Sheet 2

Solve the following

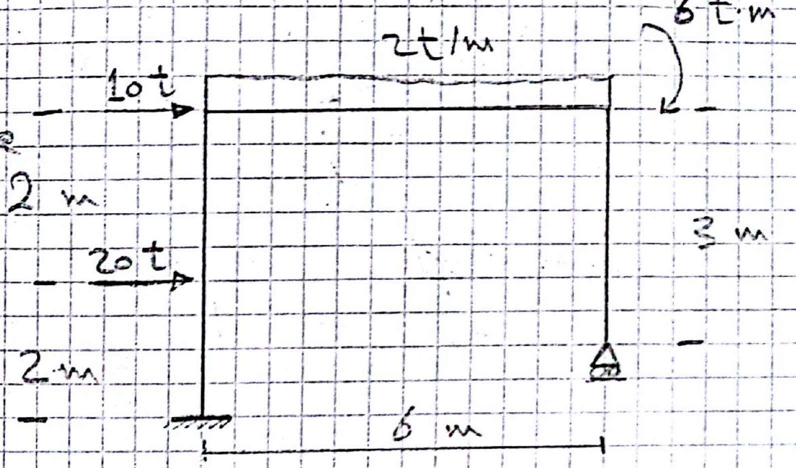
1- Shown loads

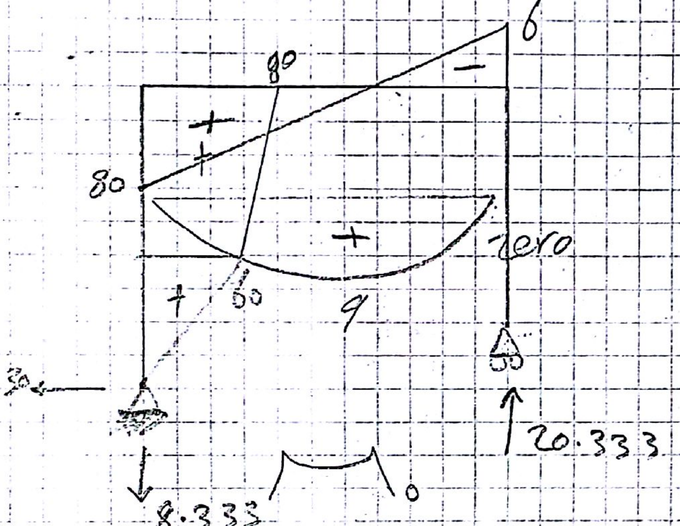
(2) 40°C inside 20°C outside

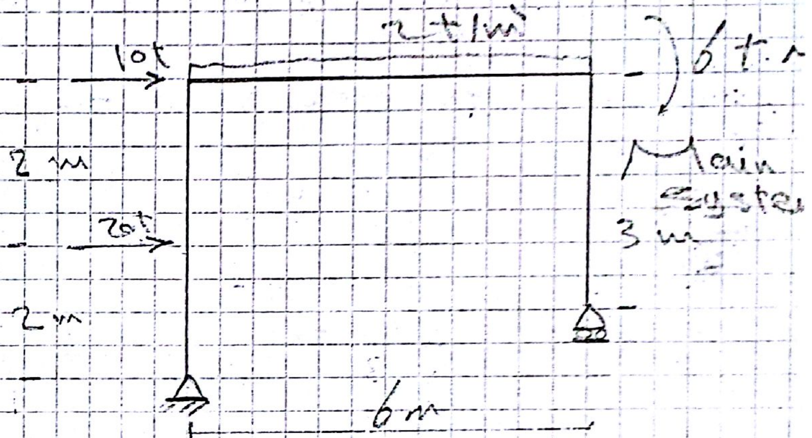
unknown = 4

equations = 3

1st indeterminate

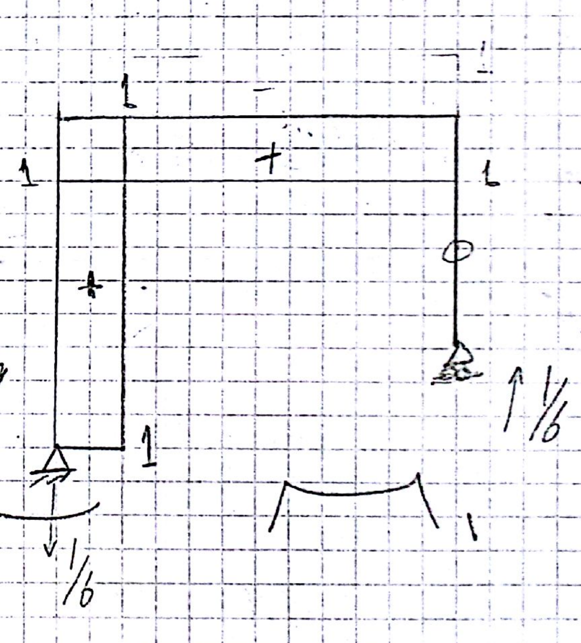






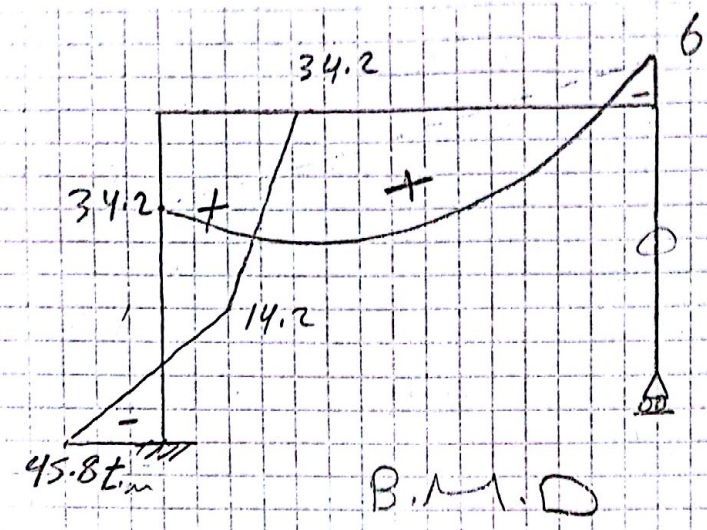
$$\delta_{10} = \int \frac{M_1 M_0}{EI} \, dl$$

$$\delta_{10} = \left[\frac{1}{2} * 60 * 2 + \frac{1}{2} * 140 * 2 + \frac{6}{6} * [2*80 - 2*6 + 80 - 6] + \frac{2}{3} * 6 * 9\right] \frac{1}{EI} = \frac{458}{20000} = 0.0229$$



$$\delta_{11} = \int \frac{M_1 M_1}{EI} \, dl = \frac{1}{EI}(4+6) = \frac{10}{20000} = \frac{1}{2000}$$

$$X_1 = \frac{-\delta_{10}}{\delta_{11}} = \frac{-0.0229}{5 * 10^{-4}} = -45.8 \, t.m = 45.8 \, t.m$$



B.M.D

Due to Rise in temperature

$$\sim_{1t} + \sim_{11} X_1 = \cancel{\sim_{et}} \rightarrow \text{zero}$$

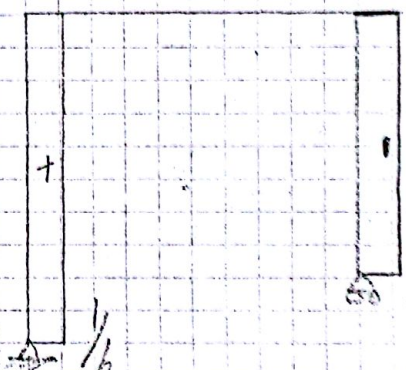
$$\therefore \sim_{1t} = \alpha \left[\frac{t_{in} - t_{out}}{h} \right] \leq A(\sim_1) + \frac{t_{in}+t_{out}}{2} \leq A N_1$$

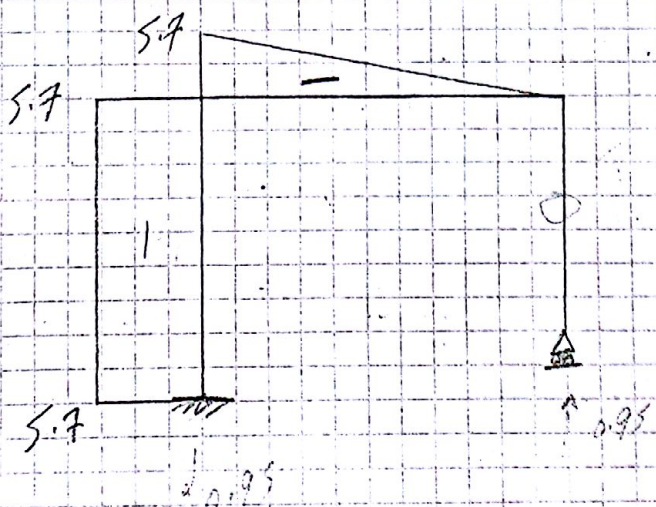
$$\sim_{1t} = 10^{-5} * \left[\frac{40-20}{0.8} \right] * [4+6] + \frac{40+20}{2} * \left[\frac{3}{6} + \frac{4}{6} \right]$$

$$= 2.85 * 10^{-3}$$

$$2.85 * 10^{-3} + \frac{1}{2000} X_1 = 0$$

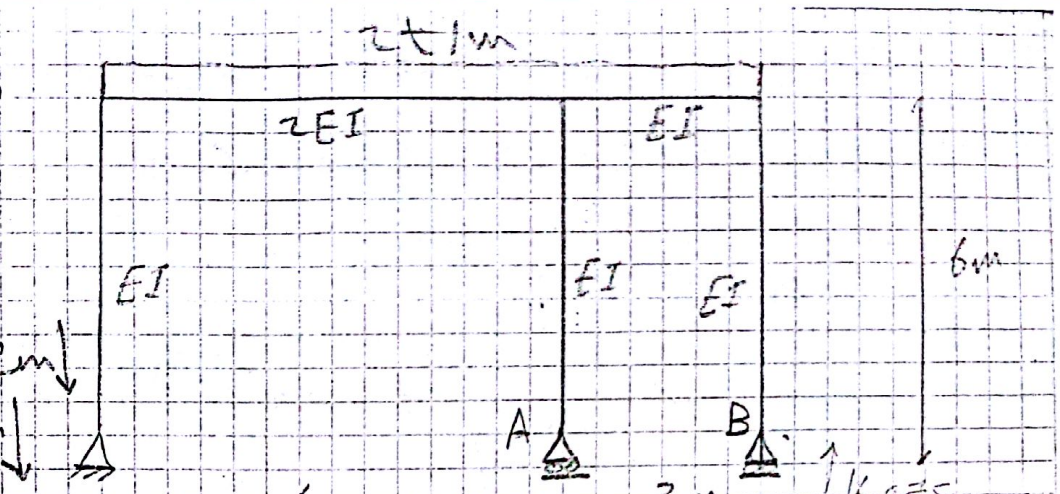
$$\therefore X_1 = 5.7 \text{ t.m} \rightarrow$$

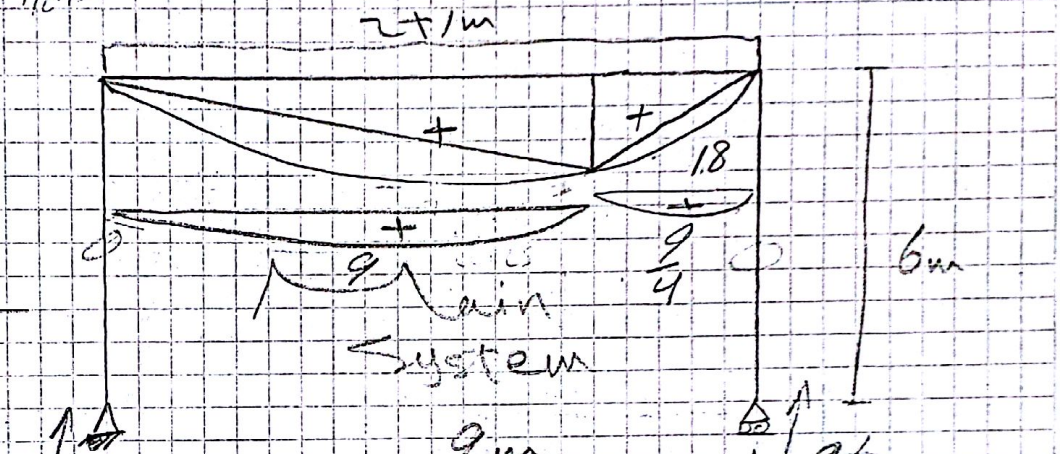




① Solve due to shown Load

② Settlement at Support A = 2 cm ↓
at Support B = 4 cm ↓

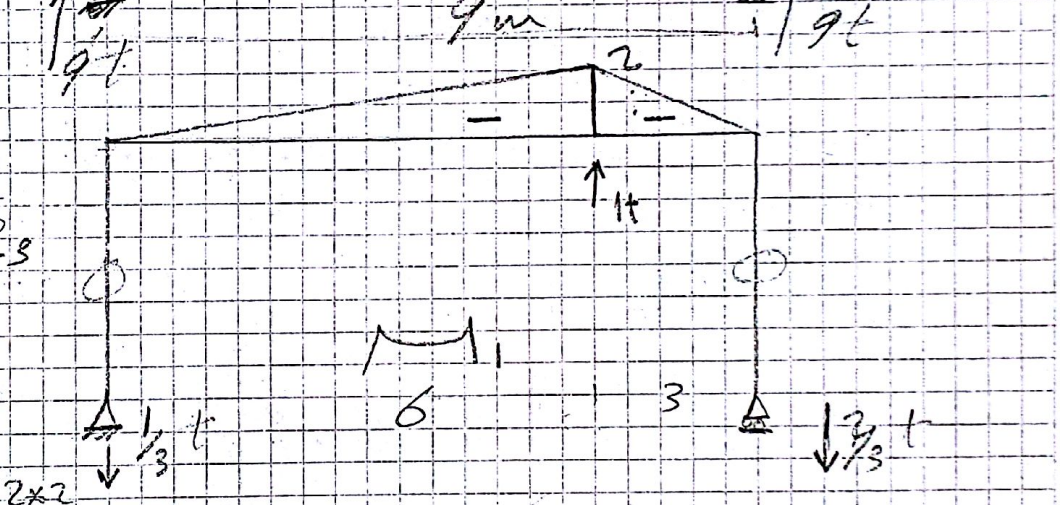




$$\delta_{10} = \frac{-3}{6EI} * [2 * 18 * 2] - \frac{\frac{2}{3} * 3 * \frac{9}{4} * 1}{EI} - \frac{1}{2EI}[2 * 2 * 18] - \frac{\frac{2}{3} * 6 * 9 * 1}{2EI}$$

$$\delta_{10} = \frac{-81}{40000} - \frac{54}{20000}$$

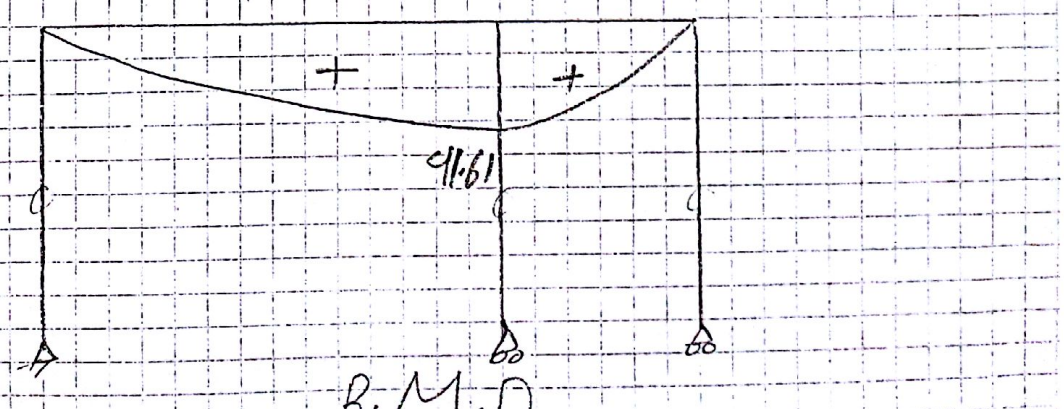
$$\delta_{10} = -4.725 * 10^{-3}$$



$$\delta_{11} = \frac{3}{6EI} * 2 * 2 * 2 + \frac{6}{6EI * 2} * 2 * 2 * 2$$

$$\delta_{11} = \frac{1}{2500}$$

$$X_1 = -\frac{\delta_{10}}{\delta_{11}} = \frac{-4.725 * 10^{-3}}{1/2500} = -11.8125\ t = 11.81\ t\downarrow$$



$$\delta_{15} + X_1 \delta_{11} + \delta_{10} = \delta_{1\,act}$$

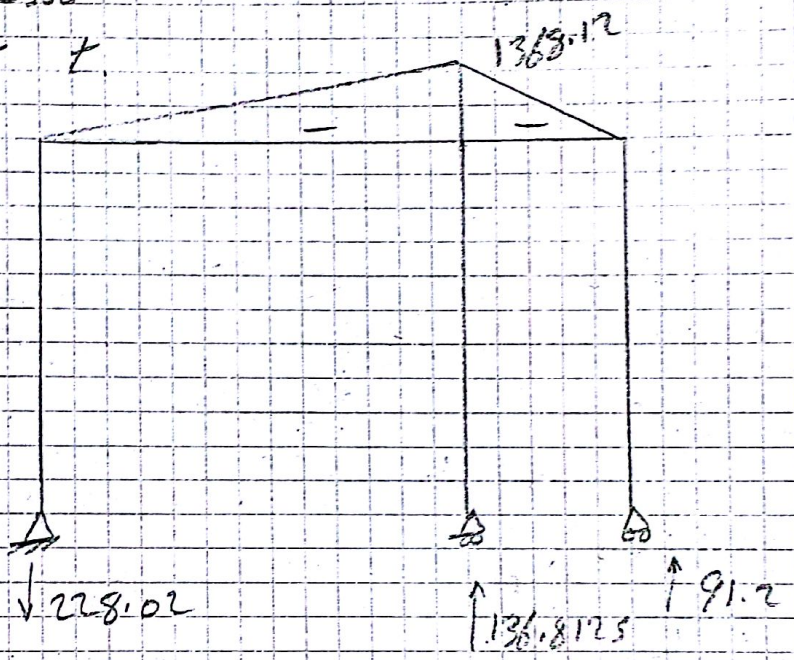
$$\delta_{15} + \sum R * \text{settlement} = \text{zero}$$

$$\delta_{15} + \frac{2}{3} * 0.04 = 0$$

$$\delta_{15} = -0.03$$

$$-0.03 + X_1 * \frac{1}{2500} - 4.725 * 10^{-3} = 0.02$$

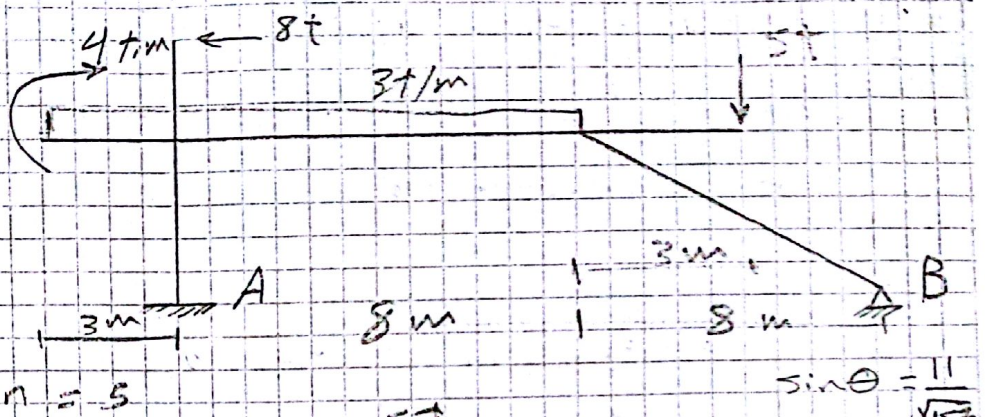
$$X_1 = 136.8125 \ t.$$



B.M.D

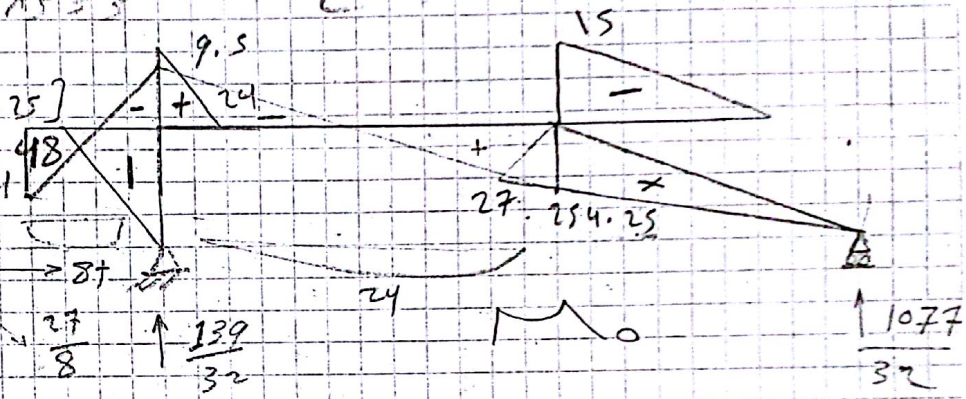
Shown load

② Settlement
at A = 1 Cm ↓
at B = 3 Cm ↓



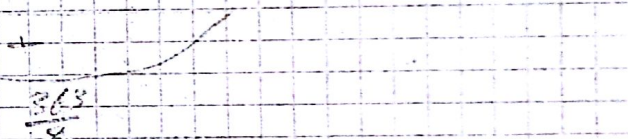
unknown = 5
equations = 3

$\sin\theta = \frac{11}{\sqrt{157}}$



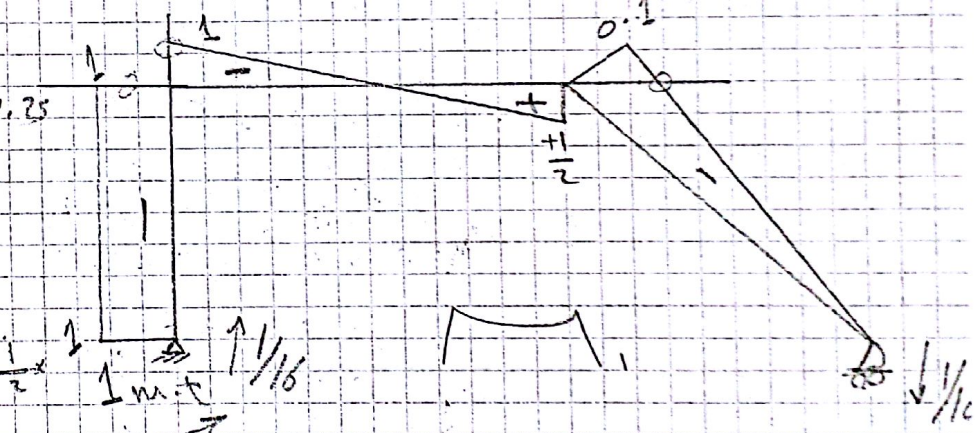
$$\delta_{10} = \frac{8}{6EI} * \left[2*9.5*1 + \frac{1}{2} * 254.25\right] + \frac{6}{6EI}\left[48*0.5*6\right] - \frac{10}{6EI}\left[\frac{27}{2} * 2 * 0.1\right]$$

$$\delta_{10} = 0.025$$



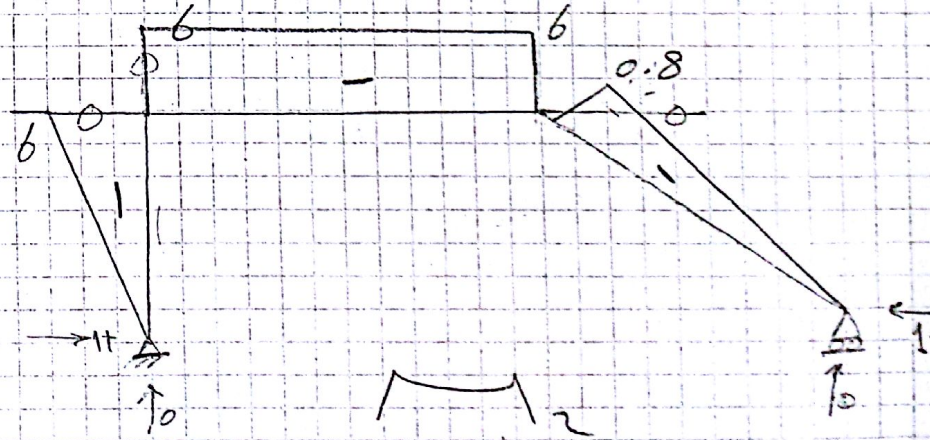
$$\delta_{20} = \frac{6}{6EI} * [2*48*6] + \frac{10}{6EI}\left[0.1*(-27)\right] + \frac{8}{6EI}*\left(2*9.5*1 + \frac{1}{2}*254.25 * \frac{1}{2}\right]$$

$$\delta_{20} = 0.034$$



$$\delta_{11} = \frac{6}{6EI} * 6 + \frac{8}{6EI} * \left[2*1 + 2*\frac{1}{2}*\frac{1}{2}\right] + \frac{10}{6EI} * 0.1 * 2 * 0.1\ ]$$

$$\delta_{11} = 4.7 * 10^{-4}$$



$$\delta_{22} = \frac{6}{6EI} * 2*6*6 + \frac{6*8*6}{EI} + \frac{10}{6EI} * 2*0.8*0.8$$

$$= 0.02$$

$$\delta_{12} = \frac{6*0.5*6}{EI} + \frac{8}{6EI}\left[6 - \frac{1}{2}*6\right] + \frac{0.1*0.8*2*10}{EI} = 1.18*10^{-3}$$

$\sigma_{10} + X_1 \sigma_{11} + X_2 \sigma_{12} = \sigma_{1,act} = 0$

$\sigma_{20} + X_2 \sigma_{22} + X_1 \sigma_{12} = \sigma_{2,act} = 0$

$0.025 + 4.7 \times 10^{-4} X_1 + 1.18 X_2 = 0$ ——→ (1)

$0.034 + 0.02 X_2 + 1.18 X_1 = 0$ ——→ (2)

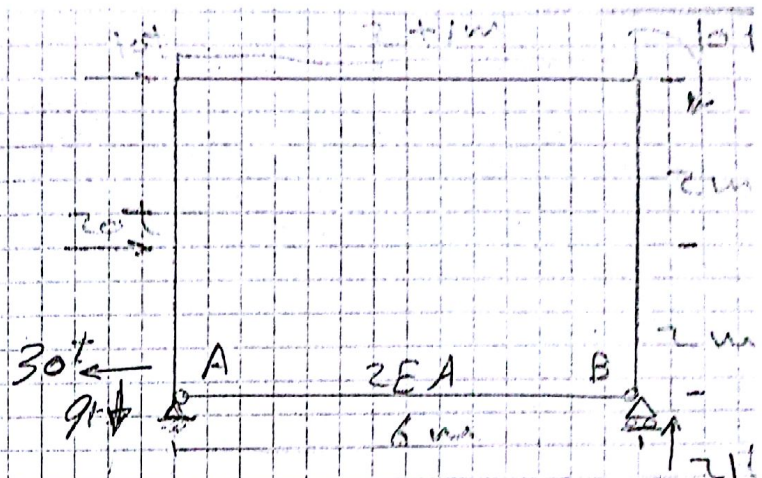
$X_1 = -0.02\ell$ $\quad X_2 = 0.02\ell$

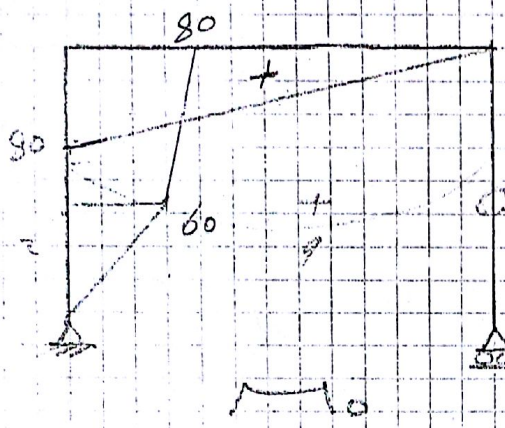
olve for

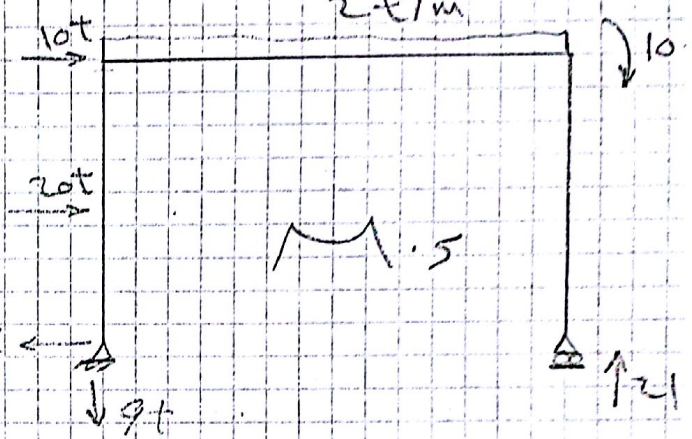
① Static load

② settlement A = 3 cm ↓

B = 6 cm ↓



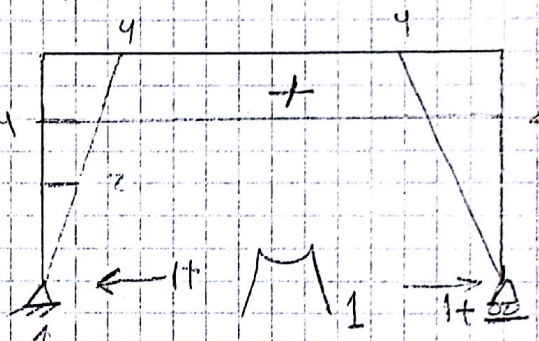




$$\delta_{10} = \frac{0.5*6*80*4}{EI} + \frac{2}{6EI}*[2*80*4 + 2*60*2 + 80*2 + 60*4]$$

$$+ \frac{2}{6EI} * 2*60*2$$

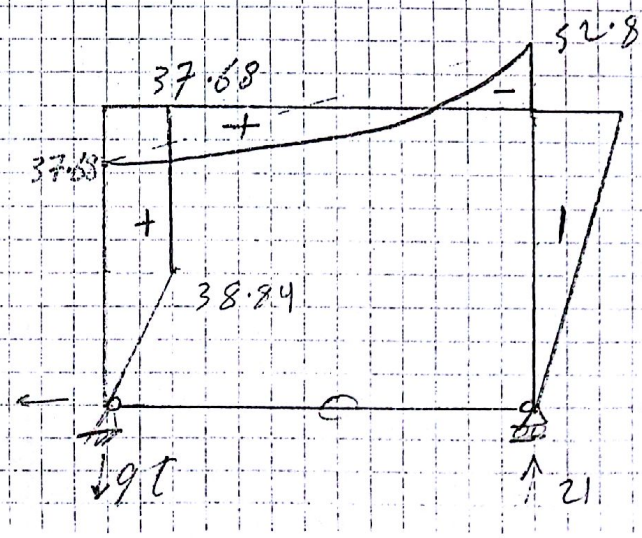
$$\delta_{10} = \frac{1280}{EI} + \frac{960}{EI} + \frac{80}{EI} = \frac{11}{150}$$



$$\delta_{11} = \frac{4}{6EI} * 2*4*4 + \frac{4*4*6}{EI} + \frac{4*4*4*2}{6EI} = \frac{13}{1875}$$

$$\delta_{10} + X_1 \delta_{11} = \delta_{1\,act}$$

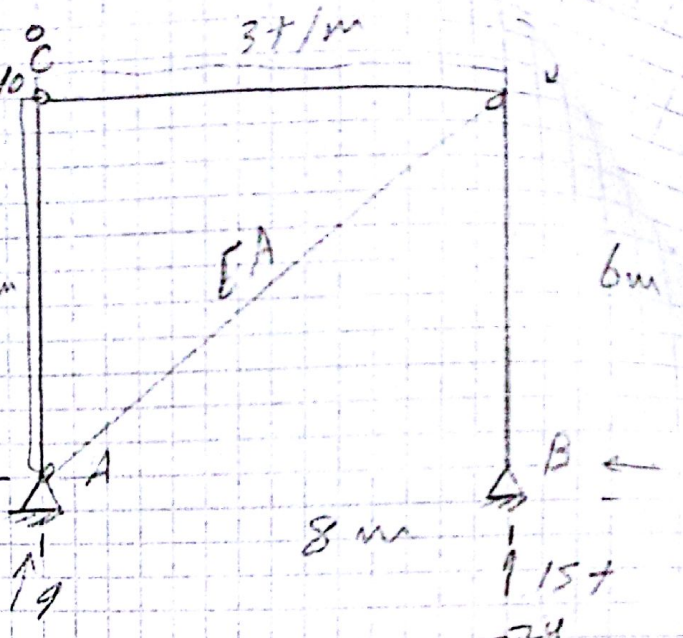
$$\frac{11}{150} + X_1 * \frac{13}{1875} = 0 \qquad X_1 = 10.58\ t \text{ tension}$$



① Known loads

② Uniform Rise in Temperature 40°C

③ Settlement at A = 4Cm ↓
and B = 5Cm ↓



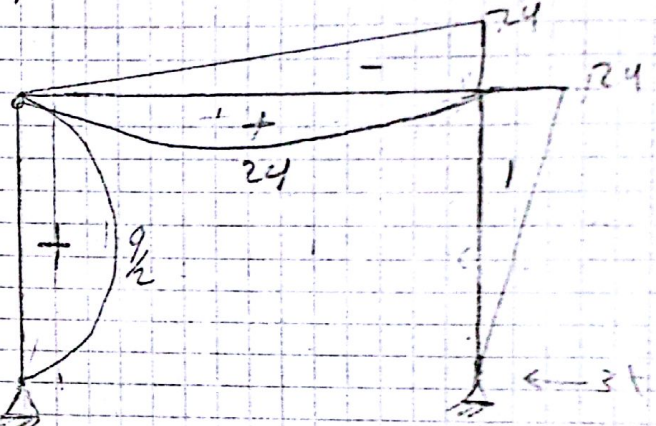
$$\sim_{10} + \sim_{11} X_1 + \sim_{12} X_2 = 0$$

$$\sim_{20} + \sim_{22} X_2 + \sim_{12} X_1 = 0$$

$$\sim_{10} = \frac{1}{6EI} * [2 * 24 * 4.8] - \frac{2}{3EI} * 8 * 24 * 2.4$$

$$- \frac{2}{3EI} * 6 * \frac{9}{2} * 2.4$$

$$= \frac{-43.2}{EI}$$



$$\sim_{11} = \frac{8}{6EI} * 2 * 4.8 * 4.8 + \frac{6}{6EI} * 2 * 4.8^2$$

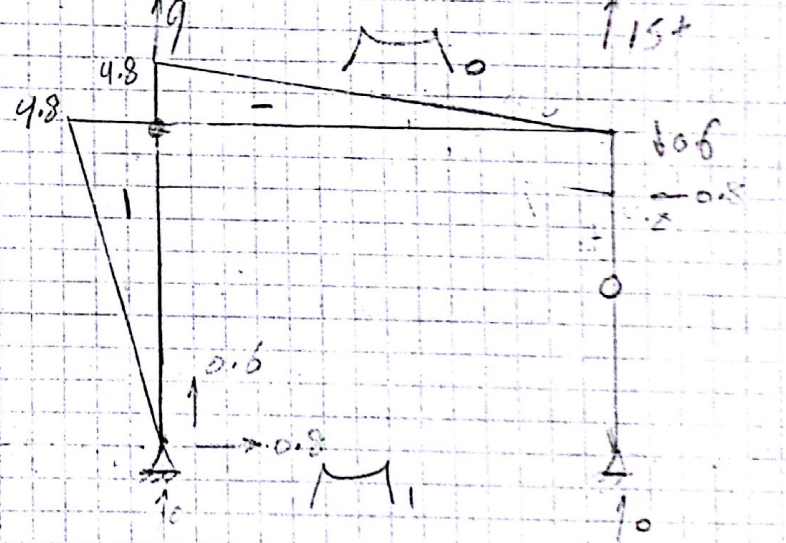
$$= 107.52/EI$$

$$\sim_{10} + \sim_{11} X_1 = 0$$

$$\frac{-43.2}{EI} + \frac{107.5}{EI} X_1 = 0$$

$$X_1 = 0.4 \text{ t}$$

$$X_1 = 3.04 \text{ t}$$



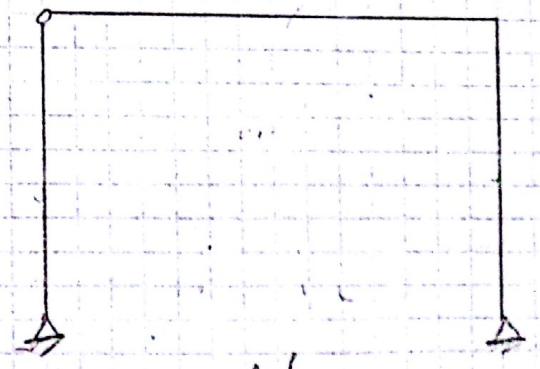
$$\sim_{15} + \sim_{11} X_1 = -0.04$$

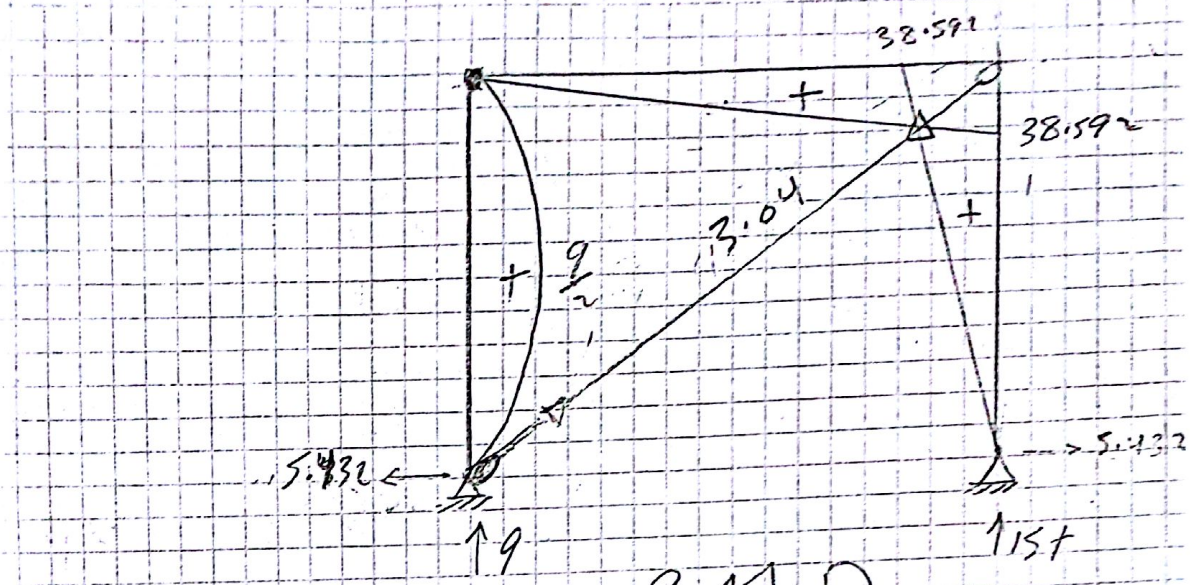
$$\sim_{15} + \Sigma R * \text{sett} = \text{zero}$$

$$\sim_{15} + 0 = 0$$

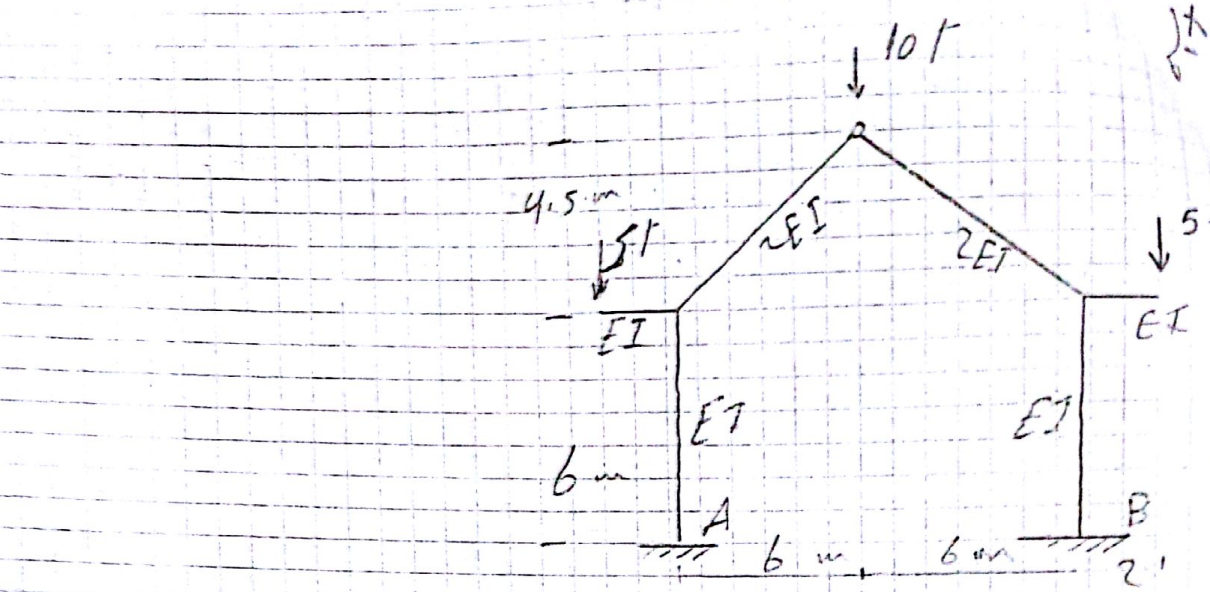
$$\sim_{11} X_1 = -0.04$$

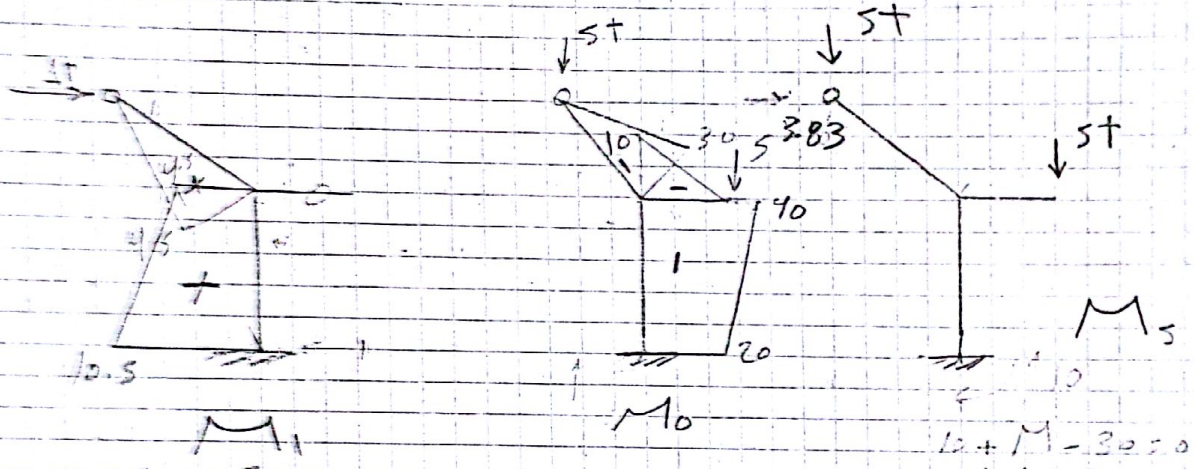
$$X_1 = 0.372 \text{ t}$$





B.M.D





$$\delta_{10} = \frac{-6}{6EI} * [2*10.5*20 + 2*4.5*40 + 4.5*20 + 10.5*40] - \frac{4.5}{2*6EI} * 2*30*4.5$$

$$= \frac{-1240}{EI} + \frac{-675}{4EI} = \frac{-5835}{4EI}$$

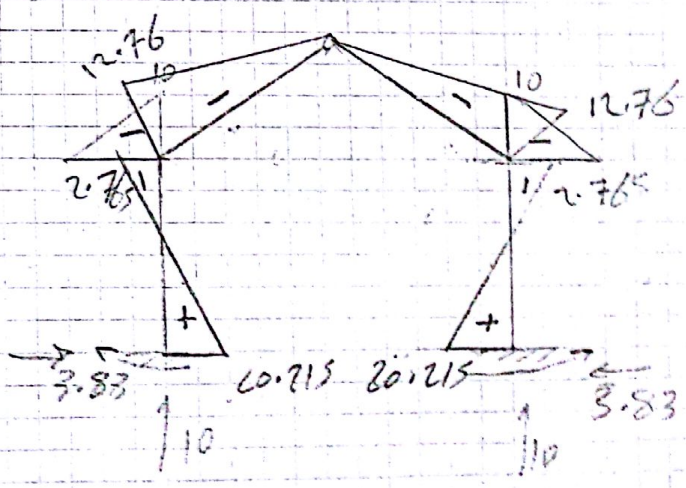
$$\delta_{11} = \frac{7.5}{2*6EI} * 2*4.5^2 + \frac{6}{6EI} * 2*10.5*10.5 + 2*4.5^2 + 4.5*10.5$$

$$= \frac{6093}{16EI}$$

$$\frac{405}{16EI} + \frac{711}{2EI}$$

$$\frac{-5835}{4EI} + \frac{6093}{16EI} X_1 = 0$$

$$X_1 = 3.83 \text{ t}$$



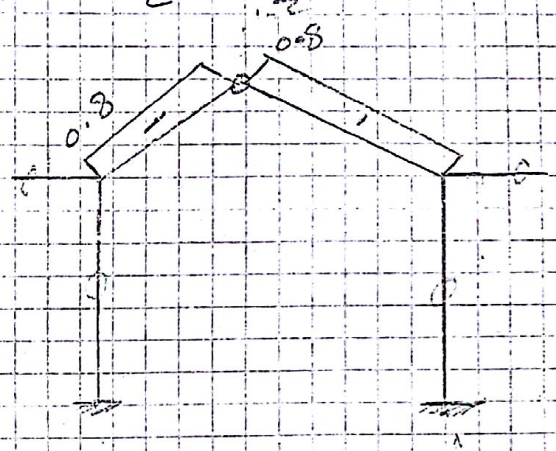
$$\sigma_{1t} = \alpha\left[\frac{t_{in} - t_{out}}{h}\right]\sum A M_1 + \alpha\left[\frac{t_{in} + t_{out}}{2}\right]\sum A M_1$$

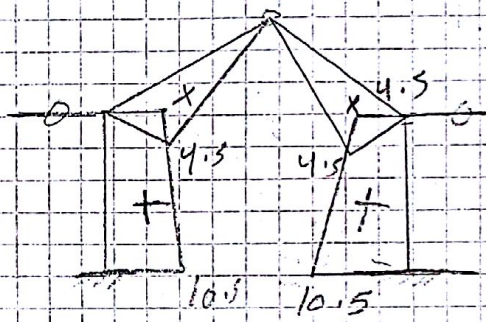
$$\sigma_{1t} = 15^{-5}\left[\frac{40-20}{0.25}\right] \times (4.5 + 16.9) \times 10^{-5} \times \frac{20}{0.2} \times 12$$

$$= 0.0184$$

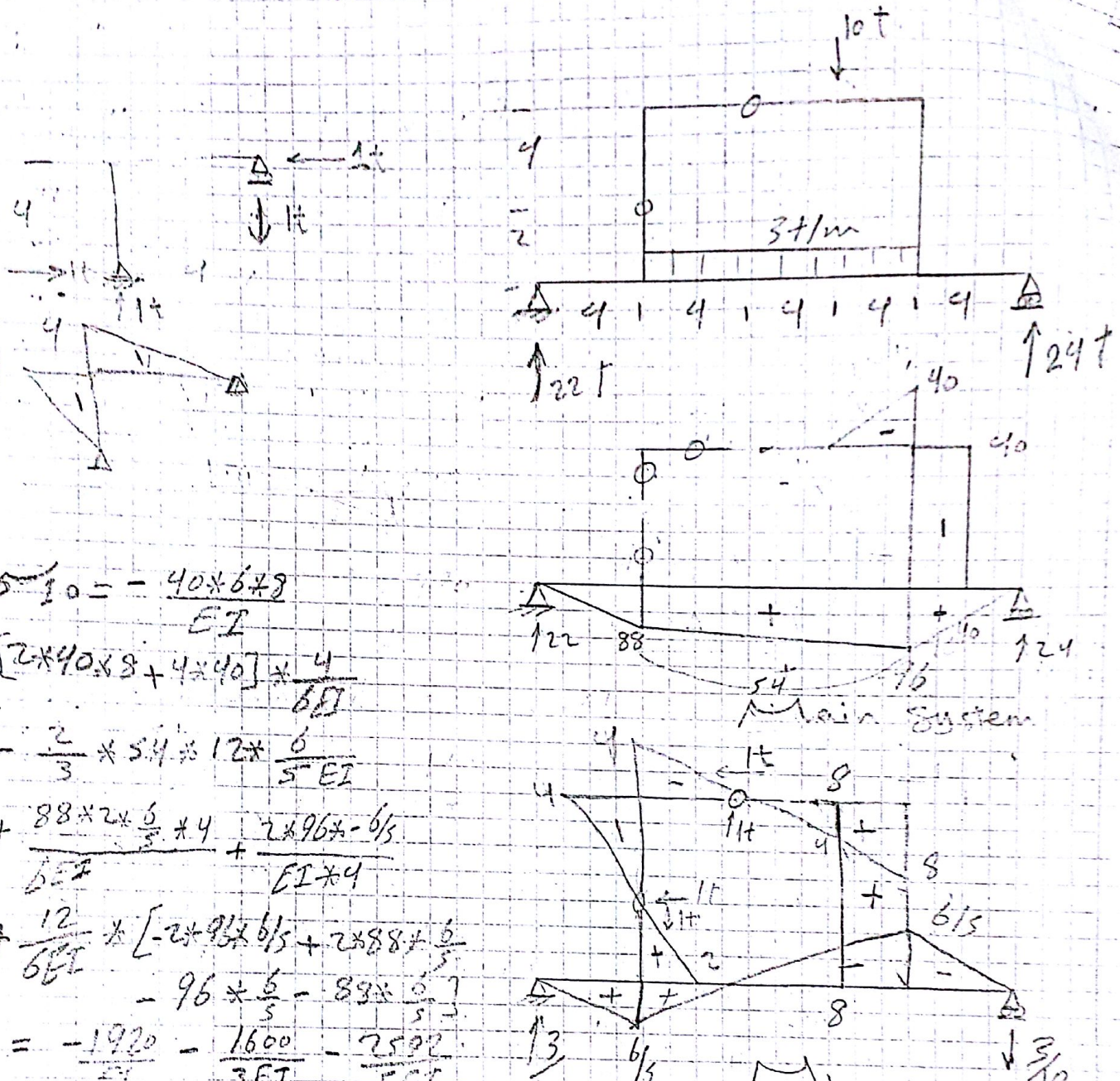
$$\sigma_{1t} + X_1 \sigma_{11} = 0$$

$$X_1 = \frac{-0.0184}{2.019} = 1.1$$





B.M.D



$$\delta_{10} = -\frac{40*6*8}{EI} - \left[2*40*8 + 4*40\right]*\frac{4}{6EI} - \frac{2}{3}*54*12*\frac{6}{5EI} + \frac{88*2*\frac{6}{5}*4}{6EI} + \frac{2*96*-\frac{6}{5}}{EI*4} + \frac{12}{6EI}*\left[-2*96*\frac{6}{5} + 2*88*\frac{6}{5} - 96*\frac{6}{5} - 88*\frac{6}{5}\right]$$

$$= -\frac{1920}{EI} - \frac{1600}{3EI} - \frac{2592}{5EI} + \frac{704}{5EI} + \frac{288}{5EI} - \frac{240}{EI} = -\frac{46928}{15EI}$$

$$\delta_{11} = \frac{12}{6EI}*\left[2*4*4 + 2*2*8 - 4*8*2\right] + \frac{6}{6EI}*\left[2*4*4 + 2*2*2 - 4*2*2\right] - \frac{8*6*8}{EI} + \frac{2*4*2*\frac{6}{5}*\frac{6}{5}}{6EI} + \frac{12}{6EI}*\left[2*\frac{6}{5}*\frac{6}{5}*2 - 2*\frac{6}{5}*2\right]$$

$$\delta_{11} = \frac{192}{EI} + \frac{24}{EI} - \frac{384}{EI} + \frac{96}{25EI} = -\frac{4104}{25EI}$$

$$\delta_{10} + \delta_{11} X_1 = 0$$

$$X_1 = -\frac{\delta_{11}}{\delta_{10}} = 19.1\ t \rightarrow$$