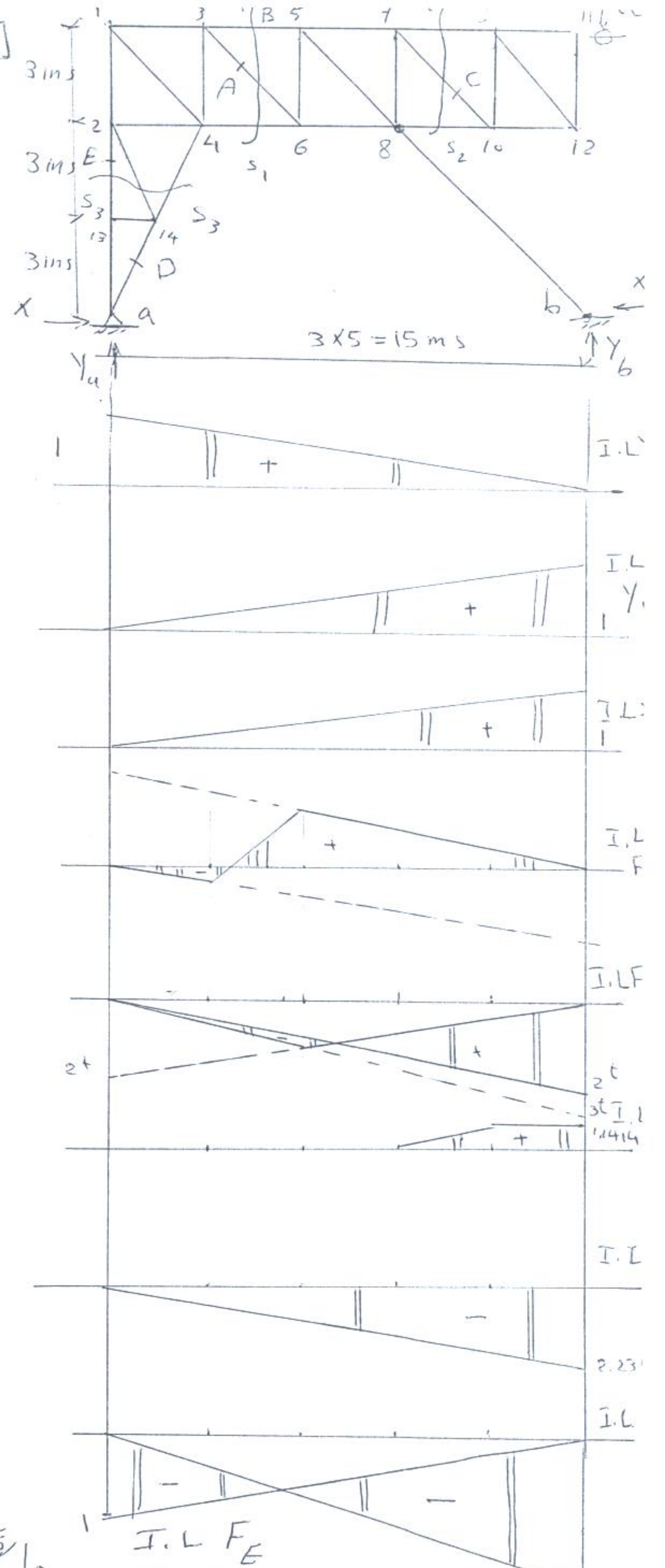
Q "1" [20]



I.L x

ΣM @ Joint 8

$Y_b \times 6 = x(6)$

$\therefore x = Y_b$

I.L F_A

Take section $S_1 - S_1$

Load at $3 \longrightarrow 6$

$\therefore \Sigma Y_{left} = 0.0$

$\therefore Y_A + F_A \sin 45^\circ = 0.0$

$\therefore F_A = +1.414\, Y_a$

Load at $2 \longrightarrow 1$

$\therefore Y_b + F_A \sin 45^\circ = 0.0$

$\therefore F_A = -1.414\, Y_b$

I.L F_B

The same section

Load at $3 \longrightarrow 6$ ΣM @

$6 Y_a + 6 X_a + F_B + 3 = 0.0$

$\therefore F_B = -2Y_a + 2X_a$

Load at $2 \longrightarrow 1$

$9 Y_b + F_B \times 3 - 6 X_b = 0.0$

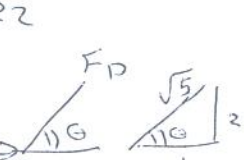
$\therefore F_B = -3Y_b + 2X_b$

I.L F_C section $S_2 - S_2$

$\Sigma Y = 0.0$

$\therefore F_C \cos 45 = 1.0$

$\therefore F_C = +1.414$



I.L F_D From joint a

$\Sigma X = 0.0$ $F_D \cos\theta + X_A = 0.0$

$\therefore F_D = -2.236\, X_a$ (1)

I.L F_E

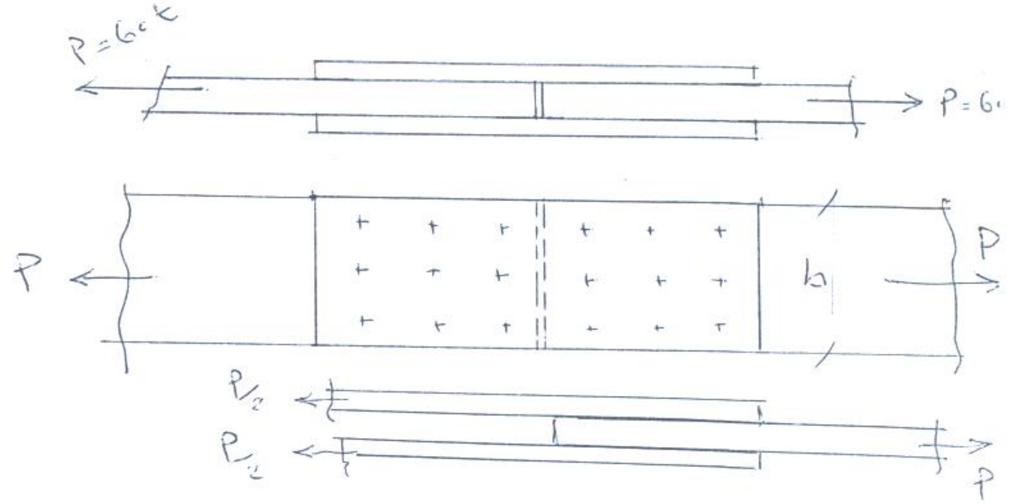
Take Sec $S_3 - S_3$

ΣM @ $2 = 0.0$

$\therefore Y_a \times 1.5 - X_a \times 3 + F_E \times 1.5 = 0.0$

$\therefore F_E = -Y_a + 2X_a$

Q_2 [12]



$\Phi = 2.1$ cm

- Shearing of rivets

$$\tau = \frac{P}{m\, n\, \frac{\pi \phi^2}{4}} = \frac{60}{2\, n\, \pi \frac{(2.1)^2}{4}} \leq 1 \text{ t/cm}^2 \quad \therefore n \geq \overset{9}{8.65}$$

- Crushing

$$\sigma_{cr} = \frac{P}{n\, \phi\, \Sigma t_{min}} = \frac{60}{n(2.1)(1.6)} \leq 3.2 \qquad \therefore n \geq \overset{6}{5.58}$$

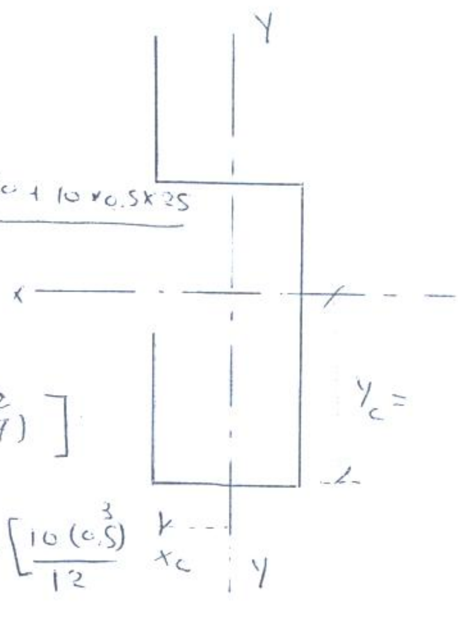
Use 9 rivets (n = 9) for each half as shown.

- Tearing of plates

$$\sigma = \frac{P}{A_{(net)}} = \frac{60}{(b - 3 \times 2.1)1.6} \leq 1.6 \qquad \therefore b = 29.8 \text{ cm}$$

Q3 (1) [20]

$$X_c = \frac{\Sigma A.x}{\Sigma A} = \frac{20 \times 10 \times 0.5 \times 5 + 20 \times 10}{4 \times 10 \times 0.5 + 20 \times 0.5} = 5 \text{ Cm}$$



$$Y_c = \frac{\Sigma A y}{\Sigma A} = \frac{10 \times 0.5 \times 5 + 20 \times 0.5 \times 10 + 10 \times 0.5 \times 20 + 10 \times 0.5 \times 25}{4 \times 10 \times 0.5 + 20 \times 0.5}$$

$$= 11.67 \text{ Cm}$$

$$I_x = \frac{10(0.5)^3}{12} + 10 \times 0.5\,(11.7)^2 + \left[\frac{0.5(10)^3}{12} + 10 \times 0.5\,(6.7)^2\right]$$
$$+ \frac{0.5(20)^3}{12} + 0.5 \times 20(1.7)^2 + \frac{0.5(10)^3}{12} \times 2 + 2 \times \left[\frac{10(0.5)^3}{12}\right.$$
$$\left. + 10 \times 0.5(5)^2\right] + \frac{20(0.5)^3}{12} + 20 \times 0.5\,(5)^2 = 2583.75 \text{ Cm}^4$$

$$I_{xy} = 10 \times 0.5(0)(11.7) + 10 \times 0.5\,(8.3) + 10 \times 0.5\,(-6.7)(-5) +$$
$$10 \times 0.5(-5)(13.3) + 20 \times 0.5\,(5)(-1.7) = -250 \text{ Cm}^4$$

$$I_y = \frac{0.5(10)^3}{12} \times 2 + 2\left[\frac{10(0.5)^3}{12} + 10 \times 0.5\,(5)^2\right] + 20 \times 0.5\,(5)^2$$
$$+ \frac{20(0.5)^3}{12} = 583.75$$

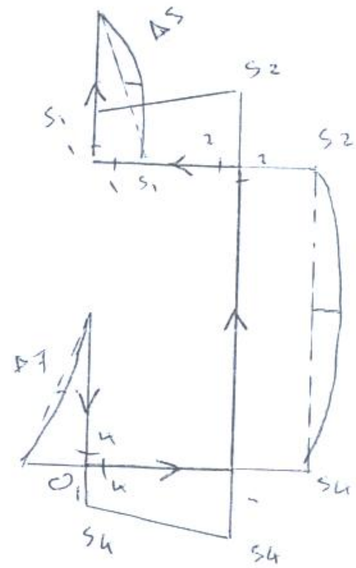
For S_x

$S_1 = 10 \times 0.5 \times 13.3 = 66.5 \text{ Cm}^3$

$S_2 = 66.5 + 10 \times 0.5 \times 8.3 = 108 \text{ Cm}^3$

$S_3 = 10 \times 0.5 \times 6.7 = 33.5 \text{ Cm}^3$

$S_4 = 33.5 + 10 \times 0.5 \times 11.7 = 92 \text{ Cm}^3$



$\Delta_5 = \frac{0.5(10)^2}{8} = 6.25$

$\Delta_6 = \frac{0.5(20)^2}{8} = 25$

$\Delta_7 = \frac{0.5(10)^2}{8} = 6.25$

$F_2 = \frac{S_1 + S_2}{2} \times 10 = \frac{66.5 + 10.5}{2} \times 10 = 872.5$

$F_3 = \frac{S_2 + S_4}{2} \times 20 + \frac{2}{3}\Delta_6 \times 20 = \frac{108 + 92}{2} \times 20 + \frac{2}{3} \times 25 \times 20 = 2333.33$

ΣM_{O_1}

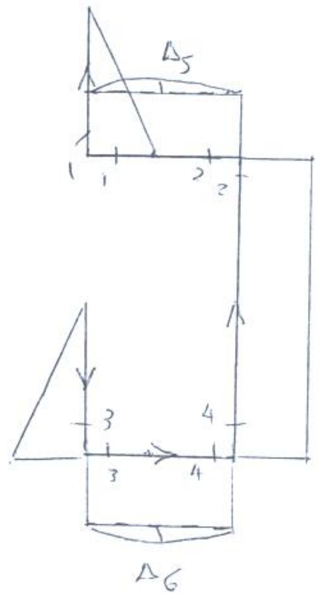
Q_3 (2)

$\therefore F_2(20) + F_3(10) = I_x e_x + I_{xy} \cdot e_y$

$\therefore 872.5(20) + 2333.33(10) = 2583.575 e_x + (-250)(e_y)$

$e_y = 10.33 e_x - 69.8 - 93.33$

$\therefore e_y = 10.33 e_x - 163.13 \longrightarrow (1)$



For Sy

$S_1 = 10 * 0.5 * 5 = 25 \ cm^3$

$S_2 = 25 + 10(0.5) * 0.0 = 25 \ cm^3$

$S_3 = 10 * 0.5 * 5 = 25 \ cm^3$

$S_4 = 25 + 10(0.5) * 0.0 = 25 \ cm^3$

$\Delta_5 = \dfrac{0.5(10)^2}{8} = 6.25$

$\Delta_6 = \dfrac{0.5(10)^2}{8} = 6.25$

$F_2 = \dfrac{S_1 + S_2}{2} * 10 + \frac{2}{3} \Delta_5 (10) = \dfrac{25 + 25}{2} * 10 + \frac{2}{3}(6.25)(10) = 291.67$

$F_3 = \dfrac{S_2 + S_4}{2} * 20 = \dfrac{25 + 25}{2} * 20 = 500$

$\Sigma M_{o_1} = I_y e_y + I_{xy} \cdot e_x \quad \therefore F_2(20) + F_3(10) = I_{\cancel{xy}\,y} \cdot e_y + I_{xy} \cdot e_x$

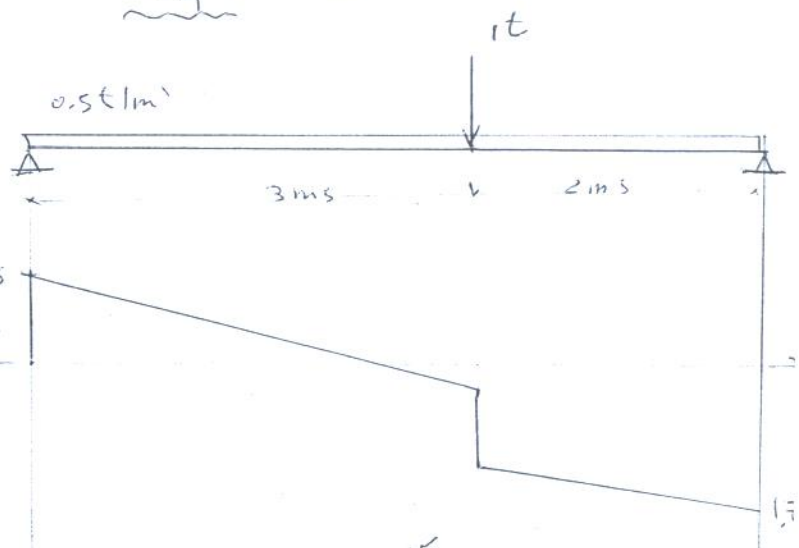
$\therefore 291.67(20) + 500(10) = 583.75 e_y - 250 e_x$

$\therefore 10 + 8.57 = e_y - 0.43 e_x$ From (1)

$18.57 = 10.33 e_x - 163.13 - 0.43 e_x$

$\therefore e_x = 18.37$ Cm , $e_y = 26.63$ Cm.

Q_4 [20]

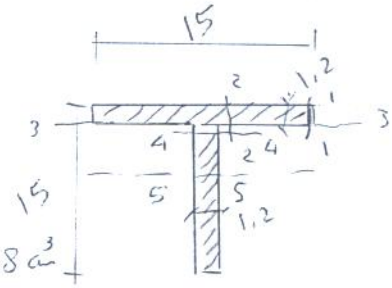


$Q_{max} = 1.75\ t$

$$y_c = \frac{\Sigma A \cdot y}{\Sigma A}$$

$$= \frac{13.8 \times 1.2 \times 6.9 + 15 \times 1.2 \times 14.4}{15 \times 1.2 + 13.8 \times 1.2}$$

$$= 10.82\ cm.$$



$S_{x_1} = 6.9 * 1.2 * 3.59 = 29.73\ cm^3$

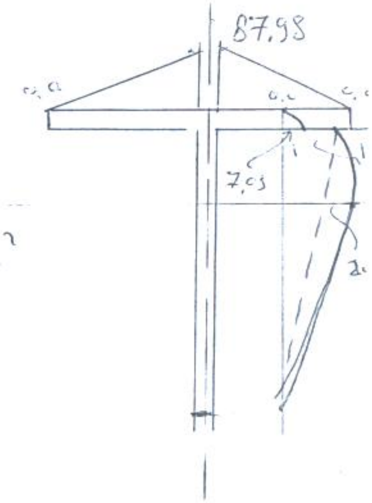
$S_{x_2} = 15 \times 1.2 \times 3.59 = 64.02\ cm^3$

$S_{x_3} = 15 * 1.2 * 3.59 + 2.99 * 1.2 * 1.495 = 69.98\ cm^3$

$$q = \frac{Q\ S_x}{I_x \cdot b}$$

$$I_x = \frac{1.2(13.8)^3}{12} + 1.2 * 13.8\,(3.91)^2 + \frac{15\,(1.2)^3}{12} + 15 * 1.2\,(3.59)^2$$

$$= 492.8\ cm^4$$



$q_1 = 0.0$

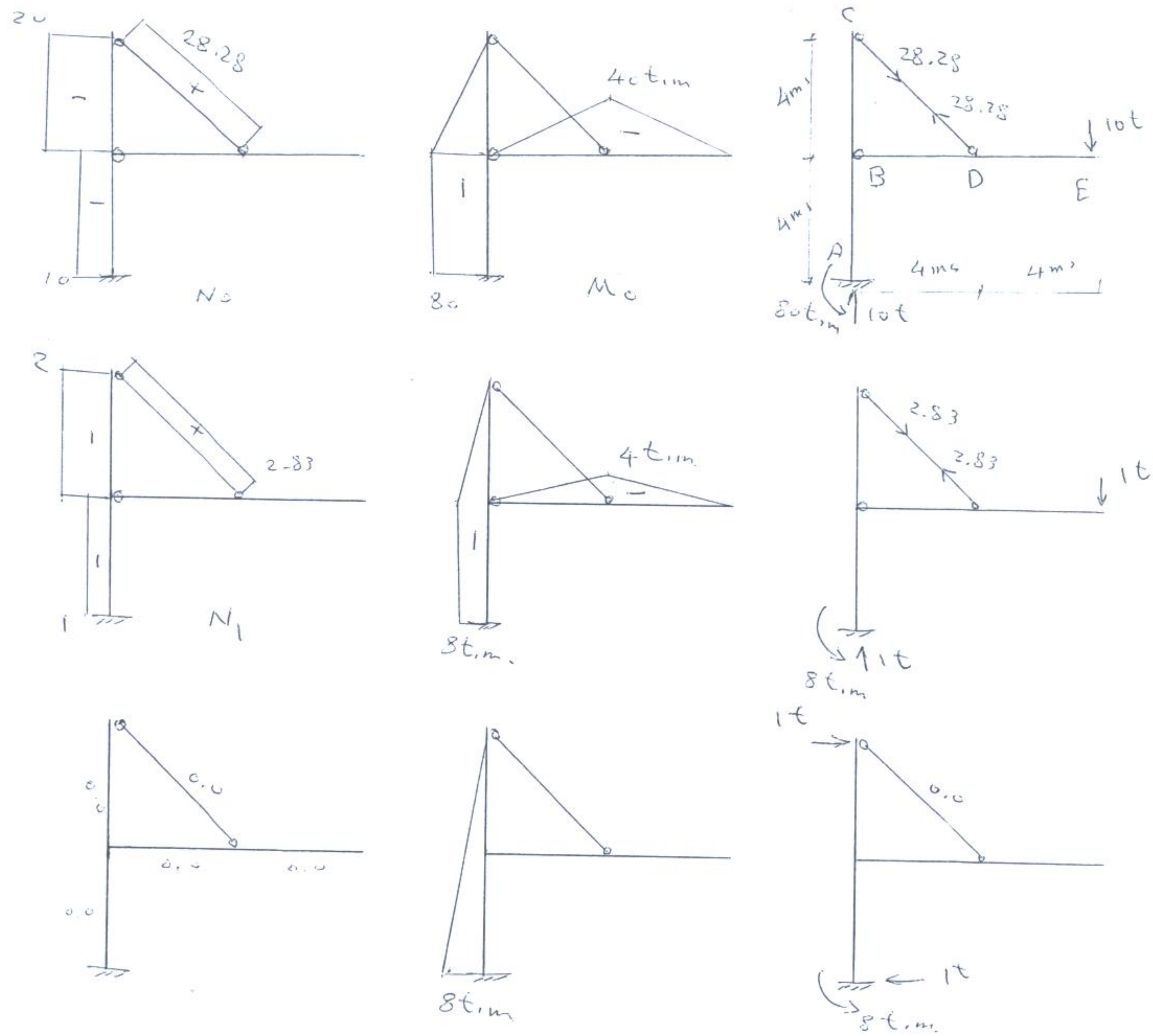
$$q_2 = \frac{Q\ S_{x_1}}{I_x \cdot b} = \frac{1.75(10)^3 \times 29.73}{492.8\,(1.2)} = 87.98\ kg/cm^2$$

$$q_3 = \frac{1.75\,(10)^3 \times 29.73}{492.8\,(15)} = 7.03\ kg/cm^2$$

$$q_4 = \frac{Q\ S_{x2}}{I_x \cdot b} = \frac{1.75\,(10)^3 \times 64.62}{492.8\,(1.2)} = 191.23\ kg/cm^2$$

$$q_5 = \frac{1.75\,(10)^3 + 69.98}{492.8\,(1.2)} = 207.09\ kg/cm^2$$

Q_5 [28]



$$V_E = \int \frac{M_0 M_1}{EI_{AC}}\, dL + \int \frac{M_0 M_1}{EI_{BE}}\, dL + \int \frac{N_0 N_1}{EA_{tie}}\, dL$$

$$= \frac{1}{EI_{AC}}\left[80 \times 4 \times 8 + \frac{80 \times 4}{2} \times \frac{2}{3} \times 8\right] + \frac{1}{EI_{BE}}\left[\frac{40 \times 4}{2} \times \frac{2}{3} \times 4 \times 2\right]$$

$$+ \frac{1}{EA_{Lie}}\left[28.28 \times 4\sqrt{2} \times 2.83\right] = 0.19 \text{ ms.}$$

$$U_C = \frac{1}{EI_{AC}}\left[-80 * 4 + \left(\frac{-8 * 4}{2}\right) + \frac{-8 * 4}{2} * \frac{2}{3} * -4\right] = \frac{1962.67}{40000}$$

$$= 0.049 \text{ ms}$$