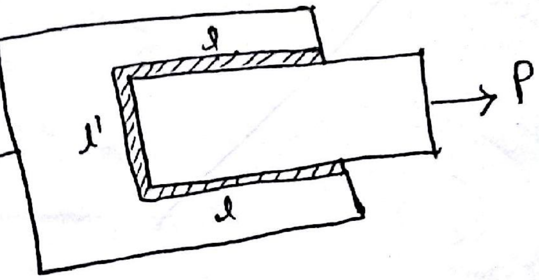
M.D.

CHAPTER-1 [JOINTS]

- welded joints

• steps to design fillet weld

1) find strength of plate



$$P = \sigma_t (w \cdot t)$$

w = width of plate

t = thickness of plate

2) find parallel fillet joint strength

$$P_1 = 2 \times \tau \times (0.707 \times t \times l)$$

3) find transverse fillet joint strength

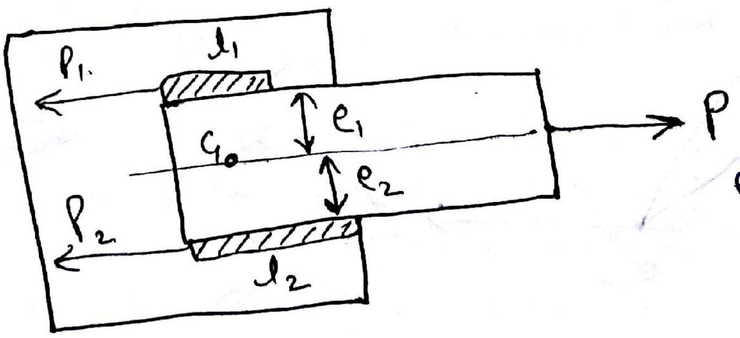
$$P_2 = \sigma_{t_1} \times (0.707 \times t \times l')$$

↳ τ is used in Gate Questions

σ_{t_1} = weld material strength.

4) $P = P_1 + P_2$

⇒



$$P = P_1 + P_2$$

$$P_1 e_1 = P_2 e_2$$

$$P_1 = .707 \times t \times l_1 \times \tau$$

$$P_2 = .707 \times t \times l_2 \times \tau$$

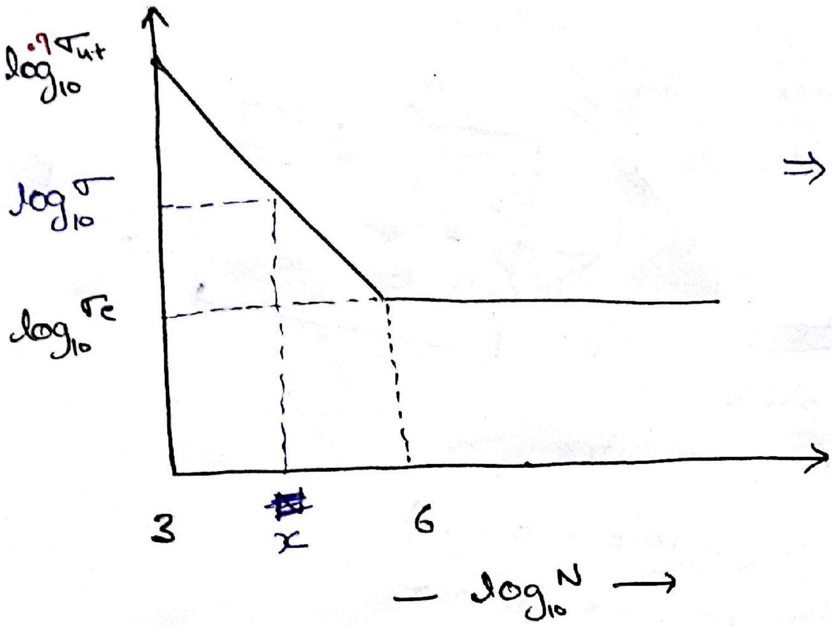
⇒ efficiency of riveted joint

$$\eta = \frac{\text{mini}\{P_{tearing}, P_{crushing}, P_{shearing}\}}{\text{Strength of Plate without rivets}}$$

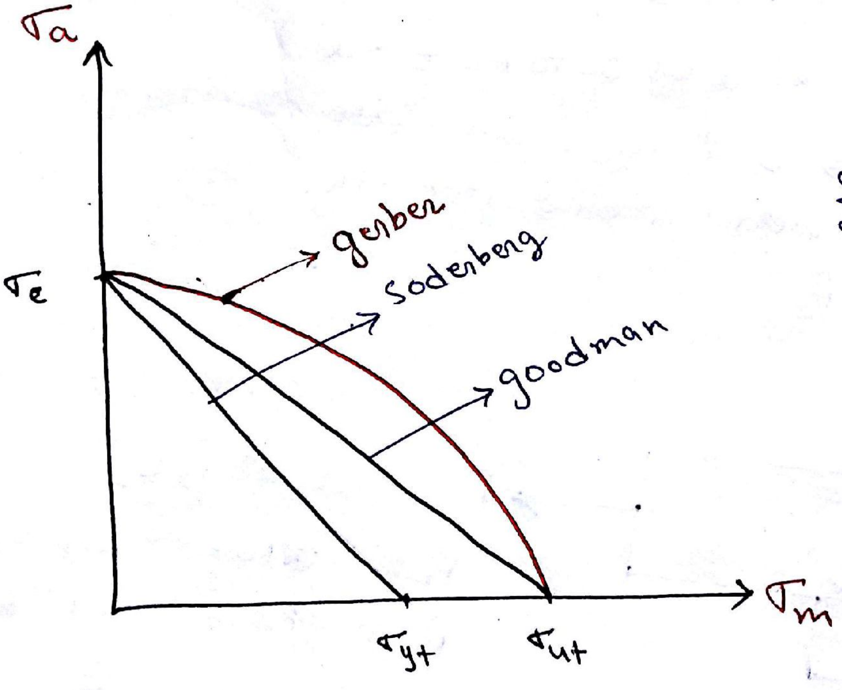
⇒ while designing a Threaded or bolted joint, nominal (outer) dia should be used unless relation b/w core dia and nominal dia is given in question

CHAPTER - 2 [Design against fatigue]

- Stress ratio = $\frac{\sigma_{min}}{\sigma_{max}}$
- $\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2}$
- Amplitude ratio = $\frac{\sigma_a}{\sigma_m}$
- $\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$



$\Rightarrow N = 10^x$



Soderberg's eqn

$$\frac{\sigma_a}{\sigma_e} + \frac{\sigma_m}{\sigma_{yt}} = \frac{1}{FOS}$$

Goodman's eqn

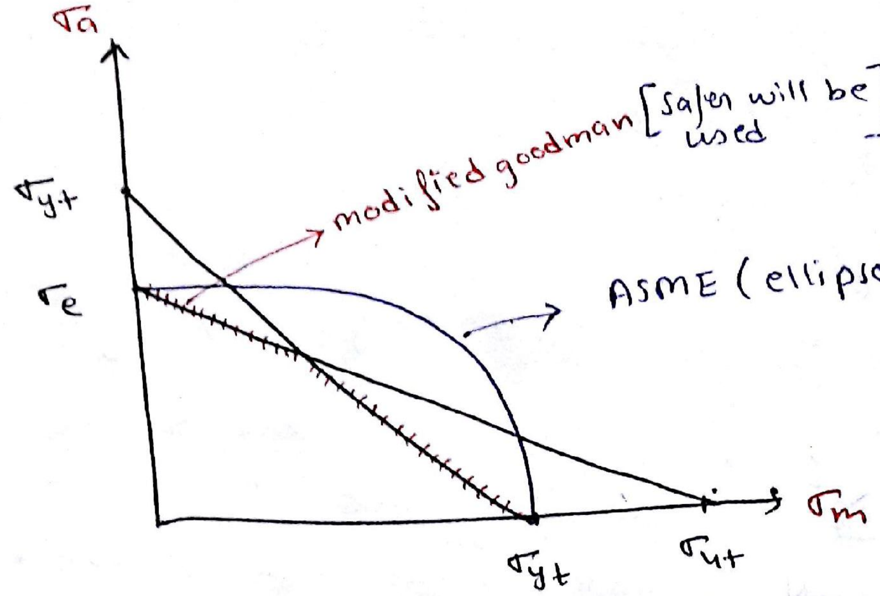
$$\frac{\sigma_a}{\sigma_e} + \frac{\sigma_m}{\sigma_{ut}} = \frac{1}{FOS}$$

Gerber's eqn

$$(FOS)\frac{\sigma_a}{\sigma_e} + \left[(FOS)\frac{\sigma_m}{\sigma_{ut}}\right]^2 = 1$$

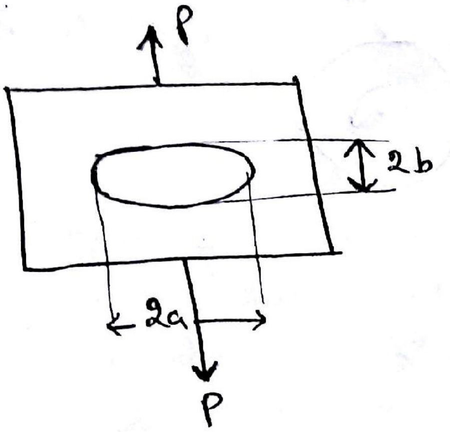
- If various stress concentration factors are given then, replace,

$$\sigma_e \Rightarrow \frac{K_s . K_L . \cdots}{K_f} \sigma_e \quad \& \quad \sigma_m \Rightarrow K_t \sigma_m$$



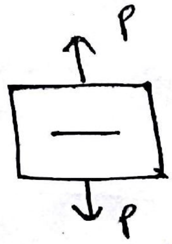
ASME (ellipse) $\Rightarrow \left(\frac{\sigma_a}{\sigma_e}\right)^2 + \left(\frac{\sigma_m}{\sigma_{yt}}\right)^2 = \frac{1}{(FOS)^2}$

$\Rightarrow$ theoretical stress concentration factor (K_t)



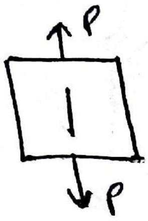
$$\boxed{K_t = \left(1 + \frac{2a}{b}\right)}$$

(i)



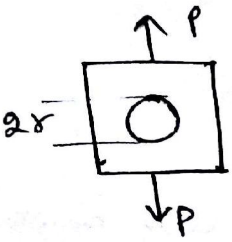
$K_t = \left(1 + \frac{2a}{0}\right) = \infty$

(ii)



$K_t = \left(1 + \frac{2 \times 0}{b}\right) = 0$

(iii)



$K_t = 1 + \frac{2r}{r}$

$K_t = 3$

$\Rightarrow$ failure stress concentration factor (K_f)

$K_f = \frac{(\sigma_e) \text{ without notch}}{[(\sigma_e) \text{ with notch}]_{\text{practically}}}$ $\qquad$ $K_t = \frac{(\sigma_e) \text{ without notch}}{[(\sigma_e) \text{ with notch}]_{\text{theore.}}}$

$K_t > K_f$ always

$\Rightarrow$ notch sensitivity (q) $= \frac{(\sigma_{max})_{actual} - \sigma_o}{(\sigma_{max})_{th.} - \sigma_o} = \frac{K_f \sigma_o - \sigma_o}{K_t \sigma_o - \sigma_o}$

$$q = \frac{K_f - 1}{K_t - 1}$$

- $q = 0 \Rightarrow K_f = 1 \Rightarrow$ not sensitive to notch
- $q = 1 \Rightarrow K_f = K_t \Rightarrow$ Purely sensitive to notch

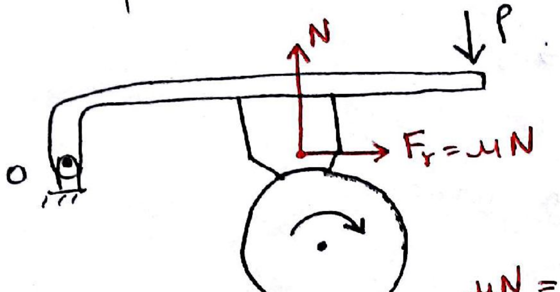
- $K_{surface\ finish} = 1$ for Cast iron

CHAPTER-3 [BRAKES]

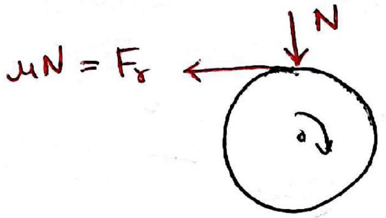
- Brake factor $= \dfrac{F_f}{P}$

if F_f supports $P \Rightarrow$ called as self energising brake

1. Simple shoe brake

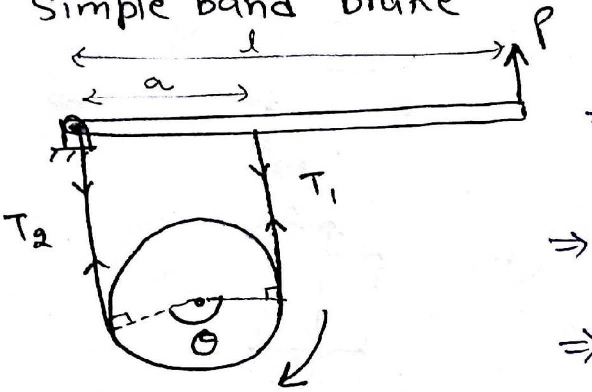


- Simply balance the torque on hing Point
- Apply torque equ^n on wheel/disc



$T_f = F_r \cdot R$

2. Simple band brake

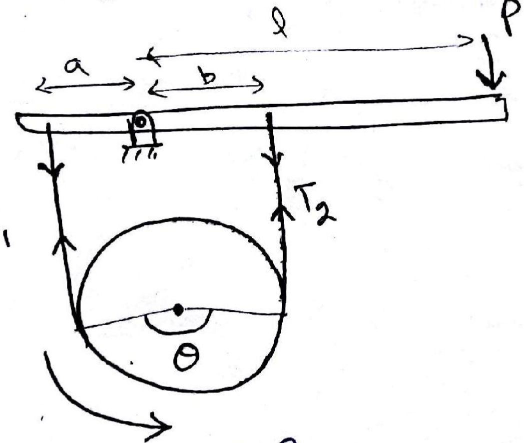


$\Rightarrow \dfrac{T_1}{T_2} = e^{\mu\theta}$

$\Rightarrow T_f = (T_1 - T_2) R$

$\Rightarrow T_1 a = P l$

3. Differential Band Brake

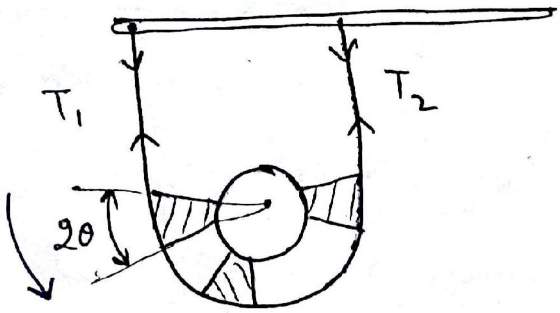


$\dfrac{T_1}{T_2} = e^{\mu\theta}$

$T_1 a = T_2 b + P l$

$(T_1 - T_2) R = T_f$

4. Band & Block Brake



$\dfrac{T_1}{T_2} = \left(\dfrac{1 + \mu \tan\theta}{1 - \mu \tan\theta}\right)^n$

$T_f = (T_1 - T_2) R$

$n =$ no. of block

- effective coefficient of friction μ'

$$\mu' = \frac{4\mu \sin\theta}{2\theta + \sin(2\theta)}$$

CHAPTER-4 [Clutches / DISC BRAKES]

New Brakes (Uniform Pressure theory)

$\Rightarrow P = \dfrac{F}{\pi(r_2^2 - r_1^2)}$

$\Rightarrow T_f = \mu . F . R_m$

$\Rightarrow R_m = \dfrac{2}{3}\dfrac{(r_2^3 - r_1^3)}{(r_2^2 - r_1^2)}$

Old Brakes (Uniform wear theory)

$\Rightarrow P = \dfrac{F}{2\pi(r_2 - r_1)\, r}$

$\Rightarrow T_f = \mu . F . R_m$

$\Rightarrow R_m = \dfrac{r_1 + r_2}{2}$

- Above formulas are for single pairing surface for 'n' pairs, multiply T_f by 'n' to get total torque transmitted.
- F remain same for all pairs of clutches
- F is distributed for thrust bearings

$$T_{loss} = \mu . n \times (F_{collar}) \times R = \mu \cancel{n} \times \left(\frac{F}{\cancel{n}}\right) . R = \mu F R$$

↳ but still independent of no. of collar

$\Rightarrow$ Cone clutch

$$T_f = \mu\left(\frac{F}{\sin\alpha}\right) . R_m$$

$\rightarrow \dfrac{2}{3}\left(\dfrac{r_2^3 - r_1^3}{r_2^2 - r_1^2}\right) \Rightarrow$ UPT

$\rightarrow \dfrac{r_1 + r_2}{2} \Rightarrow$ U.W.T.

α = half cone angle

$\Rightarrow$ Centrifugal clutch

$$T_f = n . \mu N R$$

n = no. of shoes
$N = m r (\omega^2 - \omega_0^2)$
ω_0 = speed at which shoe just tuoch the rim.
R = rim radius
r = radius of shoe center

CHAPTER-5 [GEAR Design [spur]]

⇒ According to beam strength (S_b)

1) if material is same, design for pinion
   if material is different then design for weaker
   $\left((\sigma_b)_{per} \cdot Y\right)_g$ & $\left((\sigma_b)_{per} Y\right)_p$ smaller will be considered as weaker.

2) find beam strength.

$$S_b = (\sigma_b)_{per} \cdot b \cdot m \cdot Y$$

$(\sigma_b)_{per}$ = Permissible bending stress at tooth root. due to P_t

b = face width

m = module

Y = lewis form factor or tooth geometry factor

$$Y = \pi\left(0.154 - \frac{0.912}{z}\right) \Rightarrow \text{for } 20^\circ = \phi$$

z = no. of teeth

3) calculate P_{eff}.

$$P_{eff} = (FOS) \cdot \frac{C_s}{C_v} \cdot P_t$$

P_t = tangential load on tooth

C_s = Service factor = $\frac{\text{Starting torque}}{\text{rated torque}}$

C_v = Velocity factor

$$= \frac{3}{3+V} \qquad 0 < V < 10 \text{ m/s}$$

$$= \frac{6}{6+V} \qquad 10 \leq V \leq 20 \text{ m/s}$$

$$= \frac{5.6}{5.6+\sqrt{V}} \qquad 20 < V \text{ m/s}$$