

$x_1 = \frac{\alpha L}{2}$ //

for BC

$A_2 = \frac{2}{3} bh$

$\frac{2}{3} \times (1-\alpha)L \times \frac{w(1-\alpha)^2 L^2}{8}$

$x_2 = \frac{(1-\alpha)L}{2}$ //

+ Apply 3 moment theorm

$= M_A \cdot L_1 + 2M_B(l_1 + l_2) + M_C l_2 + \frac{6A_1 x_1}{l_1}$

$+ \frac{6A_2 x_2}{l_2} = 0$

$\because (M_A = M_C = 0$ bcoz of hinge$)$

But $M_B \neq 0$ becz it is in centre

$$0 = 0 + 2M_B(\alpha L + (1-\alpha)L) + 0 + 6\left(\frac{\frac{2}{3}\alpha L \times \frac{w\alpha^2 L^2}{8} \times \left(\frac{\alpha L}{2}\right)}{L_1}\right) + \frac{6\left(\frac{2}{3}(1-\alpha)L \times w(1-\alpha)^2 L^2\right)}{(1-\alpha)L_1}$$

$$0 = 0 + 2M_B(\alpha L + (1-\alpha)L) + 0 + 6 \times \frac{\left(\frac{2}{3}\alpha L \times \frac{w\alpha^2 L^2}{8}\right) \times \left(\frac{\alpha L}{2}\right)}{\cancel{\alpha L_1}} + \frac{6\left(\frac{2}{3}(1-\alpha)L \times \frac{w(1-\alpha)^2 L^2}{8}\right) \times \frac{(1-\alpha)L}{2}}{\cancel{(1-\alpha)L_1}}$$

$$2M_B L = \frac{L}{4}\left[w\alpha^3 L^2 + (w(1-\alpha)^3 L^2\right]$$

$$M_B = \frac{-w}{8}\left[\alpha^3 L^2 + (1-\alpha)^3 L^2\right]$$

$$\frac{-w}{8}\left[\alpha^3 L^2 + (1^3 - \alpha^3 - 3(1)(\alpha)(1-\alpha)L^2\right]$$

$$\because ((a-b)^3 = a^3 - b^3 - 3ab(a-b))$$

$$= \frac{-w}{8}\left[\alpha^3 L^2 + (1 - \alpha^3 - 3\alpha(1-\alpha)L^2\right]$$

$$\frac{-w}{8}\left[\alpha^3 L^2 + L^2 - \alpha^3 L^4 - 3\alpha L^2 + 3\alpha^2 L^2\right]$$

$$\frac{-w}{8}\left[L^2 - 3\alpha L^2 + 3\alpha^2 L^2\right]$$

$$-\frac{wL^2}{8}\left[1 - 3\alpha + 3\alpha^2\right]$$

$$\boxed{M_B = \frac{-wL^2}{8}\left[1 - 3\alpha + 3\alpha^2\right]}$$

Negative B.M (Bending moment) at B

• $\alpha = 0$ $M_B = -\frac{wL^2}{8}(1) = \frac{-wL^2}{8}$

$\alpha = \frac{1}{2}$ $M_B = \frac{-wL^2}{8}\left[1 - \frac{3}{2} + \frac{3}{4}\right]$

$\frac{-wL}{8}\left[\frac{4-6+3}{4}\right]$

$= \frac{-wL^2}{8}\left(\frac{1}{4}\right)$ / $M_B = \frac{-wL^2}{32}$ kN when $\alpha = \frac{1}{2}$

As α vary $0 \leq \alpha \leq \frac{1}{2}$,

the value of negative B.M at B will decrease from $\frac{-wL^2}{8}$ to $\frac{-wL^2}{32}$ kN.m

ii Bending moment in AB

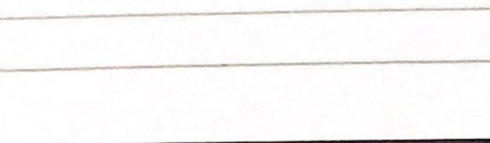
$M_{AB} = \frac{w\alpha^2 L^2}{8}$ • $\alpha = 0$ $M_{AB} = 0$ kN.m

$\alpha = 1/2$ $M_{AB} = \frac{w(1/2)^2 L^2}{8} = \frac{wL^2}{32}$ kN.m

As α vary $0 \leq \alpha \leq \frac{1}{2}$ the value positive BM in AB will increase from 0 to $\frac{wL^2}{32}$ kN.m Ans //

when $\alpha = 0$

$-\frac{wL}{8}$



A/B 00

when $\alpha = \frac{1}{2}$

$\frac{wL^2}{32}$ $-\frac{wL^2}{32}$