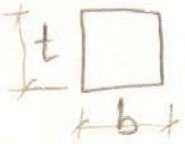
Final 2nd term 2010-2011 ME142

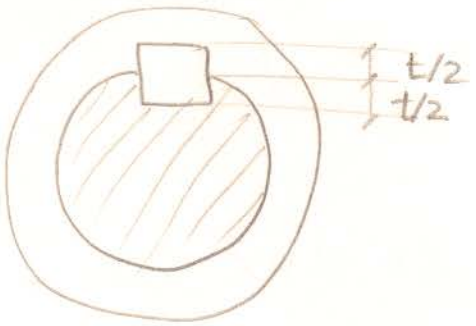
Q1

a) two types of Keys and pins:-

① The square Key



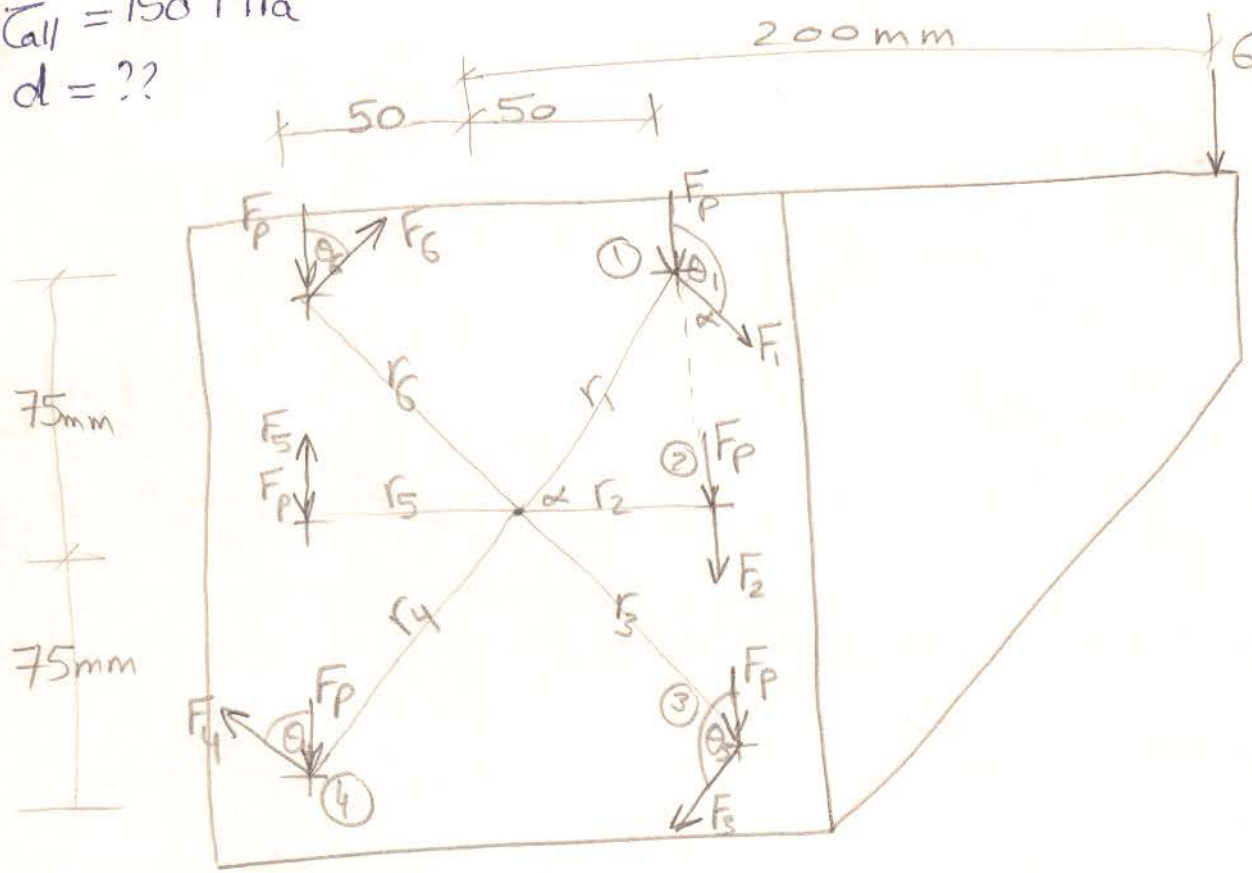
$b = t$



② The flat Key $b > t$

b) $\bar{\sigma}_{all} = 150$ MPa

$d = ??$



$r_1 = r_3 = r_4 = r_6 = \sqrt{50^2 + 75^2} = 90.14$ mm

$r_2 = r_5 = 50$ mm & $\alpha = \tan^{-1}\frac{75}{50} = 56.3°$

Symmetric $\theta_1 = \theta_3 = 180 - \alpha = 123.7°$

max. r at rivet ①

max. θ at rivet ②

$$T = F * l = 60{,}000 * 200 = 12 * 10^6 \ N.mm$$

$$F_p = \frac{F}{n} = \frac{60{,}000}{6} = 10{,}000 \ N$$

for bolt ①

$$F_1 = \frac{T r_1}{r_1^2 + r_2^2 + r_3^2 + r_4^2 + r_5^2 + r_6^2}$$

$$= \frac{12 * 10^6 * 90.14}{4 * (90.14)^2 + 2(50)^2} = 28{,}844.12 \ N$$

$$F_{S1} = \sqrt{F_1^2 + F_p^2 - 2 F_1 F_p \cos\theta_1} = 35{,}384.5 \ N$$

$$\tau = \frac{F_{S1}}{A} \leq \tau_{all}$$

$$\frac{35{,}384.5}{\frac{\pi}{4} d^2} \leq 150$$

$$17.33 \leq d \ mm$$

for bolt ②

$$F_2 = \frac{12 * 10^6 * 50}{4(90.14)^2 + 2(50)^2} = 15{,}999.63 \ N$$

$$F_{S2} = \sqrt{F_2^2 + F_p^2 - 2 F_2 F_p \cos\theta_2} = 25{,}999.63 \ N$$

$$\tau = \frac{F_{S2}}{A} \leq \tau_{all}$$

$$\frac{25{,}999.63}{\frac{\pi}{4} d^2} \leq 150$$

$$d \geq 14.86$$

Take $d = 17.33$

Q2

a) Types of Fillet welding:-

① Lap joint

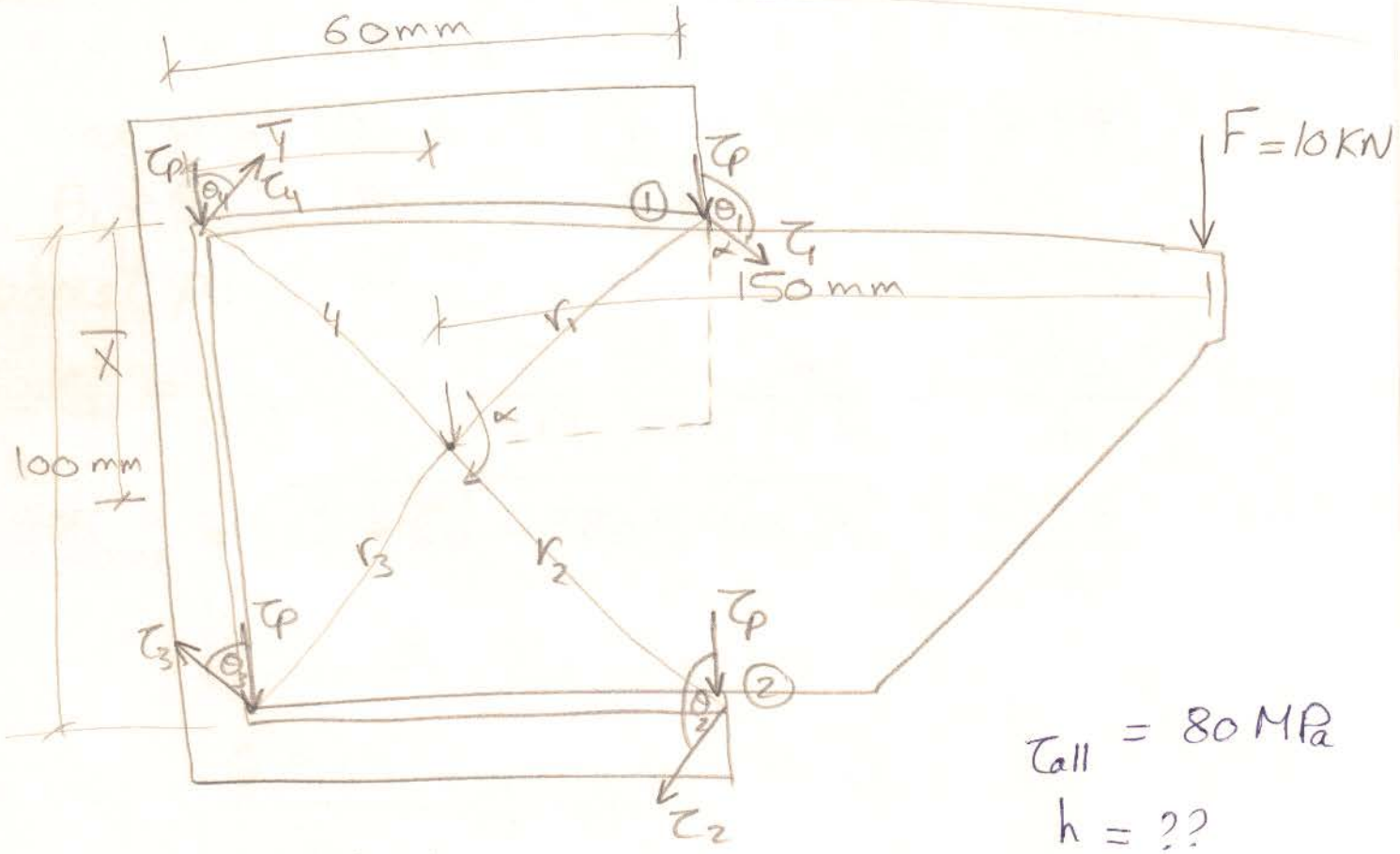
② Butt joint
- (a) square butt joint
- (b) single V-butt joint
- (c) single U-butt joint
- (d) Double ~ ~ ~
- (e) Double V ~ ~

③ Corner joint

④ Edge joint

⑤ T-Joint

b)



$\tau_{all} = 80\ MPa$

$h = ??$

$b = 100\ mm$

$d = 60\ mm$

from table $\bar{Y} = \frac{d}{2} = \frac{60}{2} = 30\ mm$

$\bar{X} = \frac{b}{2} = \frac{100}{2} = 50\ mm$

$A = 1.414\,h\,d$

$= 1.414 * h * 60$

$= 84.84\,h\ mm^2$

$T = F * \ell$

$= 10,000 * 150 = 1.5 * 10^6$ N.mm

$\tau_p = \frac{F}{A} = \frac{10,000}{84.84h} = \frac{117.87}{h}$ MPa

$\tau_s = \frac{T.r}{J}$ $\quad J = 0.707h\,J_u$

$J_u = \frac{(b+d)^4 - 6b^2d^2}{12(b+d)} = \frac{(100+60)^4 - 6*100^2*60^2}{12(100+60)} = 228,833.3$ mm^3

$\therefore J = 161,785.17h$ mm^4

$r_1 = r_2 = r_3 = r_4 = \sqrt{50^2 + 30^2} = 58.3$ mm

max. θ at ① or ② $\quad \alpha = \tan^{-1}\frac{50}{30} = 59°$

$\theta_1 = \theta_2 = 180 - \alpha = 121°$

worest point at ①

$\tau_{s1} = \frac{T r_1}{J} = \frac{1.5*10^6 * 58.3}{161,785.17h} = \frac{540.53}{h}$

$\tau_{max} = \sqrt{\tau_p^2 + \tau_{s1}^2 - 2\tau_p\tau_{s1}\cos\theta_1} = \frac{609.67}{h}$ MPa

$\tau_{max} \leq \tau_{all}$

$\frac{609.67}{h} \leq 80$

$h \geq 7.62$ mm

Q3

a) Advantages of using belt drives :-

1. light weight
2. low cost
3. No need for lubricating system
4. Available in standard sizes.
5. Easy to design and select.
6. low noise (Compared with chains).

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b) power = ?? $d_1 = 200\ mm$ $d_2 = 400\ mm$

$C = 1.5\ m$ $n_1 = 900\ rpm$ $\mu = 0.3$

$A = 50 * 5\ mm^2$ $W = 11 * 10^3\ \frac{N}{m^3}$ $\sigma_{all} = 2\ MPa$

sol^n $\theta_1 = 180 - 2\sin^{-1}\frac{d_2 - d_1}{2C}$

$= 180 - 2\sin^{-1}\frac{400-200}{2*1500} = 172.35°$

$V = \frac{\pi d_1 n_1}{60} = \frac{\pi * 200 * 900}{60} * 10^{-3} = 9.42\ m/s$

$F_c = \frac{W}{g}V^2 = \frac{11*10^3 * 50 * 5 * 10^{-6}}{9.8} * (9.42)^2 = 24.87\ New$

$F_1 = \sigma_{all} = 2 * (50*5) = 500\ N$

$\frac{F_1 - F_c}{F_2 - F_c} = e^{\mu\theta}$ $\therefore F_2 = F_c + \frac{F_1 - F_c}{e^{\mu\theta}}$

$= 24.87 + \frac{500 - 24.87}{e^{0.3 * 172.35 * \frac{\pi}{180}}} = 217.5N$

power $= (F_1 - F_2) * V$

$= (500 - 217.5) * 9.42$

$= 2660.9$ watt

$= 2.66$ KW