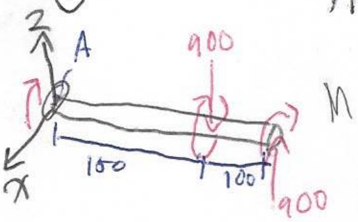
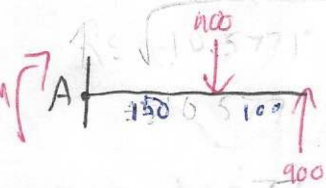
① Assignment 3 Benjamin Klassen June 11 202



$T_A = -2(900)(200)$
$= -360000$ N·mm

$\tau_T = \dfrac{-360000 \cdot 15}{\pi/2[15^4 - 10^4]}$
$= -84.6215$

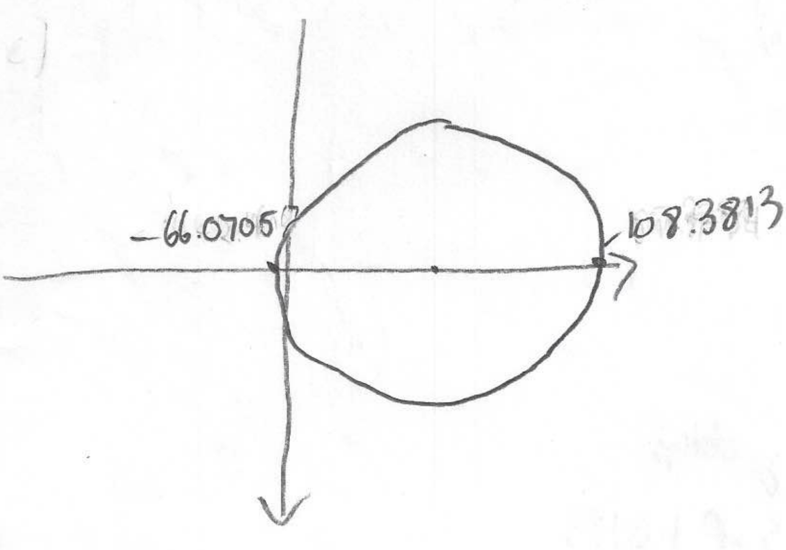


$\Sigma M = 0,\ M_A + 900(150) - 900(250) = 0$
$M_A = 90000$ N·mm

$\sigma_B = \dfrac{90000 \cdot 15}{\frac{\pi}{4}(15^4 - 10^4)}$
$= 42.31\ N/mm^2$

$\sigma_{ave} = \dfrac{42.31}{2} = 21.1554$

$R = \sqrt{21.1654^2 + (-84.6215)^2}$
$= 87.22592$ N/mm



a) Von Mises

$\sigma_2 > \sqrt{(-66.0705)^2 + (108.3813)^2 - (-66.0705)(108.3813)}$

$250 = 152.5537\ FS$
$1.64 = FS$

b) Tresca

$\tau_{max} = \dfrac{\sigma_y}{2}$

$FS\left(\dfrac{108.3813 + 66.0705}{2}\right) = \dfrac{\sigma_y}{2}$

$FS(174.4518) = \sigma_y = 250$

$FS = 1.43$

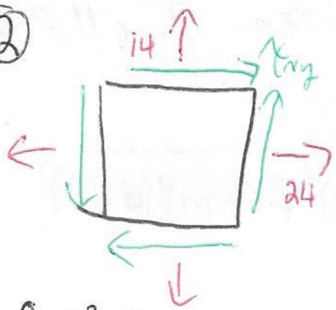
c) Rankine

$\sigma_y = FS \cdot \sigma_y$

$\dfrac{250}{108.3813} = FS$

$FS = 2.31$

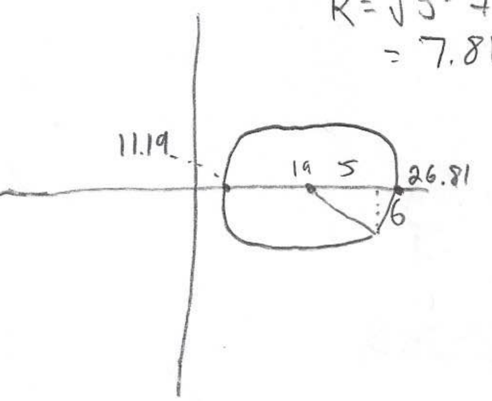
(2)



$\sigma_y = 30$ ksi

a) $\sigma_{ave} = \dfrac{24+14}{2} = 19$

$R = \sqrt{5^2+6^2}$
$= 7.81$



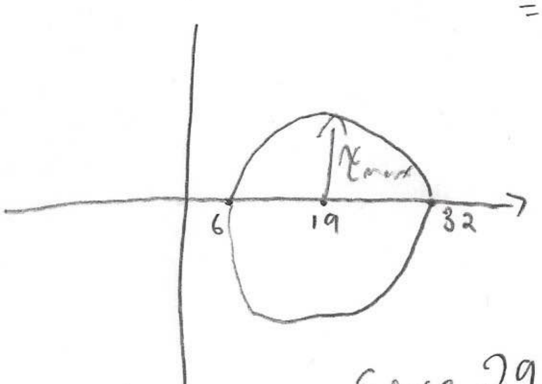
$\sigma_1 = 19 + 7.81 = 26.81$
$\sigma_2 = 19 - 7.81 = 11.19$

$\sigma_y > \sqrt{26.81^2 + 11.19^2 - (26.81)(11.19)}$
> 23.32 ksi

Since $23.32 < 30$, no yield would occur. $\dfrac{30}{23.32} =$ FS of 1.28645

b) $R = \sqrt{5^2 + 12^2}$
$= 13$

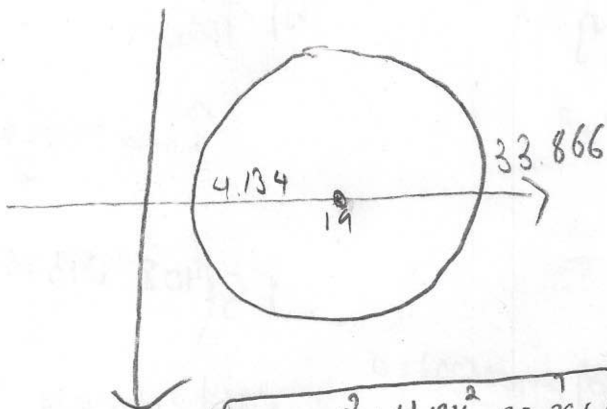
$\sigma_y > \sqrt{32^2 + 6^2 - (32)(6)}$
$= 29.46$ ksi



Since $29.46 < 30$, no yielding
$\dfrac{30}{29.46} =$ FS of 1.0183

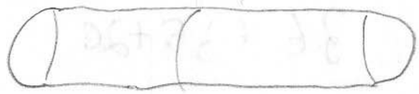
c) $R = \sqrt{5^2+14^2}$
$= \sqrt{221} \sim 14.866$

$\sigma_1 = 19 + 14.866$
$\sigma_2 = 19 - 14.866$

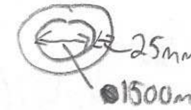


$\sqrt{33.866^2 + 4.134^2 - 33.866(4.134)}$
$= 32$ ksi > 30, ∴ yielding would occur

3

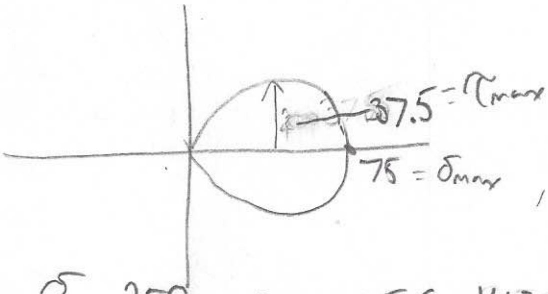


x-section =



@ Spherical Cap

From hoop stress, $\sigma_1 = \sigma_2 = \frac{pr}{2t} = \frac{5 \cdot 750}{2 \cdot 25} = 75$ MPa



$\tau_{max} = 37.5$

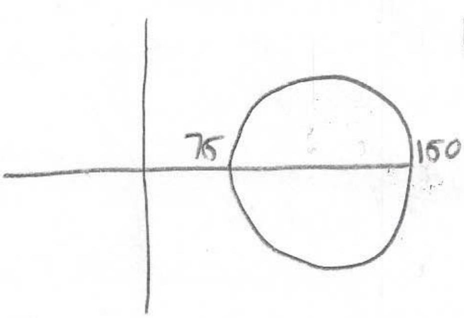
$\sigma_y = 250$ $\quad 37.5\,FS = 143$

@ Cylinder (worst case scenario)

$\sigma_1 = \frac{pr}{t} = \frac{5 \cdot 750}{25} = 150$

$\sigma_2 = \frac{pr}{2t} = \frac{5 \cdot 75}{2 \cdot 25} = 75$

$\sigma_{avg} = \frac{150+75}{2} = 112.5$



$150\,FS = 250$

$FS = 1.6$

Tresca

$\left[\frac{150\ \sigma_1}{2}\right] = \tau_{max} = \frac{\sigma_y}{2}$

$150\,FS = 250$

$FS = 1.66$

Von Mises

$\sqrt{150^2 + 75^2 - 150(75)}\ FS = \sigma_y$

$129.9\,FS = 250$

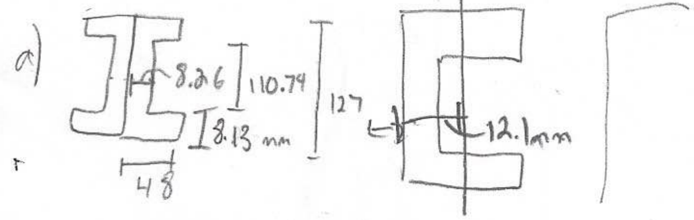
$FS = 1.92$

④ $L_e = 3000\ mm,\ 3m$ $\quad A = 127(8.26) + 2(39.74)(8.13)$ $\quad 36 + 35 + 20$

$E\ 200000\ MPa$ $\quad = 1695.1924$

$\frac{kN}{m} = \frac{N}{mm}$

a)



$I_{x_t} = 2I_x = 7.4E6\ mm^4$

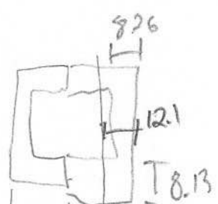
$I_{y_t} = 2(I_y + A(12.1))$

$= 2(0.260E6 + 1695.1924(12.1))$

$= 1.016386E6\ mm^4$

$P_{crit} = \frac{\pi^2\, 200000 \cdot 1.016386E6}{3000^2} = \frac{222.9\ kN}{2.4} = 93\ kN\ P_{allow}$

b)



I_x = same as above ($7.4\ E6\ mm^4$)

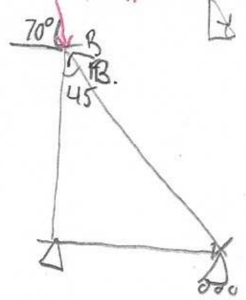
$I_{y_t} = 2(I_y + A(y - \bar{y})^2)$

$= 2(0.260E6 + 1695.1924(48 - 12.1)^2)$

$= 4889561.834 < I_x$, $\therefore I_y$ is used

$P_{crit} = \frac{\pi^2 \cdot 200000 \cdot 4889561.834}{3000^2} = \frac{1072.4}{2.4} = 448\ kN$

5



@B

$\Sigma F_x = 0, \; 5.2\cos 70 + B_x,$

$B_x = -1.7785 \text{ kN}$

$\Sigma F_y = 0,$ Since 45°, $B_x = B_y$ (sign Δ)

$-5.2\sin 70 + 1.7785 + F_{AB} = 0$

$F_{AB} = 3.1079$

$P_{crit} = \dfrac{\pi^2 EI}{Le^2}$, Double pin $L = Le$

$= \dfrac{\pi^2 \, 200000 \cdot \frac{\pi}{4}(9)^4}{1200^2}$

$= 7.063617406 \text{ kN}$

$\dfrac{7.063617406}{3.1079} = 2.2728, \; \therefore \; FS = 2.27$

6. $I = \frac{1}{12} \cdot 32 \cdot 32^3 = 87381.\overline{33}\ mm^4$

$E = 70000\ MPa$

$P_{applied} = 24000N$

$v = 4mm$

$L_e = 2L = 650mm \times 2 = 1300$

a) $$e = \frac{v}{\left[\sec\left(\sqrt{\frac{P}{EI}} \cdot \frac{L}{2}\right) - 1\right]} = \frac{4}{\left[\sec\left(\sqrt{\frac{24000}{EI}} \cdot \frac{1300}{2}\right) - 1\right]}$$

$\frac{1}{\cos}$

$$e = \frac{4}{[3.578 - 1]}$$

$$e = 1.552mm$$

b) $c = r = 16$ $\quad , r = \sqrt{\frac{I}{A}} = \sqrt{\frac{87381.33}{32^2}} = 9.2376$

$$\sigma_{max} = \frac{24000}{32^2}\left[1 + \frac{16 \cdot 1.552}{9.2376^2}(3.578)\right]$$

$$= 47.8\ MPa$$