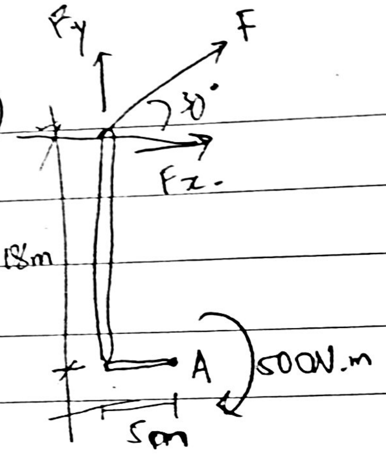
CV011

1. a)

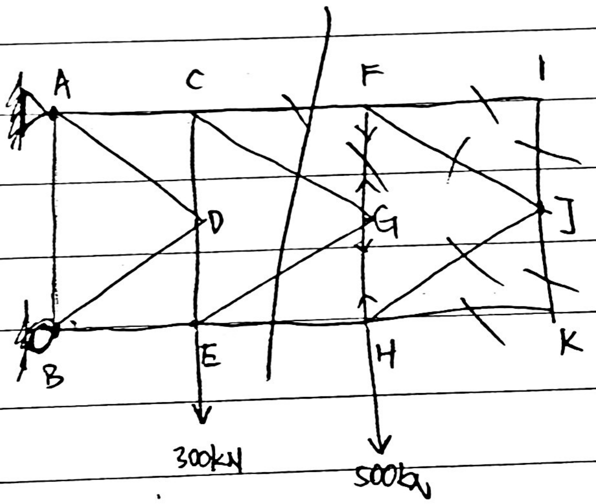


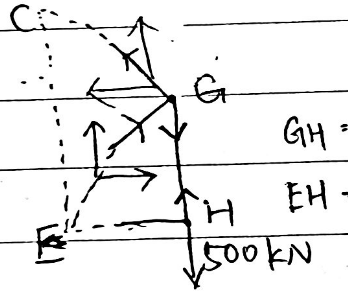
$$(F\sin 30)(5) + (F\cos 30)(18) = 500$$

$$2.5F + 15.59F = 500$$

$$F = 27.64\ N$$

b)





GH = 500kN (Tension)

EH = 0

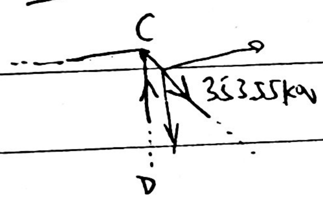
Take moment at E

$$F_{CG}\cos 45(1) + F_{CG}\sin 45(1) = 500(1)$$

$$F_{CG} = 353.55\ kN$$

$$F_{CG} = F_{EG} = 353.55\ kN\ \text{(Compression)}$$ #

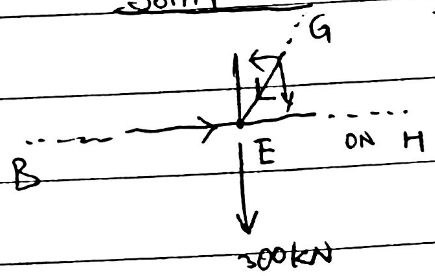
Joint C



$353.55\sin 45 = CD$

CD = 250 kN (Compression) #

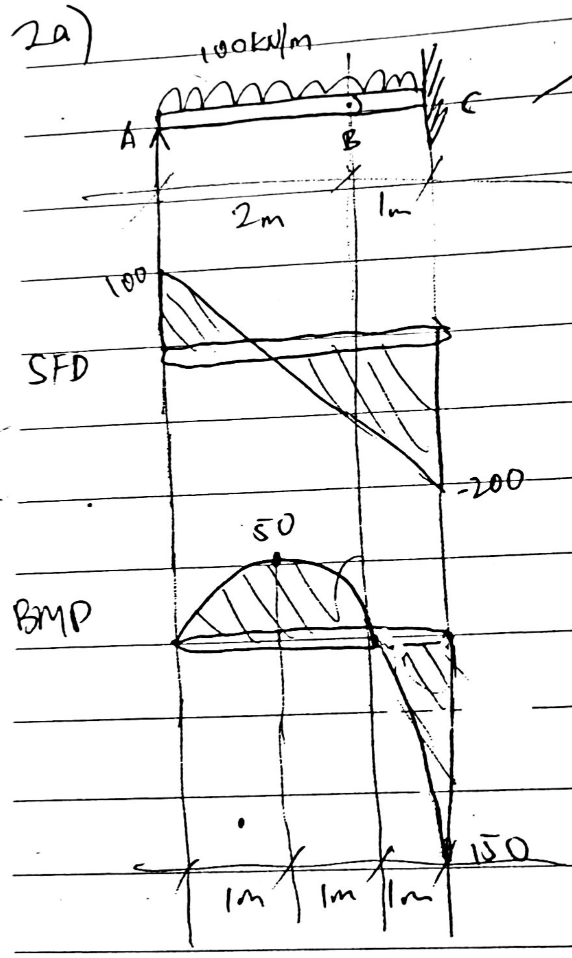
Joint E

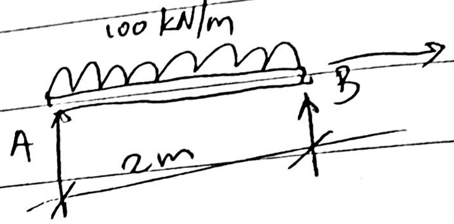


$353.55\cos 45 = BE$

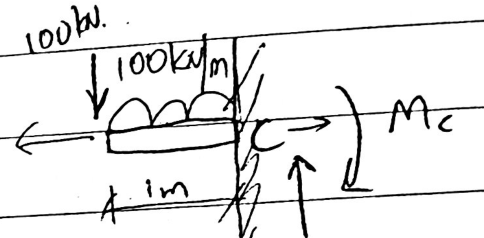
BE = 250kN (Compression) #

2a)





$A_y = B_y = 100\text{kN}$



$C_y = 200 \text{ kN}$

$M_c = 100(1) + 100(0.5)(1)$

$= 150 \text{ kNm}$

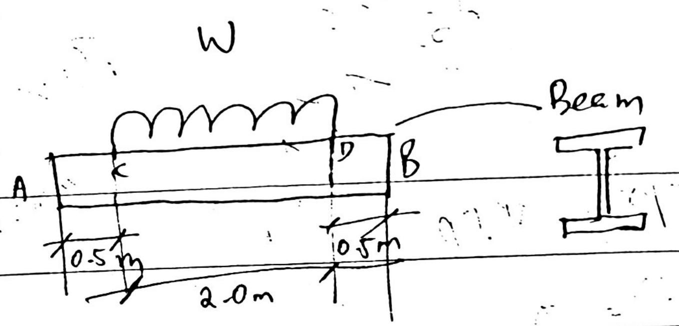
b) $$\delta = \Sigma \frac{PL}{AE} = \frac{+30 \times 10^3 (16000)}{\left(\frac{618^2 \pi}{4}\right)(200\times10^3)} + \frac{-15\times10^3(12000)}{\left(\frac{1070^2 \pi}{4}\right)(200\times10^3)} + \frac{+60\times10^3(12000)}{\left(\frac{1070^2\pi}{4}\right)(200\times10^3)}$$

$$= (8\times10^{-3}) - (1\times10^{-3}) + (4\times10^{-3})$$

$$= 11 \times 10^{-3} \text{ mm}$$

$$\approx 0.000011 \text{ m}$$ #

3a).



Max shear $= \frac{w}{3}$

$t = 0.01$

$I_x = 2\left[\frac{1}{12}(0.17)(0.02)^3 + (0.17)(0.02)(0.15)^2\right] + \frac{1}{12}\left[0.01\,(0.28)^3\right]$

$= 0.00017152$

$Q = \Sigma \bar{y} \cdot A = (0.17 \times 0.02)(0.15) + (0.14 \times 0.01)(0.07)$

$= 6.08 \times 10^{-4}$

allowable shear $= 80MPa.$

$80 = \dfrac{\frac{w}{3}(6.08 \times 10^{-4})}{0.00017152\,(0.01)}$

$w = 0.677$ i

3 b

$$\tau_{AB} = \frac{T\rho}{J} = \frac{T\rho}{\frac{\pi}{2}c^4} = \frac{T\,\cancel{d_2/2}}{\cancel{\frac{\pi}{2}}\left(\frac{d_2}{2}\right)^4}$$

$$\tau_{EF} = \frac{T\rho}{J} = \frac{T\rho}{\frac{\pi}{2}\left(c_o^4 - c_i^4\right)} = \frac{T\,d_1/\cancel{2}}{\cancel{\frac{\pi}{2}}\left(\left(\frac{d_1}{2}^4\right) - \left(\frac{d_2}{2}^4\right)\right)}$$

$$\tau_{AB} = \tau_{EF}$$

$$\frac{d_2}{\left(\frac{d_2}{\cancel{2}}\right)^4} = \frac{d_1}{\left(\frac{d_1}{\cancel{2}}^4\right) - \left(\frac{d_2}{\cancel{2}}^4\right)}$$

$$\frac{d_1}{d_2} = \frac{d_1^4 - d_2^4}{d_2^4}$$

Let $\frac{d_1}{d_2} = x$

$$x = x^4 - 1$$

$$x = (1+x)^{\frac{2}{4}}$$

by trial & error (Joseph's favorite)

Let $x = 1.5$ (try only).

$x_i = (1+1.5)^{\frac{1}{4}} = 1.2574$, $\therefore \neq 1.5$,

Let $x = 1.2$

$x_1 = (1+1.2)^{\frac{1}{4}} = 1.218 \therefore \neq 1.2$ but getting close

Let $x = 1.22$

$x_1 = (1+1.22)^{1/4} = 1.22 \therefore$ yes!

$$x = \frac{d_1}{d_2} = 1.22 \;\#$$

POWERING LIVES

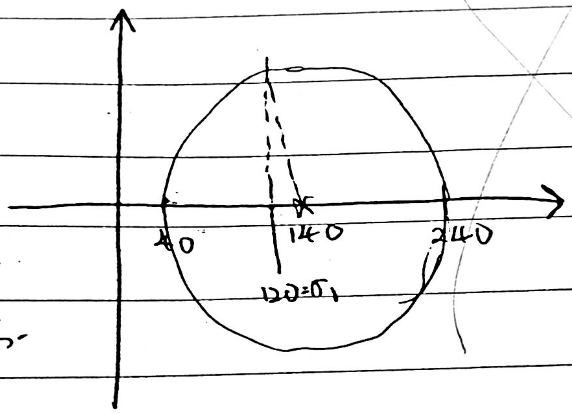
4a.

$\sigma_{ave} = \frac{240+40}{2}$

$= 140$

$R = \cancel{100}$ 260

= max-inplane shear stress.



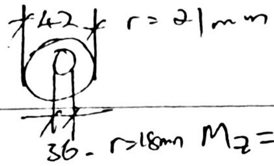
* when $\sigma = 120$

τ_{xy} at 120 MPa

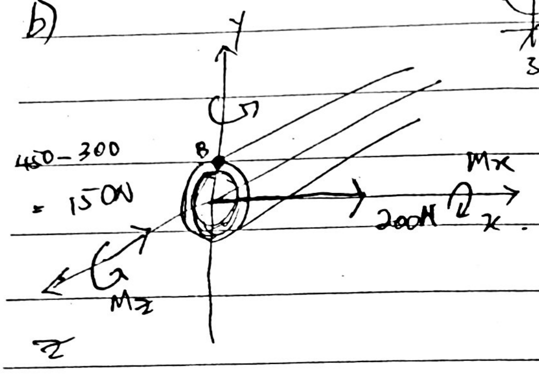
$= \sqrt{100^2 - 20^2}$

$= 97.98$ MPa.

$\tau_{xy} \leq 97.98$ MPa



b)



$M_z = 200(0.225)$
$= 45 \text{ N.m}$

$M_x = 450(0.225) + 300(0.225)$
$= 168.75 \text{ N.m}$

$M_y = 200(0.25)$
$= 50 \text{ N.m}$

Normal stress $\sigma = \frac{P}{A} = \frac{150}{\pi 0.021^2 - \pi 0.018^2} = 408.090 \text{ KPa}$

Torsion (M_z) $= \frac{Tc}{J} = \frac{45(0.021)}{\frac{\pi}{2}(0.021^4 - 0.018^4)} = 6721.476 \text{ kPa}$

Bending stress (M_x) $= \frac{Mc}{I} = \frac{M_x c}{I} = \frac{168.75(0.021)}{\left(\frac{1}{4}\pi 0.021^4 - \frac{1}{4}\pi 0.018^4\right)} = 50411.068 \text{ kPa}$ (compression)

Shear stress $= \frac{VQ}{It} = \frac{200(2.286\times10^{-6})}{\left(\frac{1}{4}\pi(0.021^4) - \frac{1}{4}\pi(0.018^4)\right)(0.006)}$

$= \frac{0.0762}{7.0297\times10^{-8}}$

$= 1083.971 \text{ kPa}$

$Q = \bar{y}A = \frac{4}{3\pi}(0.021)\left[\frac{1}{2}\pi 0.021^2\right] - \frac{4}{3\pi}(0.018)\left[\frac{1}{2}\pi 0.018^2\right]$
$= 2.286\times10^{-6} \text{ m}^3$

$t = 0.042 - 0.036$
$= 0.006 \text{m}$

Total $\tau = -6721.476 + 1083.971 = -5.638 \text{ MPa}$

Total $\sigma = -408.090 - 50411.068 = -50.819 \text{ MPa}$

In-plane shear stress $= \sqrt{\left(\frac{50.819}{2}\right)^2 + 5.638^2}$
$=$ ~~[illegible]~~ MPa
25.83