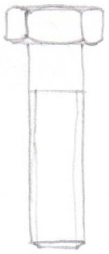
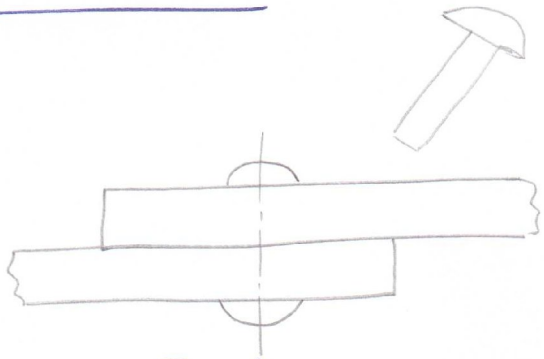
Design of riveted and bolted joints



screw bolt

non-permenant joint



Rivet

permenant joint

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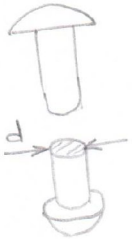
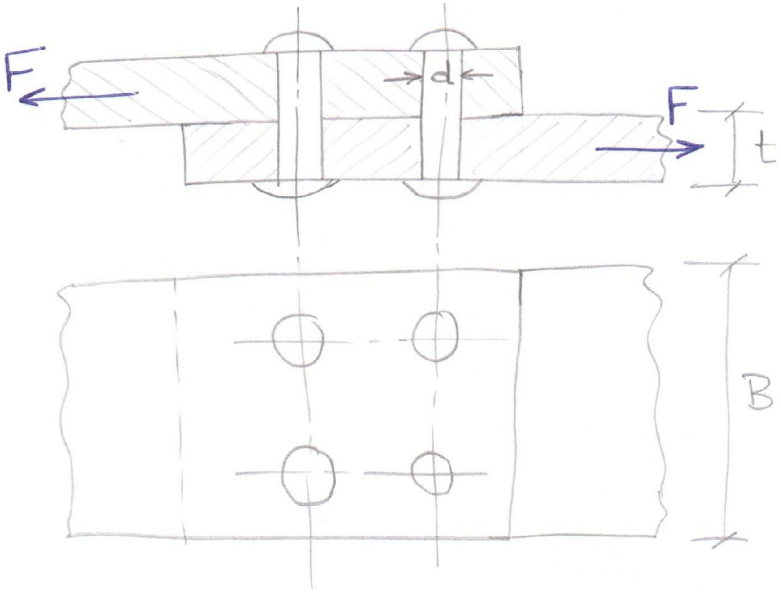
* lap-joint





shear stress

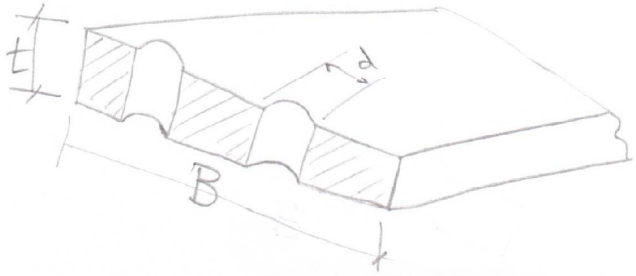
$$\tau = \frac{F}{nA}$$

Bearing stress $\quad \sigma_{br} = \dfrac{F}{\text{projected area}} = \dfrac{F}{d * t * n}$

For plate: tension stress across rivet holes

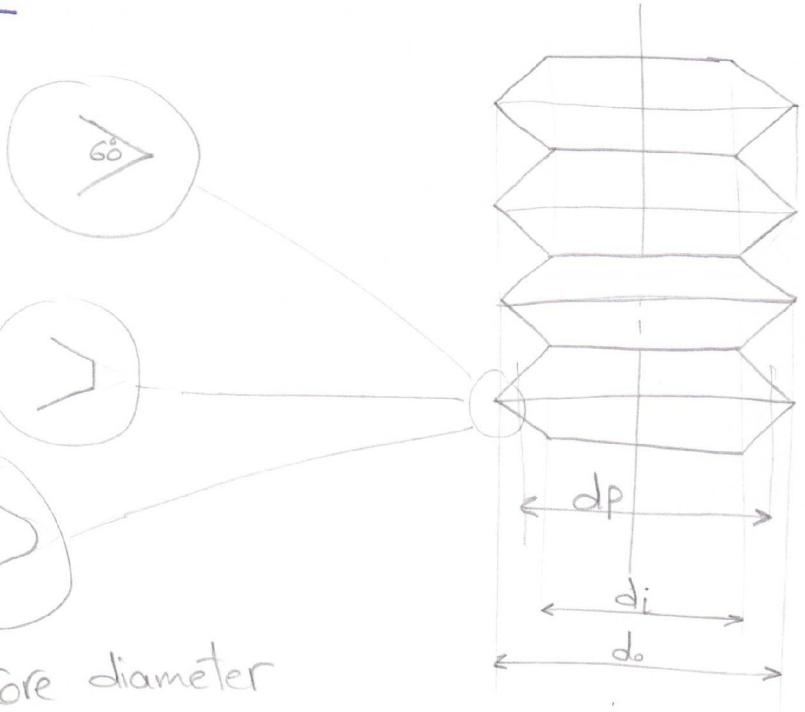
$$\sigma_t = \frac{F}{A}$$

$$= \frac{F}{Bt - ndt}$$



for bolts

M6 → bolt, $d_b = 6mm$



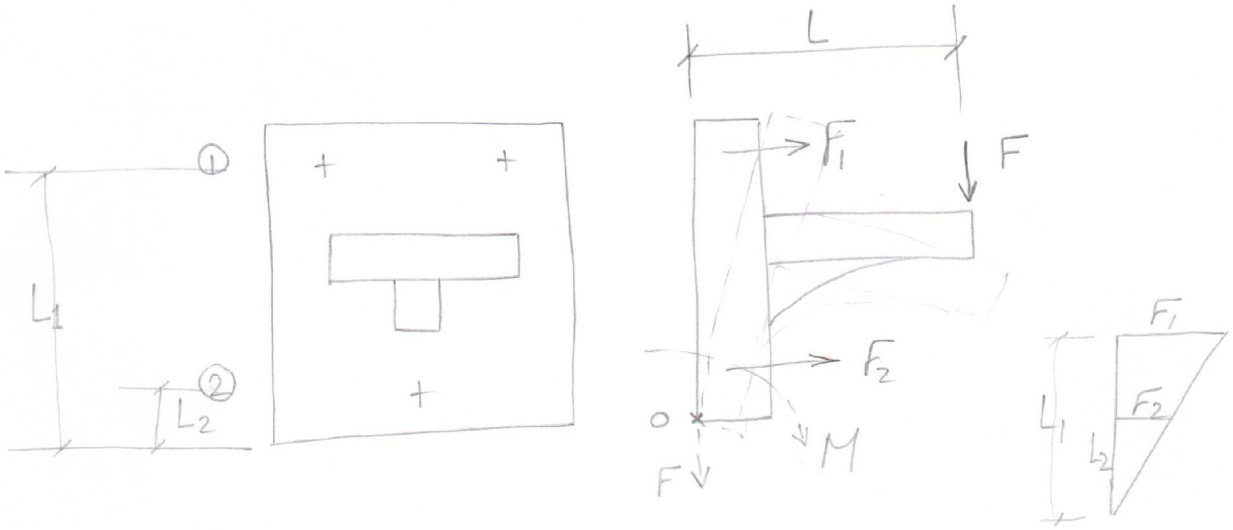
d_i inner or Core diameter

d_o outer or nominal diameter

d_p pitch diameter

Design of shear use small area $d = d_i = 0.85\, d_b$

Design based on tension



F_1, F_2 tension Forces

$F_1 > F_2$

$M = F * L$

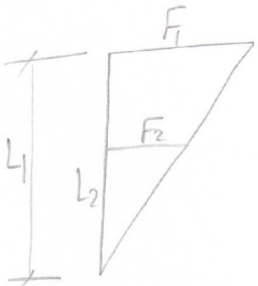
$M = 2F_1 * L_1 + 1F_2 * L_2$

For bracket } ①

For bolts }

L_1 ← عدد المسامير صف ①

L_2 ← عدد المسامير صف ②



From triangle

$$\frac{F_1}{L_1} = \frac{F_2}{L_2}$$ } ②

from ① & ②

$\therefore F_1 = \swarrow N$

$F_2 = \swarrow N$

shear force $F' = \frac{F}{n}$ ← عدد المسامير الكلي

choose the max. force bolt (bolt ①)

tension stress $\sigma_t = \frac{F}{A} = \frac{F_1}{\frac{\pi}{4} d_i^2}$

shear stress $\tau = \frac{F}{A} = \frac{F'}{\frac{\pi}{4} d_i^2}$

$$\sigma_{max} = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_x = \sigma_t \quad , \quad \sigma_y = 0 \quad , \quad \tau_{xy} = \tau$$

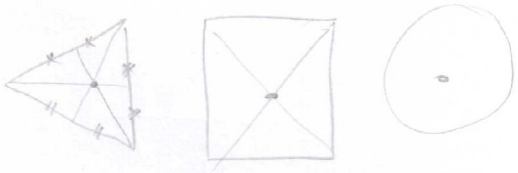
$$\sigma_{max} = \frac{\sigma_t}{2} + \sqrt{\left(\frac{\sigma_t}{2}\right)^2 + \tau^2} = \frac{S_y}{f.s.} \longrightarrow ③$$

or $$\tau_{max} = \sqrt{\left(\frac{\sigma_t}{2}\right)^2 + \tau^2} = \frac{0.5\, S_y}{f.s.} \longrightarrow ④$$

يتم ايجاد المجاهيل من المعادلات ③ و ④ مع مراعاة أخذ الابعاد (البعد الأكبر) أو القوى (القوة الأصغر).

Design based on shear due to eccentric load

Find the center of bolts



$$T = F * L$$

$$T = F_1 * r + F_2 * r_2 + F_3 r_3 \quad \} \ (1)$$

Knowing that $F_1 \propto r_1$, $F_2 \propto r_2$, - - -

$$\frac{F_1}{r_1} = \frac{F_2}{r_2} = \frac{F_3}{r_3} = - \ - \ - = \text{Const}$$

sub. in (1)

$$T = F_1 r_1 + \left(\frac{r_2}{r_1} F_1\right) r_2 + \left(\frac{r_3}{r_1} F_1\right) r_3$$

$\therefore F_1 = \_\_ N$, $F_2 = \_\_ N$, $F_3 = \_\_ N$

shear force $F' = \frac{F}{n}$ → Number of bolts

from drawing choose the most stress bolt with max. r and/or lowest θ

$$F_{total} = \sqrt{F_1^2 + F'^2 + 2 F_1 F' \cos\theta}$$

$$\tau = \frac{F}{A} = \frac{F_{total}}{\frac{\pi}{4}(d_i^2)} = \frac{0.5\, S_y}{f.s.}$$