6.9a) $\tau = \dfrac{VQ}{It}$

$$Q = A\bar{y}$$

$$= 200(12)\left(\frac{150}{2} - \frac{12}{2}\right) + 100\left(\frac{150-12\times2}{2}\right) \times \left(\frac{150-12\times2}{2\times2}\right)$$

$$= 364050 \text{ mm}^3$$

$$= 3.6405\times10^{-4} \text{ m}^3$$

$$I = \frac{1}{12}(200)(150)^3 - 2\left(\frac{1}{12}\right)\left(\frac{200-100}{2}\right)\left(150-12\times2\right)^3$$

$$= 39580200 \text{ mm}^4$$

$$\approx 3.95802\times10^{-5} \text{ m}^4$$

$$\tau = \frac{10\times10^3\times3.6405\times10^{-4}}{3.95802\times10^{-5}\times100\times10^{-3}}$$

$$= 919778.0709 \text{ Pa}$$

$$\approx 920 \text{ kPa}$$

6.9b) $\tau = \frac{VQ}{It}$

$I = 3.95802 \times 10^{-5} \, m^4$

$Q = 12 \times 200\left(\frac{150}{2} - \frac{12}{2}\right) + (40-12)(100)\left(75 - 40 + \frac{40-12}{2}\right)$

$= 302800 \, mm^3$

$= 3.028 \times 10^{-4} \, m^3$

$\tau = \frac{10 \times 10^3 (3.028 \times 10^{-4})}{3.95802 \times 10^{-5} \times 100 \times 10^{-3}}$

$= 765028.9791 \, Pa$

$\approx 765 \, kPa$

6.17) Taking moments about A:

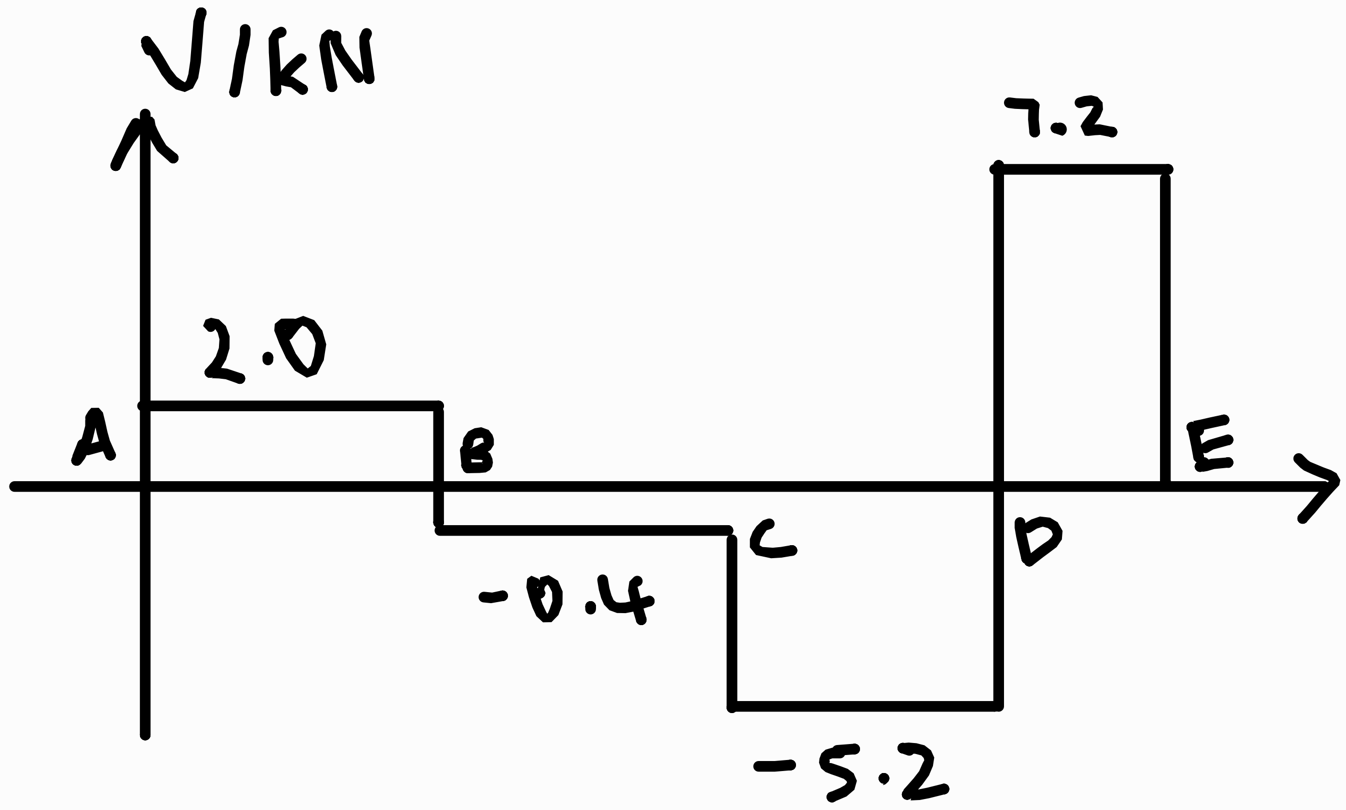
$$2.4(1) + 4.8(2) + 7.2(3.5) = F_D(3)$$

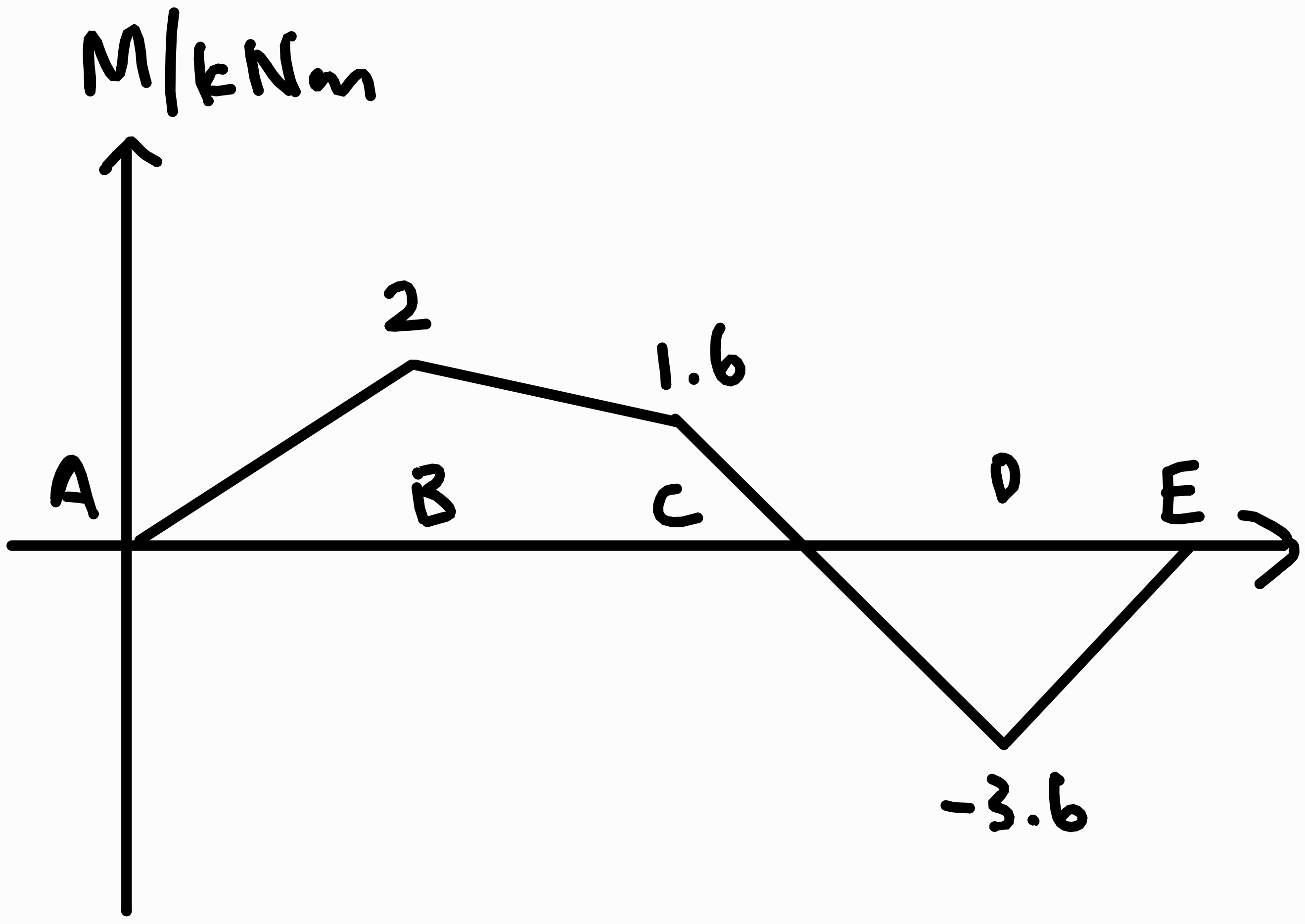
$$F_D = 12.4 kN$$

Taking moments about E:

$$F_A(3.5) + 12.4(0.5) = 2.4(2.5) + 4.8(1.5)$$

$$F_A = 2 kN$$





$V_{max} = 7.2 kN$

$M_{max} = 3.6 kNm$

$$\sigma = \frac{My}{I}$$

$$12 \times 10^6 = \frac{3.6 \times 10^3 \times \frac{1}{2}(150 \times 10^{-3})}{\frac{1}{12} b (150 \times 10^{-3})^3}$$

$$3375 b = 270$$

$$b = 0.08 \, m$$

$$= 80 \, mm$$

$$\tau = \frac{VQ}{It}$$

$$Q = A\bar{y}$$

$$= \frac{150}{2} \times 10^{-3} b \times \frac{150}{4} \times 10^{-3}$$

$$= 2.8125 \times 10^{-3} b \, m^3$$

$$825 \times 10^3 = \frac{7.2 \times 10^3 (2.8125 \times 10^{-3} \cancel{b})}{\frac{1}{12} b (150 \times 10^{-3})^3 \cancel{b}}$$

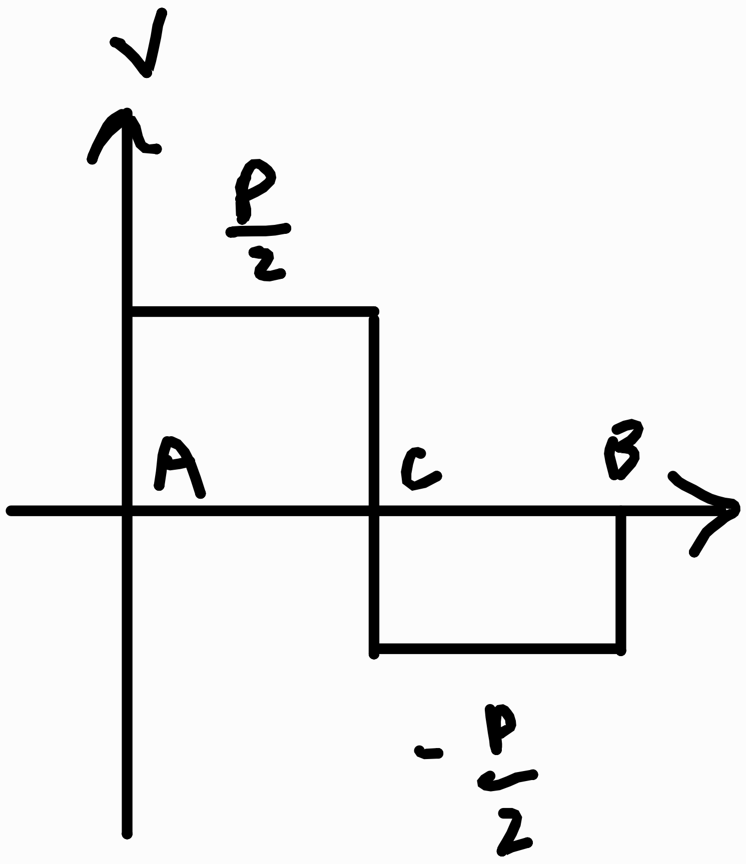
$$232.03125 b = 20.25$$

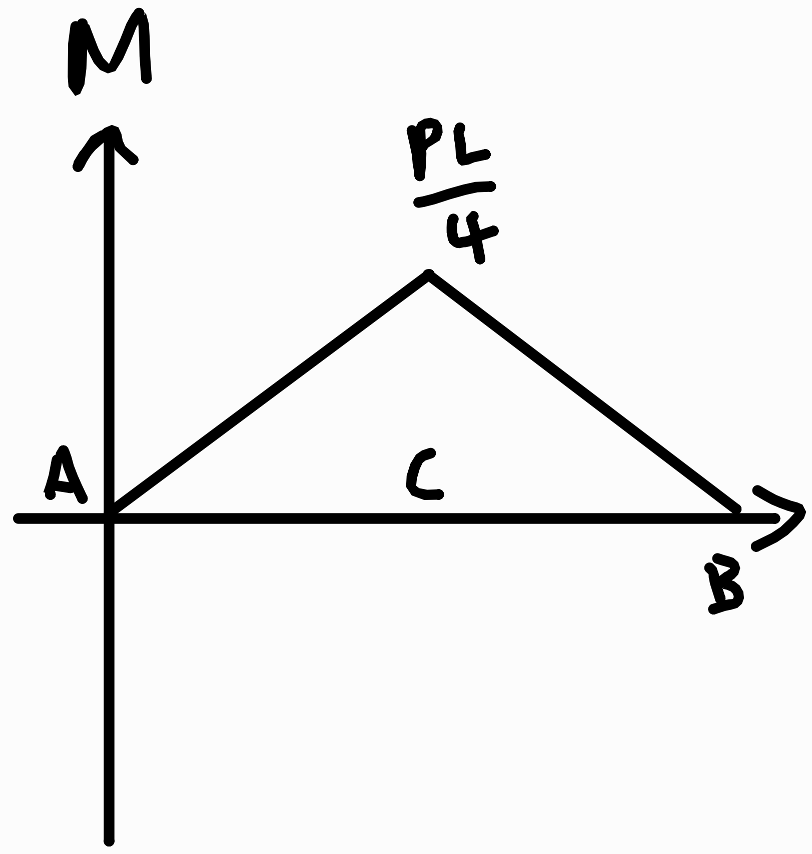
$$b = 0.08\dot{7}\dot{2} \, m$$

$$\approx 87.3 \, mm$$

$$\therefore b = 87.3 \, mm$$

6.(9a) $F_A = F_B = \frac{P}{2}$





$V_{max} = \frac{P}{2}$

$\tau_m = \frac{VQ}{It}$

$= \frac{\frac{P}{2}\left(\frac{1}{2}h\cancel{b}\right)\left(\frac{h}{4}\right)}{\frac{1}{12}bh^3\cancel{b}}$

$= \frac{3P}{4bh}$

$M_{max} = \frac{PL}{4}$

$\sigma_m = \frac{My}{I}$

$= \frac{\frac{PL}{4}\left(\frac{\cancel{h}}{2}\right)}{\frac{1}{12}bh^{\cancel{3}2}}$

$= \frac{3PL}{2bh^2}$

$\frac{\tau_m}{\sigma_m} = \frac{3P}{4bh} \div \frac{3PL}{2bh^2}$

$= \frac{\cancel{3P}}{\cancel{4}_2\cancel{bh}} \times \frac{\cancel{2bh}}{\cancel{3P}L}$

$= \frac{h}{2L}$ (shown)

6.19b) $\frac{\tau_m}{\sigma_m} = \frac{h}{2L}$

$$h = \frac{2L\tau_m}{\sigma_m}$$

$$= \frac{2\times2(960\times10^3)}{12\times10^6}$$

$$= 0.32\,m$$

$$= 320\,mm$$

$$\tau_m = \frac{3P}{4bh}$$

$$b = \frac{3P}{4h\tau_m}$$

$$b = \frac{3(40\times10^3)}{4(320\times10^{-3})(960\times10^3)}$$

$$= 0.09765625\,m$$

$$\approx 97.7\,mm$$

6.92a) Taking moments about B:

$$R_A(1.05) = 50(0.4) + 50(0.65)$$

$$R_A = 50\,kN$$

At n-n,

$$V = 50kN$$

$$M = 50 \times 0.2 = 10\,kNm$$

$$\tau = \frac{VQ}{It}$$

Position of the NA $= \dfrac{100 \times 50 \times 25 + 100 \times 25 \times (50+50)}{100 \times 50 + 100 \times 25}$

$$= 50\,mm$$

$$I = \frac{1}{12}(25)(100)^3 + 25(100)(100-50)^2 + \frac{1}{12}(100)(50)^3$$
$$+ 100(50)(25)^2$$
$$= 1.25 \times 10^7\,mm^4 = 1.25 \times 10^{-5}\,m^4$$

6.92a) $\tau = \dfrac{50 \times 10^3 \times 25^2\left(150 - \frac{25}{2} - 50\right) \times 10^{-9}}{1.25 \times 10^{-5} \times 25 \times 10^{-3}}$

$$= 8.75 \times 10^6\,Pa$$
$$= 8.75\,MPa$$

6.92b) $\tau = \dfrac{50\times10^3 \times 25(50)(100-25)\times10^{-9}}{1.25\times10^{-5}\times 25\times10^{-3}}$

$= 1.5\times10^7\ Pa$

$= 15\ MPa$