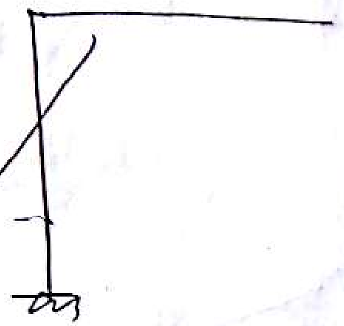
Virtual work (Frames)

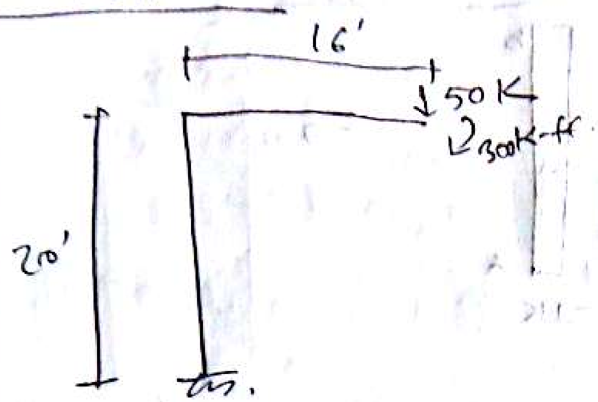
Assignment:



$$\Sigma Q\cdot\delta = \Sigma \frac{F_P F_Q L}{EA} + \Sigma F_Q\,\alpha_t\,tL$$

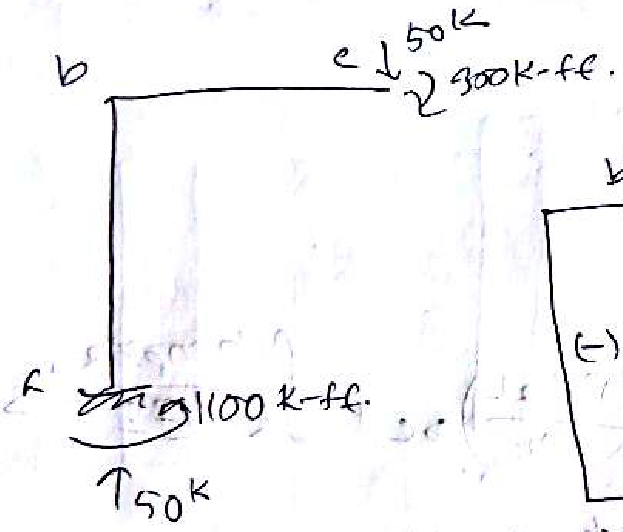
$$+ \int \frac{M_P M_Q}{EI}\,ds.$$

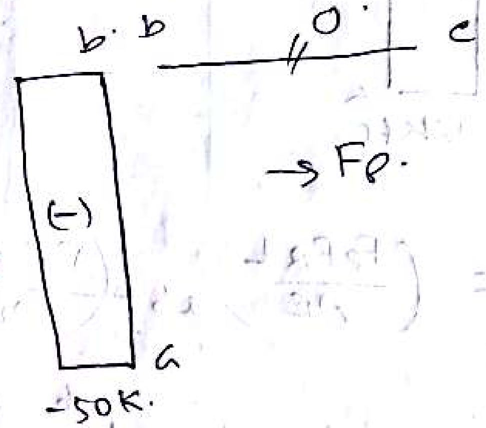
Assignment:



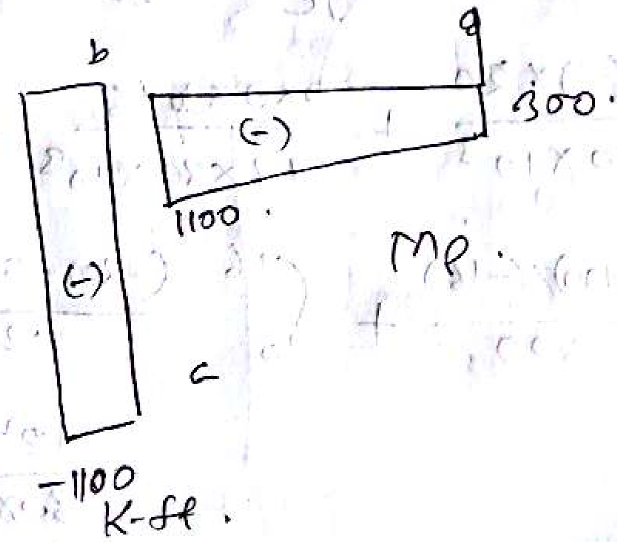
(i) vertical deflection at c
(ii) horizontal " " b
(iii) Change in slope at c

$E = 30 \times 10^3$ ksi
$A_{col} = 12 in^2$
$A_{beam} = 10 in^2$
$I_{col} = 300 in^4$
$I_{beam} = 200 in^4$



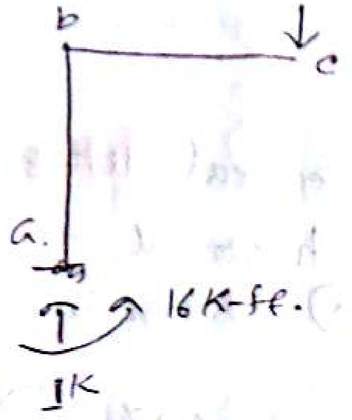


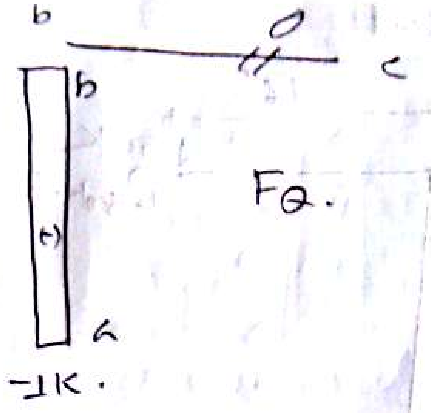
→ Fp.

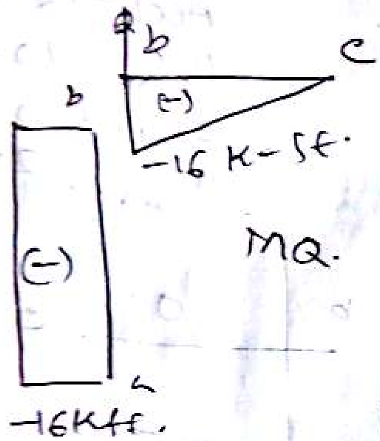


Mp.

①







$$\therefore 1\cdot\delta_c = \left(\frac{F_P F_Q L}{AE}\right)_{ab} + \left(\frac{F_P F_Q L}{AE}\right)_{bc} + \int_a^b \frac{M_P M_Q}{EI}\,ds$$

$$+ \int_c^b \frac{M_P M_Q}{EI}\,ds.$$

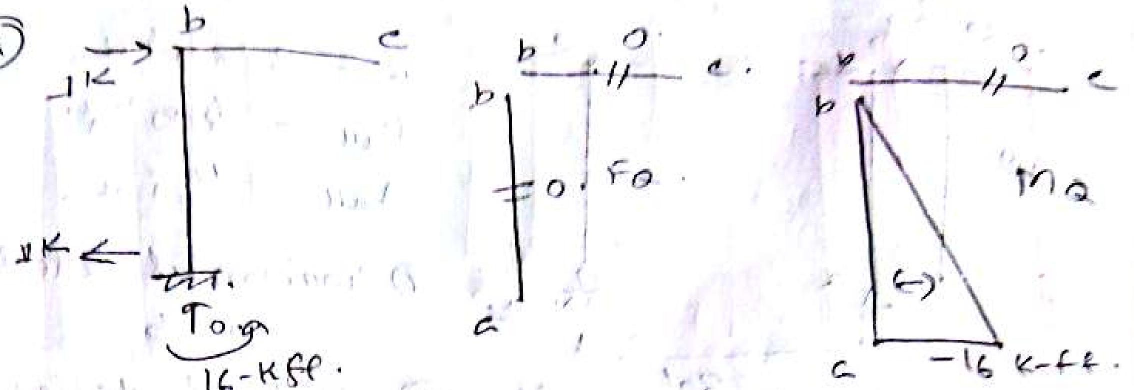
$$= \frac{(-50)\times(-1)\times 20}{12\times 30\times 10^3} + \frac{0\times 0\times 16}{12\times 30\times 10^3} +$$

$$\left[\int_0^{20} \frac{(-1100)\times(-16)}{300} + \int_0^{16} \frac{(-300-50x)\times(-x)}{200}\right] \times \frac{12^2}{30\times 10^3}$$

$m = \frac{y}{x} = \frac{16}{20} = \frac{4}{5}$

$\delta_c = 8.2\ ft = 98.4''$

(ii)

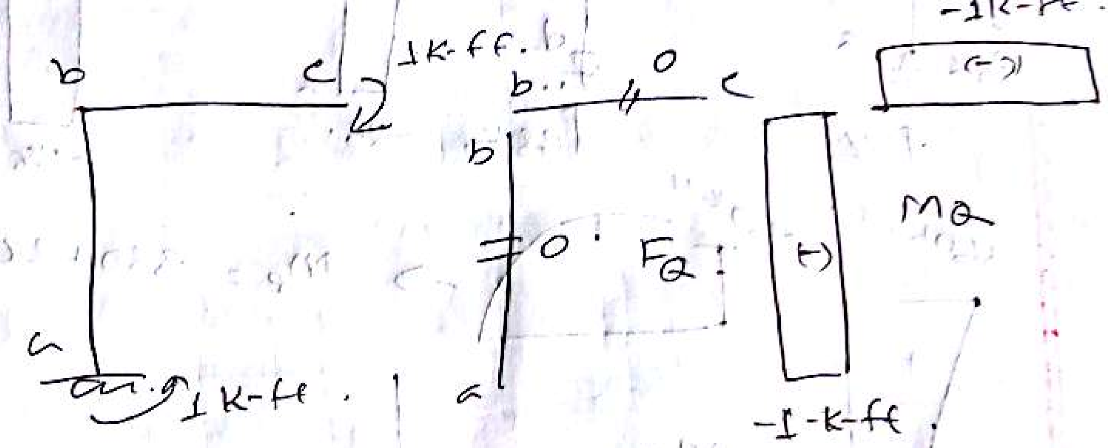


Applying principal of virtual work.

$$1\cdot\delta_b = 0 + 0 + \int_0^{20} \frac{(-1100)\times\left(\frac{4}{5}x-16\right)}{300\times 30\times 10^3\times\frac{1}{12^2}}\,dx + 0$$

$= 2.82\ ft = 33.84''$

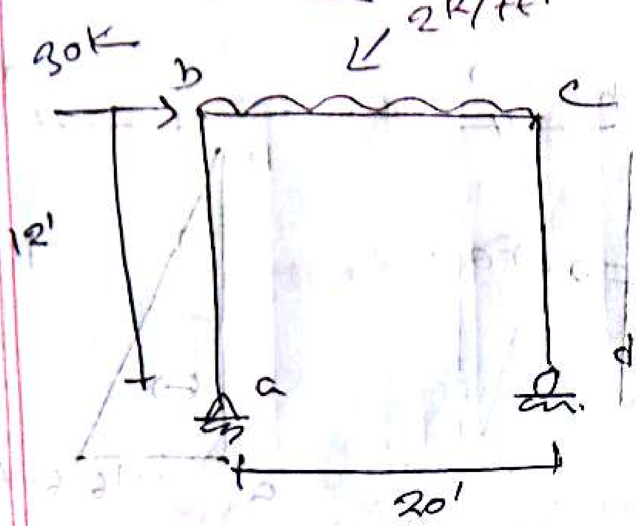
(iii)



$$1\cdot\alpha_c = 0+0+\left[\int_0^{20}\frac{(-1100)\times(-1)}{300}\,dx + \int_0^{16}\frac{(-300-50x)\times(-1)}{200}\right]\times\frac{12^2}{30\times10^3}$$

$= 0.62$ rad.

Assignment:



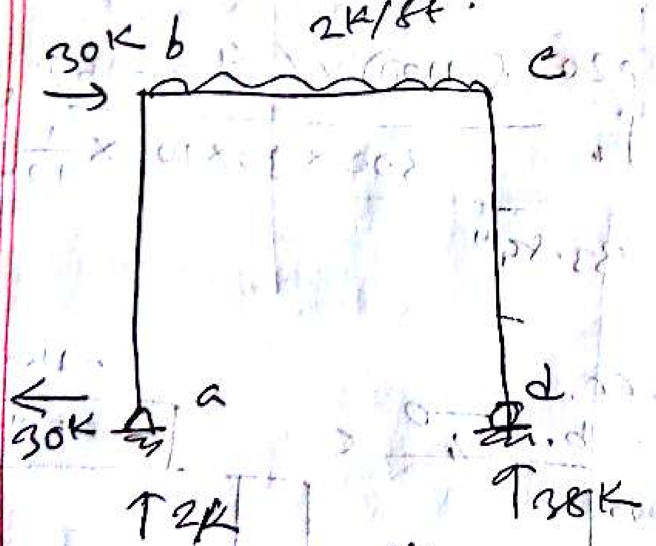
$E = 30 \times 10^3$ ksi

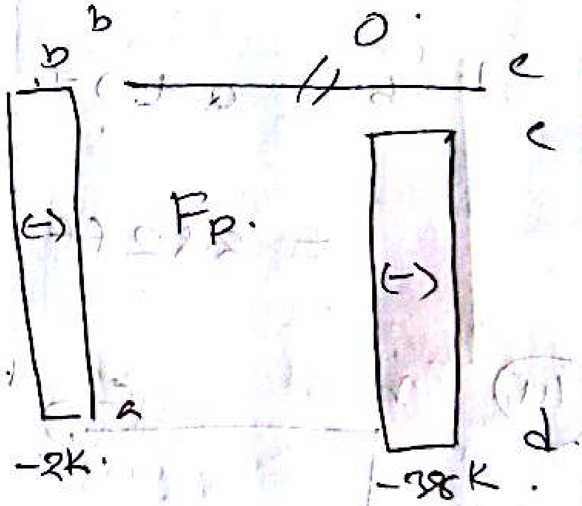
$I_{all} = 400\ in^4$

$A_{all} = 15\ in^2$

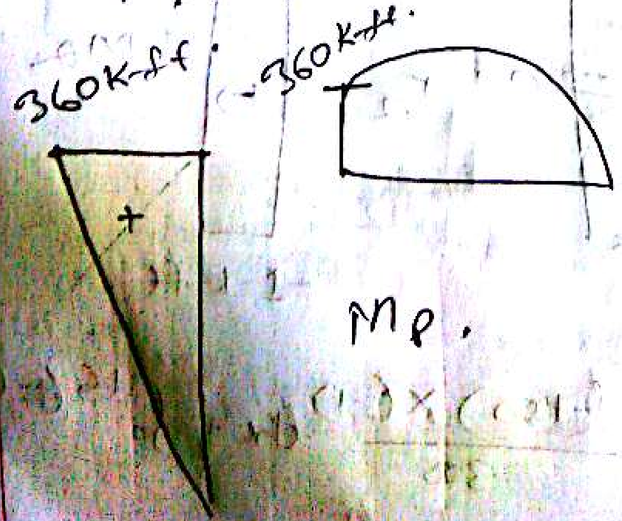
(i) horizontal deflection at b.

(ii) Vertical deflection at mid point of beam





Fp.

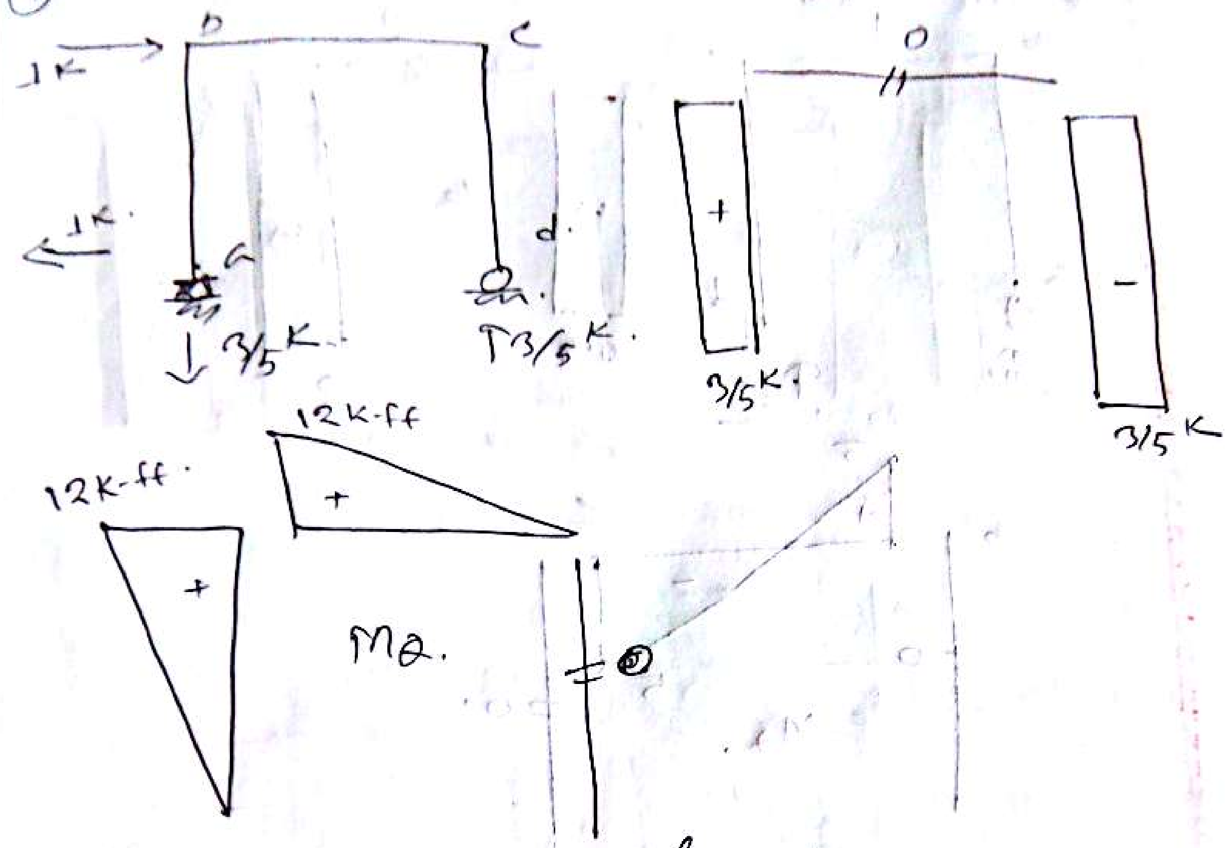


$\rightarrow M_p = 360 + 2x - x^2$

Mp.

$\neq 0$.

1



Applying principal of virtual work.

$$1\cdot\delta_b = \left(\frac{F_P F_Q L}{AE}\right)_{ab} + \left(\frac{F_P F_Q L}{AE}\right)_{bc} + \left(\frac{F_P F_Q L}{AE}\right)_{cd} +$$

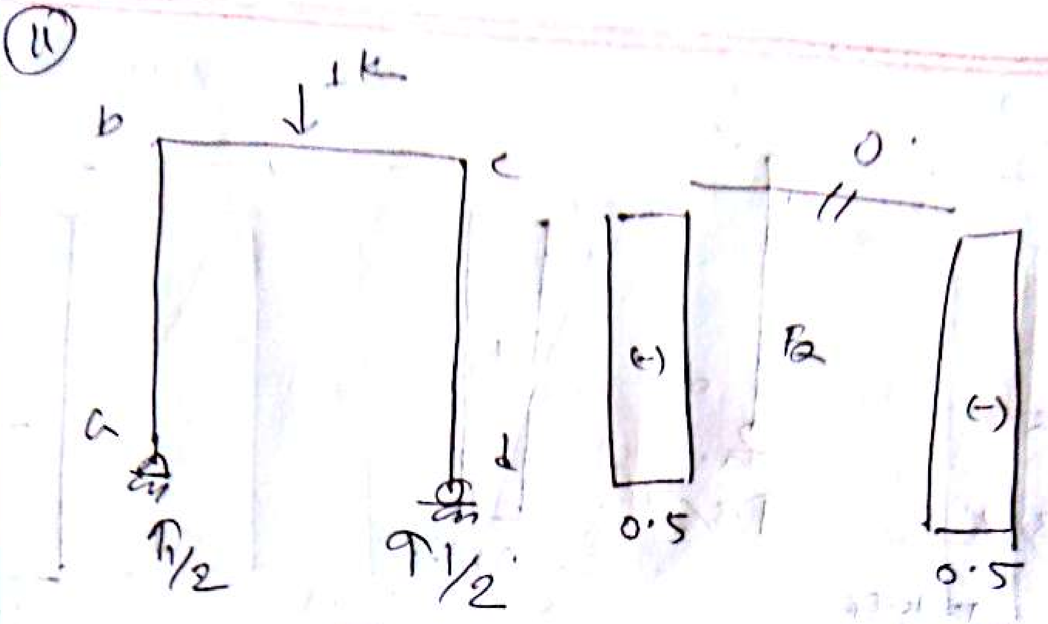
$$\int_a^b \frac{m_P m_Q}{IE}\,ds + \int_b^c \frac{m_P m_Q}{IE}\,ds + \int_c^d \frac{m_P m_Q}{IE}\,ds$$

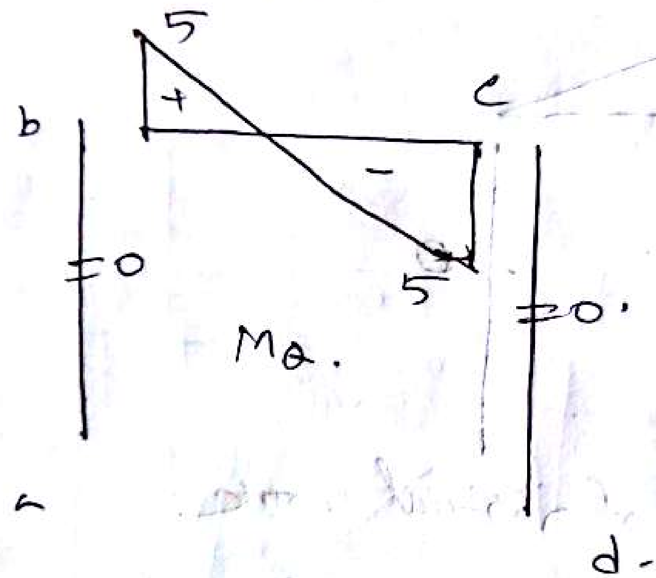
$$= \frac{(-2)\times(3/5)\times 12}{EI} + \frac{0\times 0\times 20}{EI} + \frac{-38\times(-3/5)\times 20}{EI}$$

$$+\left[\int_0^{12} 30x\cdot x\,dx + \int_0^{20}(360+2x-x^2)(12-\tfrac{3}{5}x)\,dx + 0\right]\frac{12^2}{400\times 30\times 10^3}$$

$$= 0.65\,ft = 7.8''$$

(11)

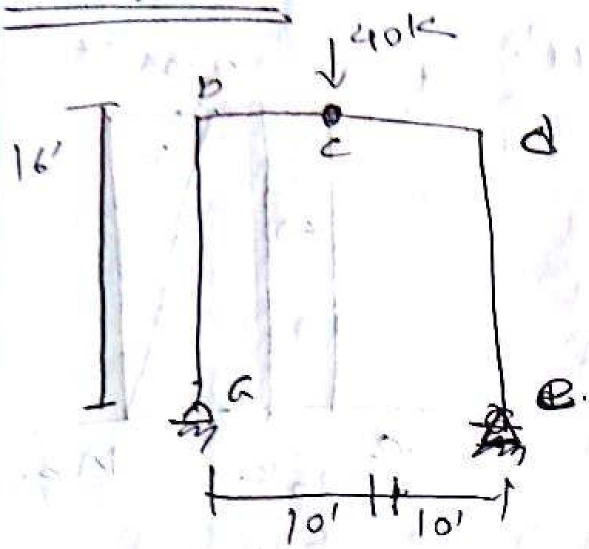




$$1\cdot\delta_{mia} = \frac{(0.5\times2\times12 + 36\times0.5\times12)}{15\times30\times10^3} + \int_0^{20}\frac{(360+2x-x^2)(5-x/2)\,dx}{4100\times30\times10^3\times\frac{1}{12^2}} + 0 + 0$$

$$= 0.073\,ft = 0.88''$$

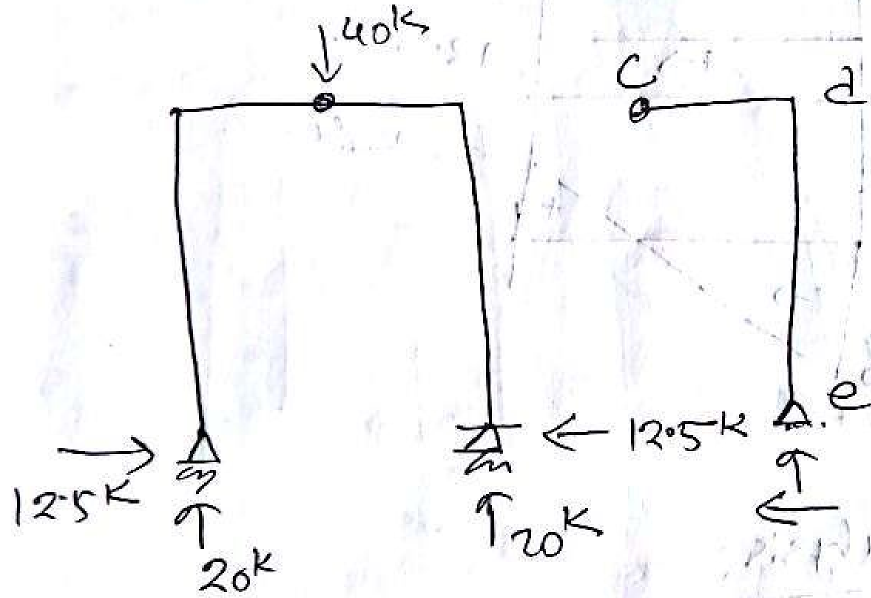
Assignment:



both pin support

① Vertical deflection at c

② Changing slop of member eb.

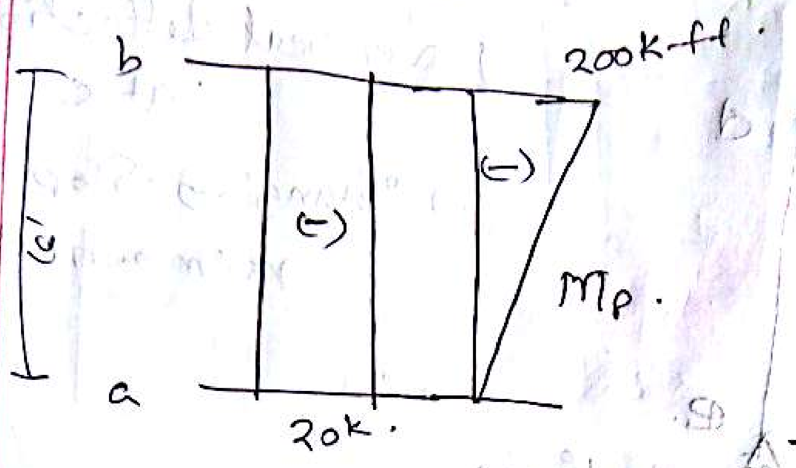


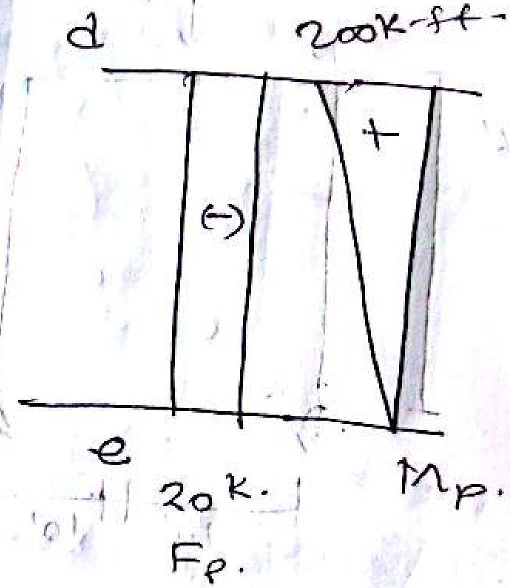
$\sum M_c = 0$

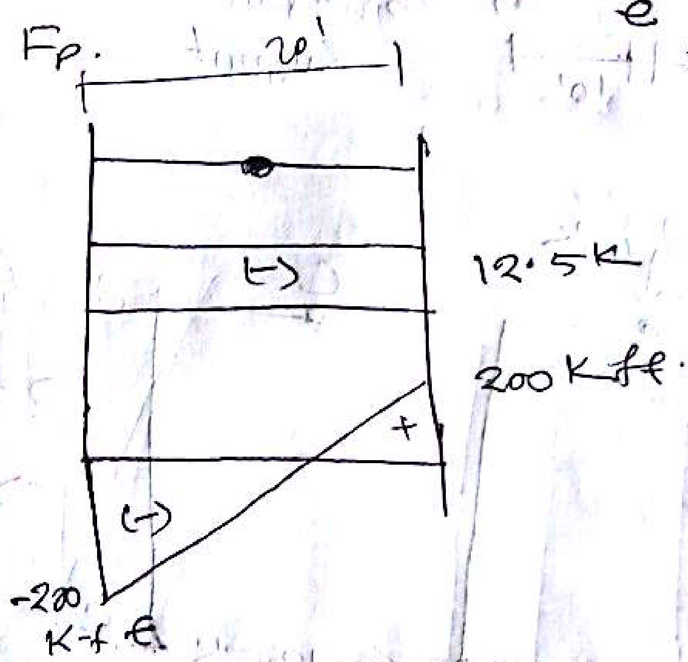
$\Rightarrow -R_{ey} \times 10 + R_{ex} \times 16 = 0$

$\Rightarrow R_{ex} = 12.5^k (\leftarrow)$

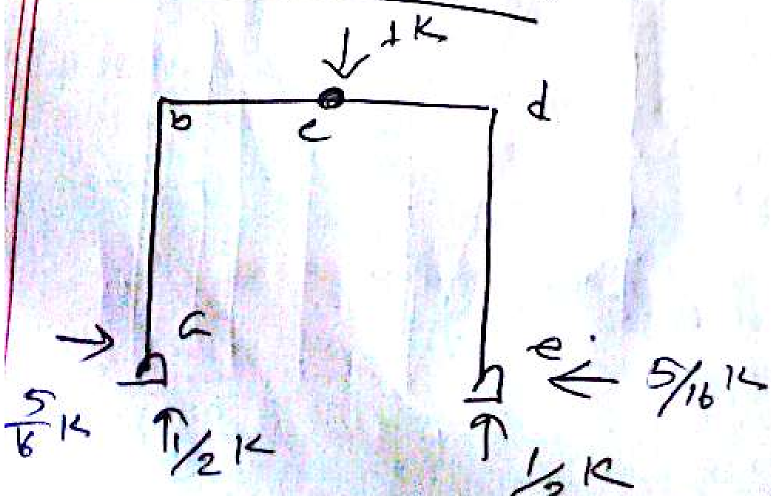
P force analysis:

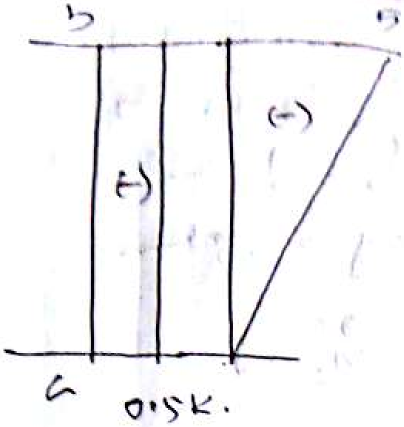


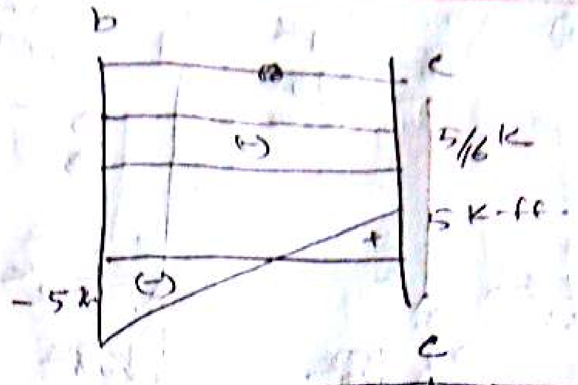


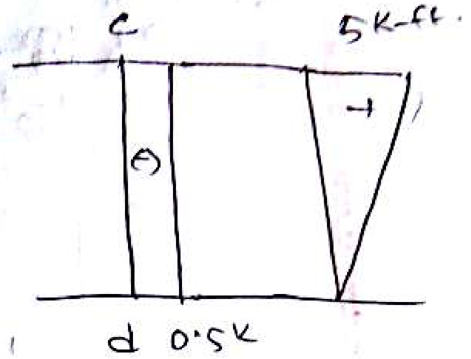


Q force analysis:









Applying principal of virtual work

$$1.\delta_c = \left(\frac{F_P F_Q L}{AE}\right)_{ab} + \left(\frac{F_P F_Q L}{AE}\right)_{bcd} + \left(\frac{F_P F_Q L}{AE}\right)_{de}$$

$$+ \int_c^b \frac{M_P M_Q}{EI} ds + \int_d^b \frac{M_P M_Q}{EI} ds + \int_d^e \frac{M_P M_Q}{EI} ds$$

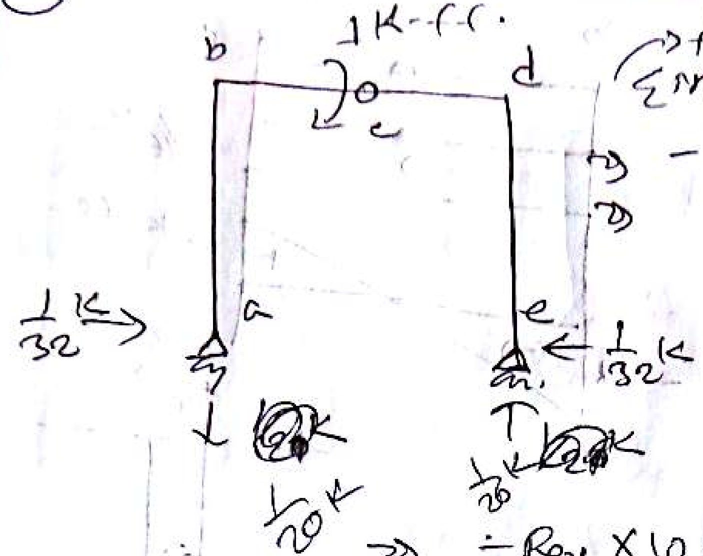
$$= \left[\left(20 \times 0.5 \times 16 \times \underset{\boxed{ab, de}}{2}\right) + \left(12.5 \times 20 \times \frac{5}{16}\right)\right] \times \frac{1}{15 \times 30 \times 10^3}$$

$$+ \int_0^{16} (-12.5x)(-5/16\, x)\, dx + \int_0^{16} 12.5x * \frac{5}{16} x\, dx$$

$$\left. + \int_0^{20} (200 - 20x)(5 - x/2)\, dx \right] \frac{\times 12^3}{400 \times 30 \times 10^3}$$

$$\delta_c = 0.21 \text{ ft} = 2.52 \text{ in}.$$

(11)



$\overset{+}{\curvearrowright} \Sigma M_A = 0$

$\Rightarrow -R_{ey} \times 20 + 1 = 0$

$\Rightarrow R_{ey} = \frac{1}{20} K$

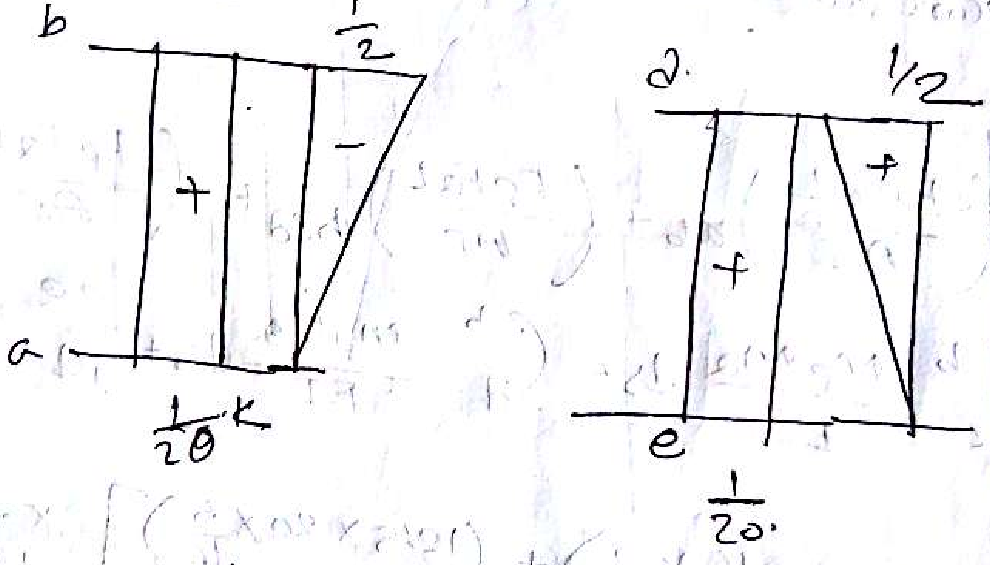
$R_{ay} = -\frac{1}{20} K$

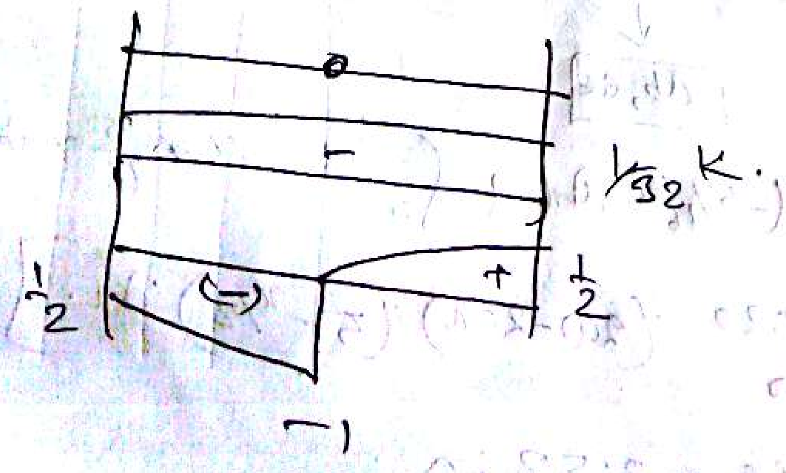
$\overset{+}{\curvearrowright} M_c = 0$

$\Rightarrow -R_{ey} \times 10 + R_{ex} \times 16 = 0$

$\Rightarrow R_{ex} = \frac{1}{32} K$

$R_{ax} = -\frac{1}{32} K$





1. $\alpha_C = \left(\frac{F_P F_Q L}{AE}\right)_{ab} + \left(\frac{F_P F_Q L}{AE}\right)_{bcd} + \left(\frac{F_P F_Q L}{AE}\right)_{de}$

$$+ \int_a^b \frac{M_P M_Q}{EI}\,dx + \int_E^b \frac{M_P M_Q}{EI}\,dx + \int_c^d \frac{M_P M_Q}{EI}\,dx$$

$$+ \int_e^d \frac{M_P M_Q}{EI}\,dx.$$

$$= \left(-20 \times \tfrac{1}{2} \times 16 + 20 \times \tfrac{1}{2} \times 16 + 12.5 \times \tfrac{1}{32} \times 20\right) \times \frac{1}{15 \times 30 \times 10^3}$$

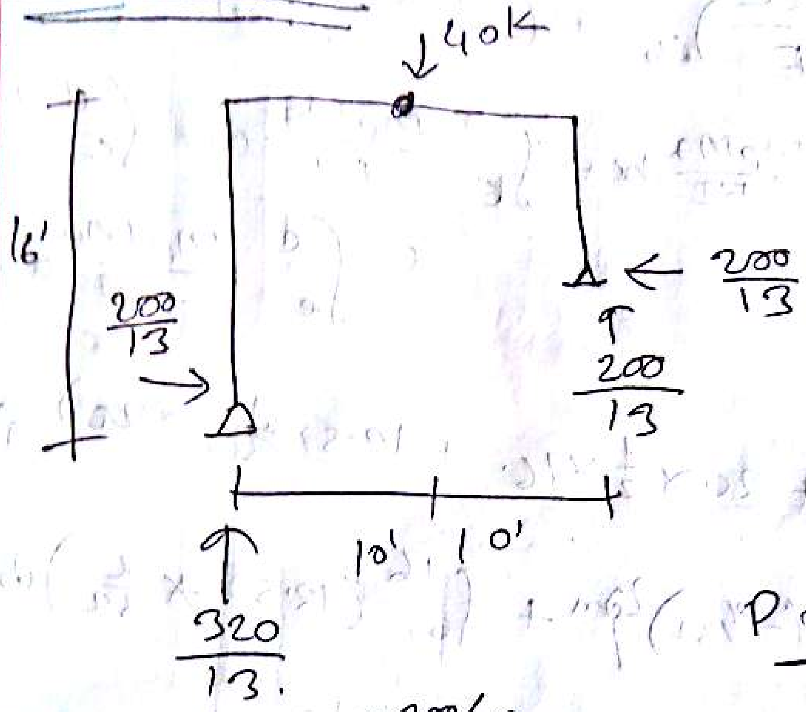
$$+ \int_0^{16} \left(-12.5x \cdot x \left(-x/32\right)\right) dx + \int_0^{16} \left(12.5x \times \frac{x}{32}\right) dx +$$

$$\left.\int_0^{10} \left(\frac{x}{20} + \frac{1}{2}\right) \cdot dx \right] \times \frac{12^2}{400 \times 30 \times 10^3}$$

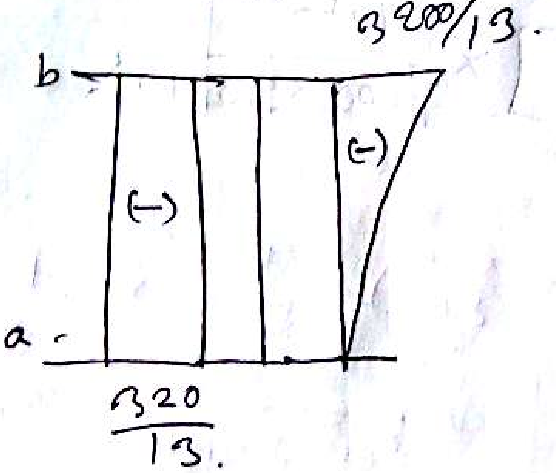
$= 0.0188$ rad (↻)

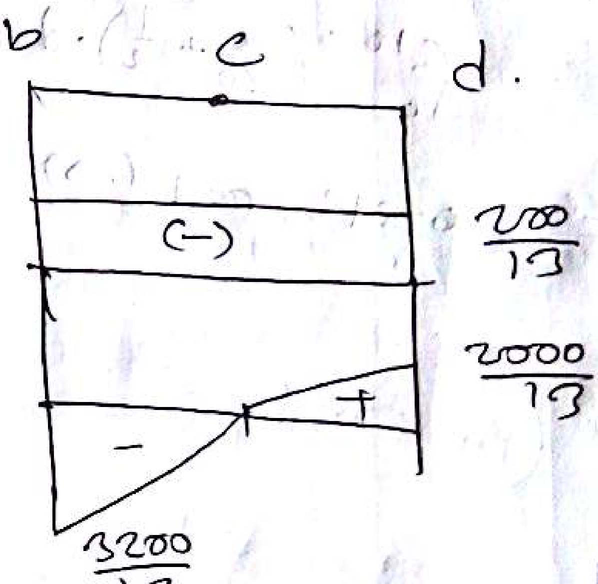
Assignment:

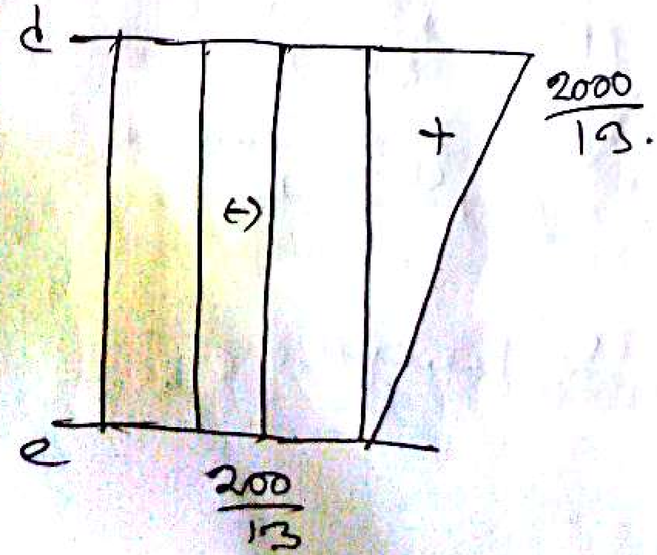
& all values same like before math.



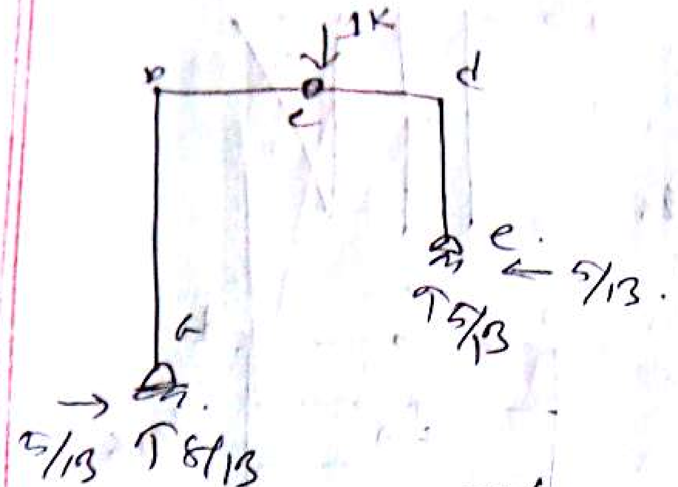
P force analysis

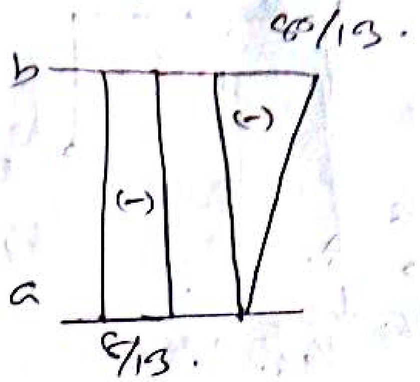


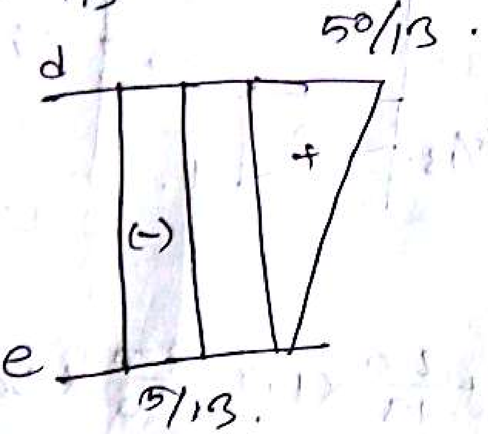


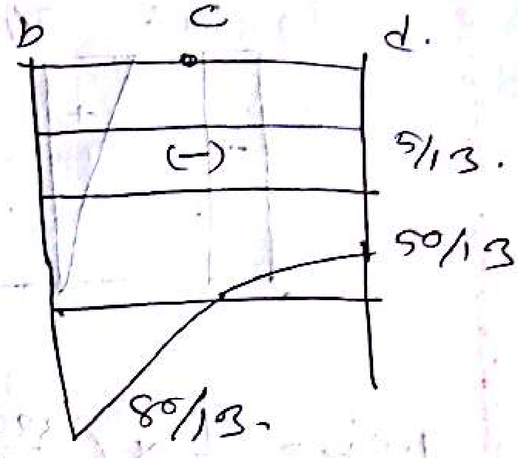


Q force analysis (deflection at c)









$$\therefore \delta_c = \left(\frac{320\times 8}{13^2}\times 16 + \frac{200\times 5}{13^2}\times 10 + \frac{200\times 5}{13^2}\times 20\right)$$

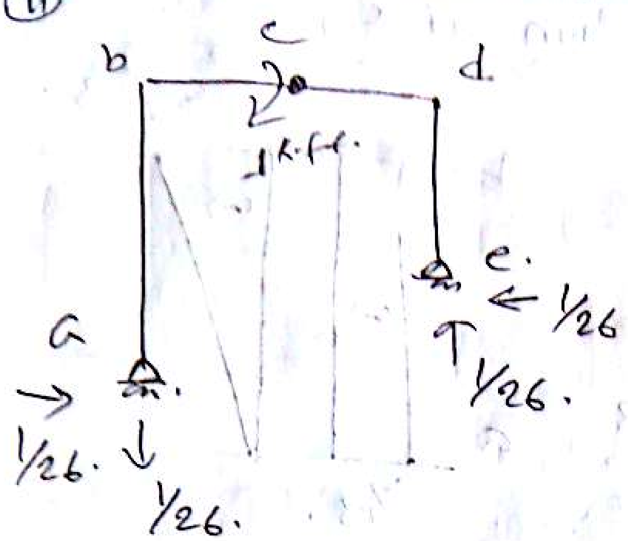
$$\times \frac{1}{15\times 30\times 10^3} + \left[\underbrace{\int_0^{16}\left(\frac{200x}{13}\cdot\frac{5x}{13}\right)dx}_{ab} + \cancel{\int_0^{10}}\left(\right.\right.$$

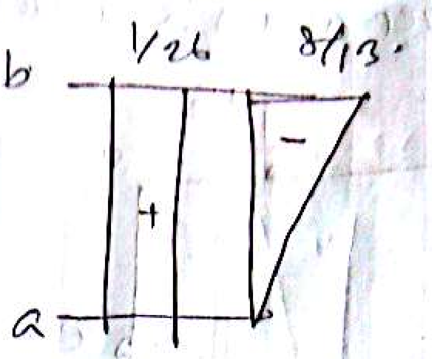
$$+ \underbrace{\int_0^{10}\left(\frac{-320x}{13}\right)\left(\frac{-8x}{13}\right)dx}_{bc} + \underbrace{\int_0^{10}\frac{200x}{13}\times\frac{5x}{13}\,dx}_{cd}$$

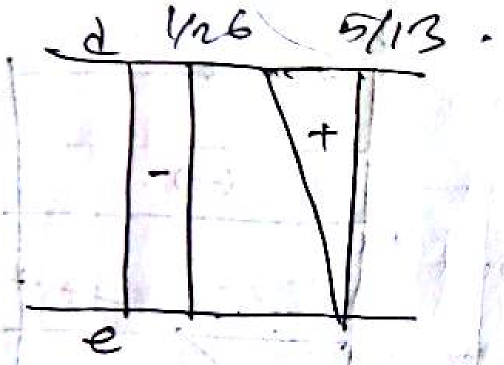
$$\left.+ \underbrace{\int_0^{10}\frac{200x}{13}\times\frac{5x}{13}\,dx}_{de}\right]\frac{12^2}{400\times 30\times 10^3}$$

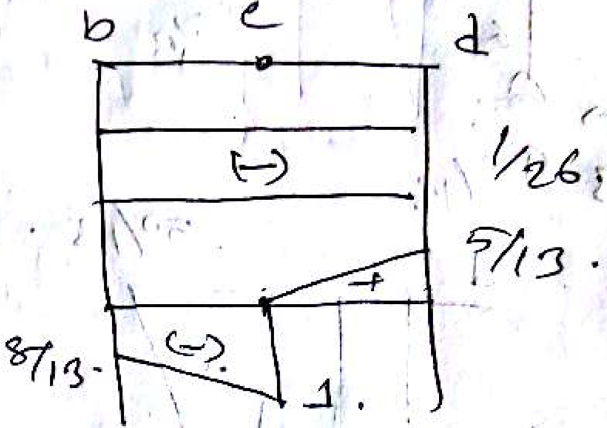
$$= 0.18' = 2.16''$$

(11)





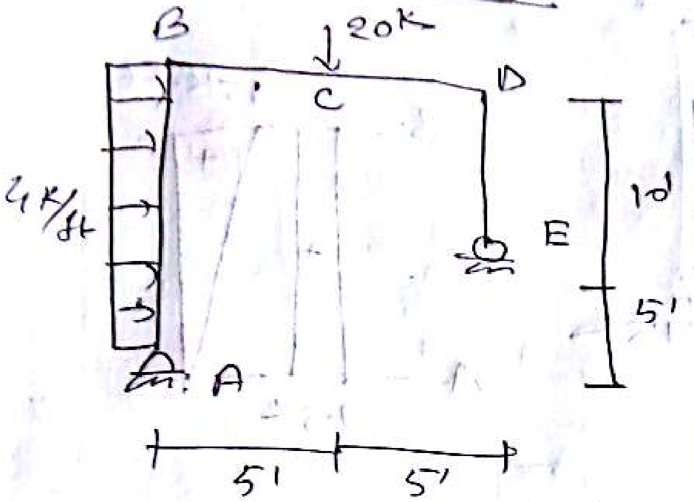




$$1\cdot\alpha_{bc} = \frac{1}{26}\times\left(\frac{320}{13}\times 16+\frac{200}{13}\times 10+\frac{200}{13}\times 20\right)\times \frac{1}{15\times 30\times 10^3} + \left[\int_0^{16}\left(-\frac{200x}{13}\times -\frac{x}{26}\right)dx + \int_0^{10}\left(\frac{200x}{13}\times\frac{x}{26}\right)dx + \int_0^{10}\left(-\frac{320x}{13}\times\frac{x}{26}\right)dx + \int_0^{10}\left(\frac{x}{26}\times\frac{200x}{13}\right)dx\right]\times\frac{12^2}{400\times 30\times 10^3}$$

$= 0.0911$ rad (2)

Assignment (13 batch)



$E = 30 \times 10^3$ ksi

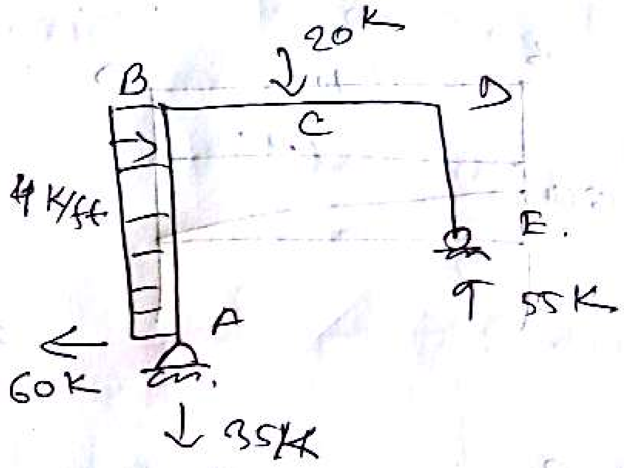
$I_{col} = 300 \text{ in}^4$.

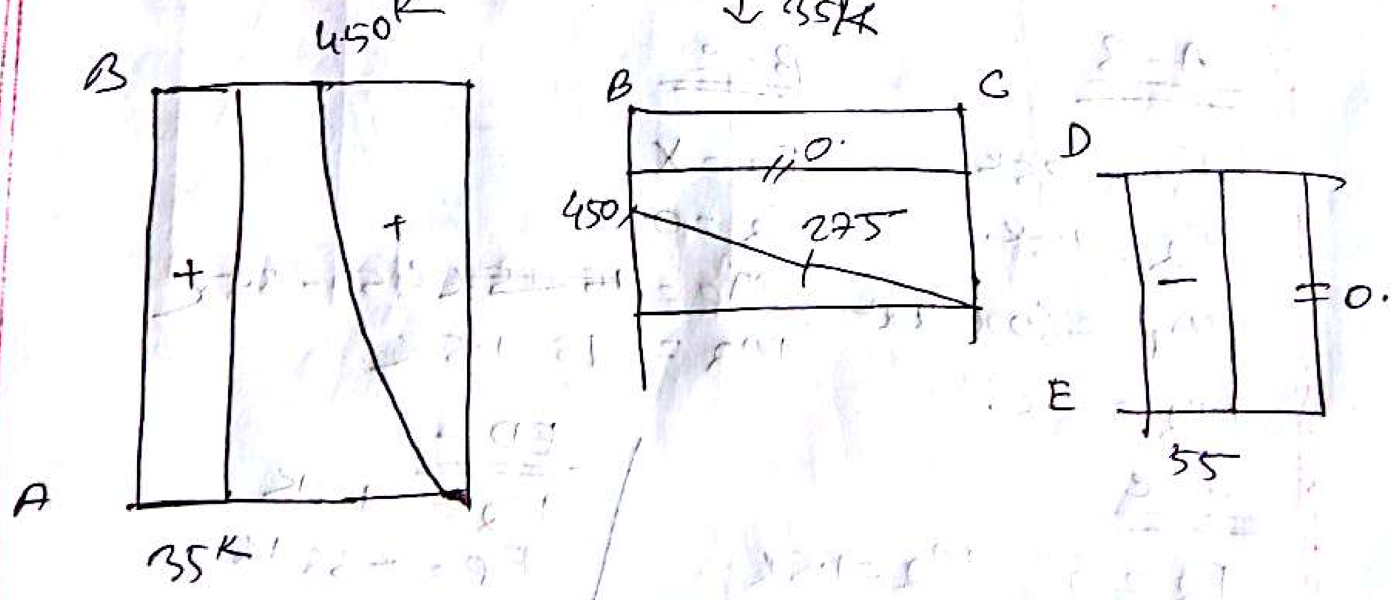
$I_{beam} = 400 \text{ in}^4$.

$A_{col} = 15 \text{ in}^2$

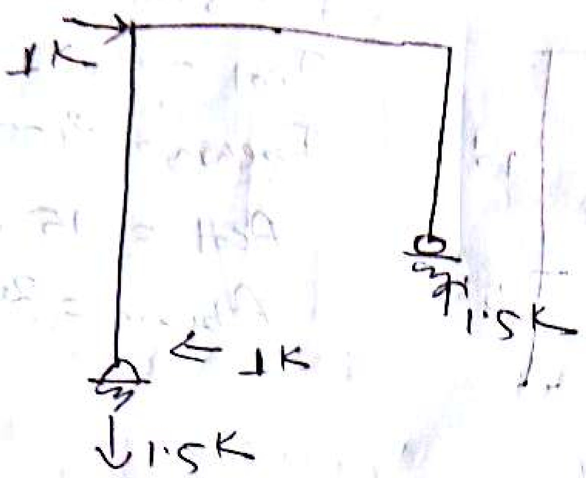
$A_{beam} = 20 \text{ in}^2$

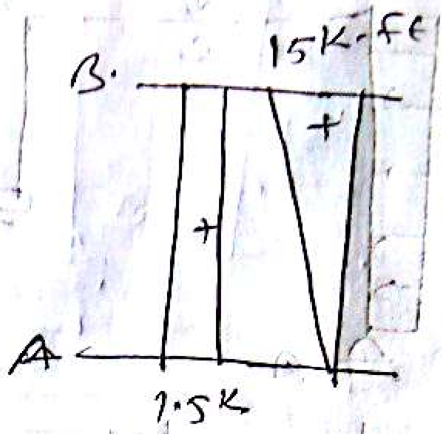
P force analysis:

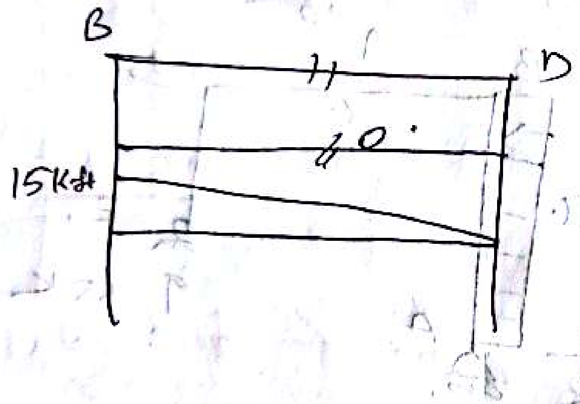


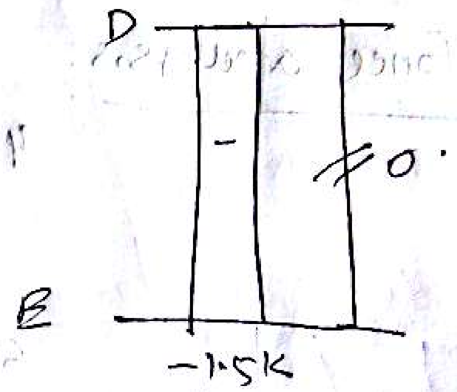


Q Force analysis:









A-B

$F_P = 35K$

$F_Q = 1.5K$

$M_P = 260x - 2x^2$

$M_Q = x$

B-C

$F_P = X$

$F_Q = 0$

$M_P = \cancel{15-1.5x}\ 450 - 35x$

$M_Q = 15 - 1.5x$

D-C

$F_Q = 0$

$F_P = X$

$M_Q = 1.5x$

$M_P = \cancel{15}\ 35x$

ED -

$F_Q = -1.5K$

$F_P = -55K$

$M_Q = 0$

$M_P = 0$

$$Q.\ \delta_{BH} = \frac{\sum F_Q F_P L}{AE} + \int \frac{m_Q m_P}{EI}\, ds.$$

$$1.\ \delta_{BH} = \left[\frac{1.5\times 35\times 15}{30000\times 15}\right]_{AB} + \left[\frac{-1.5\times(-55)\times 10}{30000\times 15}\right]_{DE}$$

$$+ \int_0^{15} \frac{x\cdot(60x-2x^2)}{EI}\,dx + \int_0^{5} \frac{(15-1.5x)(450-35x)}{EI}\,dx.$$

$$+ \int_0^{5} \frac{1.5x\cdot 55x}{EI}\,dx.$$

$= 0.97$ ft.

Question :

~~2014-15~~

2015-16 → 10

2014-15 → 11

2013-14 → 7

2012-13 → 13

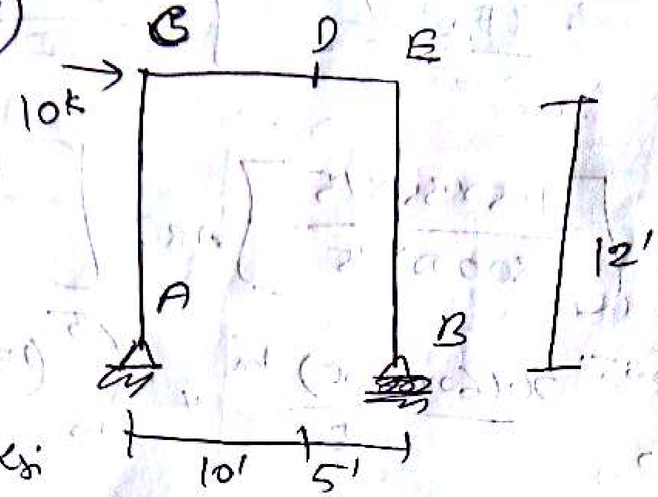
2011-12 → 7

2010-11 →

Scanned by CamScanner

2011-12

7



deflection at D.

$E = 30 \times 10^3$ Ksi

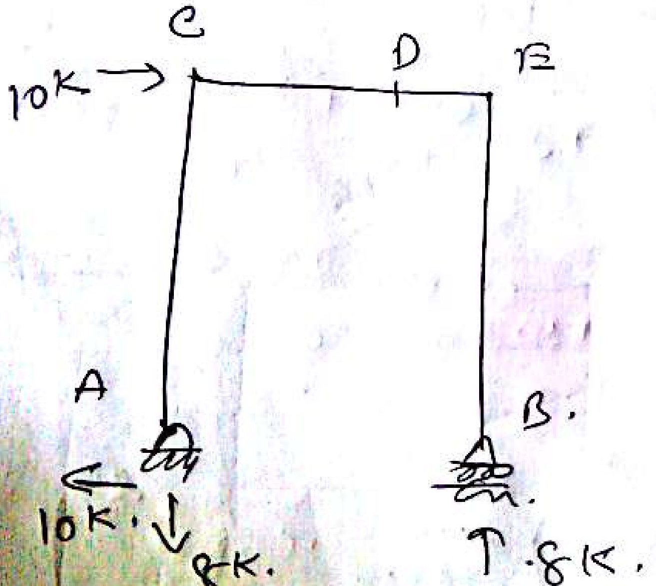
$I_{col} = 400\ in^4$

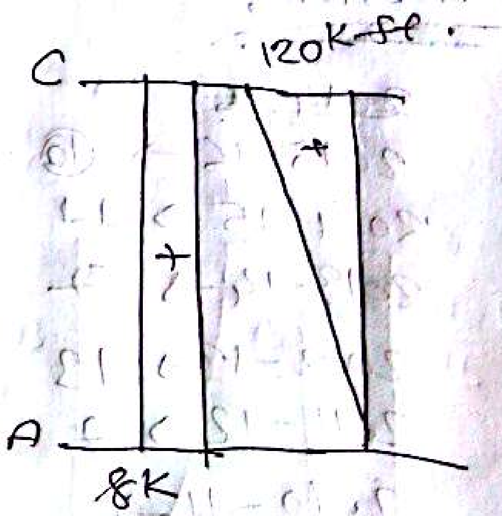
$I_{beam} = 600\ in^4$

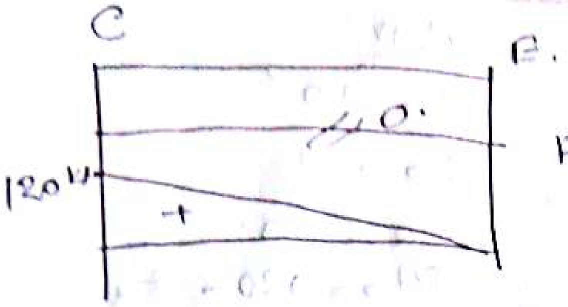
$A_{col} = 15\ in^2$

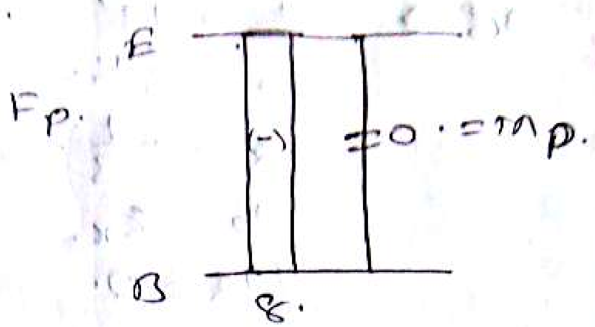
$A_{beam} = 20\ in^2$

P force analysis

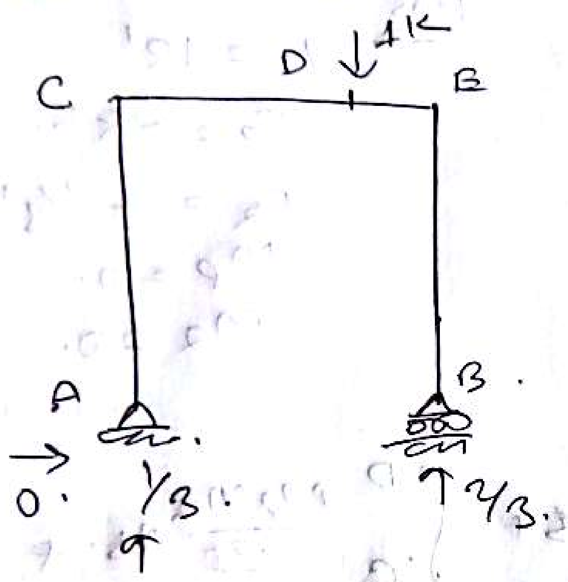


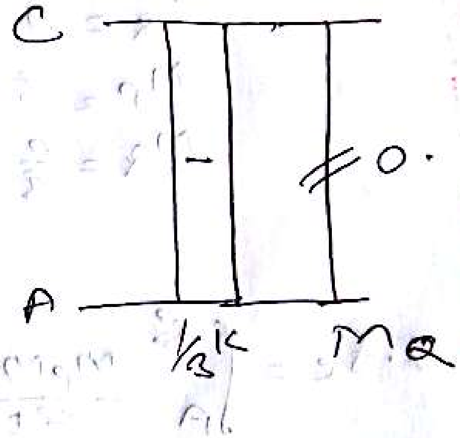


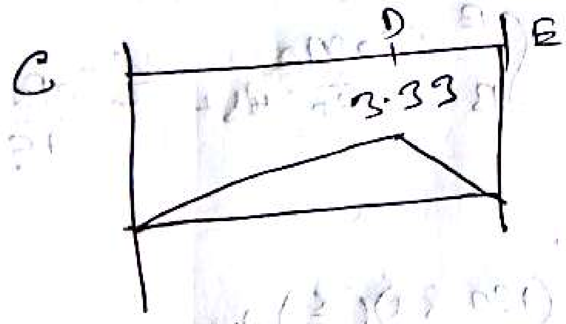


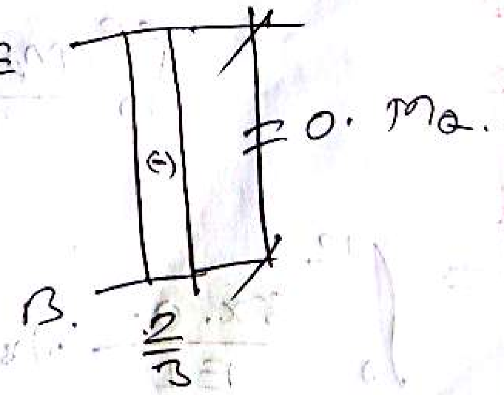


Q force analysis:









A ⊥ ⊥ B

AB →

$L = 12'$
$F_P = 8K$.
$F_Q = -\frac{1}{3}$.
$M_P = 8x$.
$M_Q = 0$.

<u>CD</u>

$L = 10'$
$F_P = 0$
$F_Q = 0$.
$M_P = 120 - 8x$
$M_Q = x/3$.

<u>DE</u>

$L = 5'$
$F_P = 0$
$F_Q = 0$
$M_P = 8x$.
$M_Q = \frac{2}{3}x$.

<u>EB</u>

$L = 12'$
$F_P = -8K$.
$F_Q = -2/3 K$
$M_P = 0$.
$M_Q = 0$.

$$Q \cdot \delta_C = \int_A^B \frac{M_P M_Q}{EI} ds + \int_C^D \frac{M_P M_Q}{EI} ds + \int_D^B \frac{M_P M_Q}{EI} ds + \int_B^E \frac{M_P M_Q}{EI} ds + \sum \frac{F_P F_Q L}{AE}$$

$$= \int_0^{12} \frac{8x \cdot 0}{EI} dx + \int_0^{10} \frac{(120-8x)(\frac{x}{3})\, dx}{EI}$$

$$+ \int_0^5 \frac{8x \cdot \frac{2}{3}x}{EI} dx + \int_0^{12} \frac{0 \times 0}{EI} dx +$$

$$\frac{8 \times (-\frac{1}{3}) \times 12}{15 \times 30000} + \frac{0 \times 0 \times 10}{20 \times 30000} + \frac{0 \times 0 \times 5}{20 \times 30000}$$

$$+ \frac{-8 \times (-2/3) \times 12}{15 \times 30000}$$

$$= \frac{10000}{9EI} + \frac{2000}{9EI} + -\frac{2}{28125} + \frac{4}{28125}$$

সঠিক নয়. ☺