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SHORT NOTES (ME)

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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

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

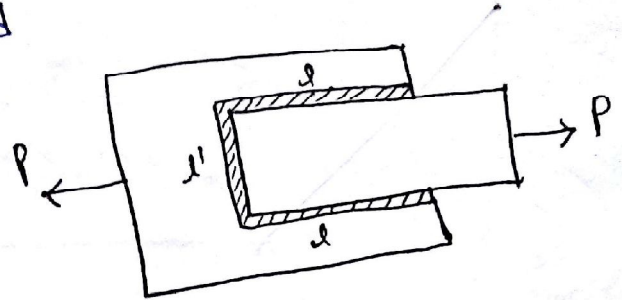
3) find transverse fillet joint strength

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

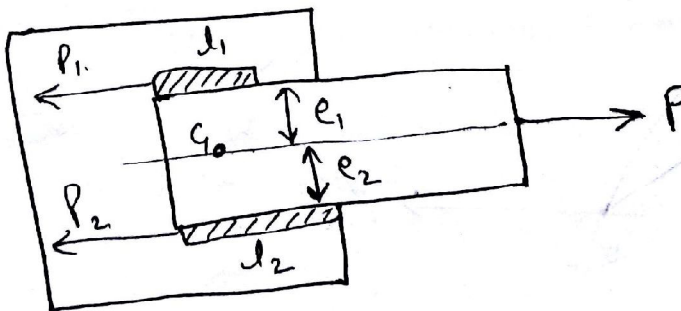
↳ τ is used in Gate questions

σ_{t_1} = weld material strength.

4) $P = P_1 + P_2$



⇒



$$P = P_1 + P_2$$

$$P_1 e_1 = P_2 e_2$$

$$P_1 = 0.707 \times t \times l_1 \times \tau$$

$$P_2 = 0.707 \times t \times l_2 \times \tau$$

⇒ efficiency of riveted joint

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

⇒ 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

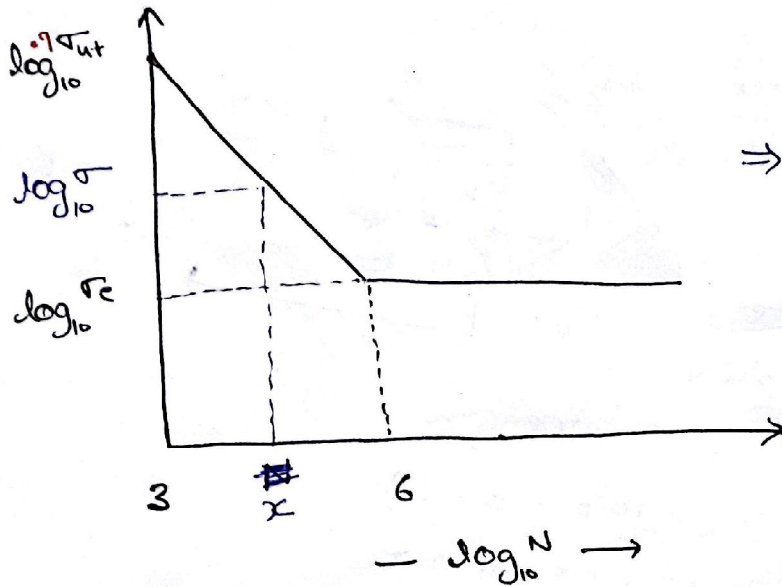
CHAPTER-2 [Design against fatigue]

• Stress ratio = $\frac{\sigma_{min}}{\sigma_{max}}$

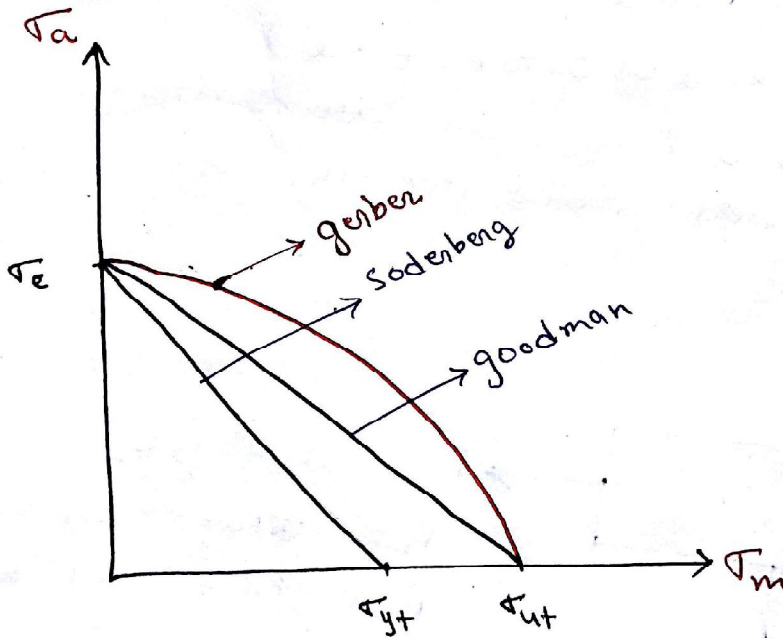
• $\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2}$

• Amplitude ratio = $\frac{\sigma_a}{\sigma_m}$

• $\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$



$\Rightarrow N = 10^x$



Soderberg's eqnⁿ

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

Goodman's eqnⁿ

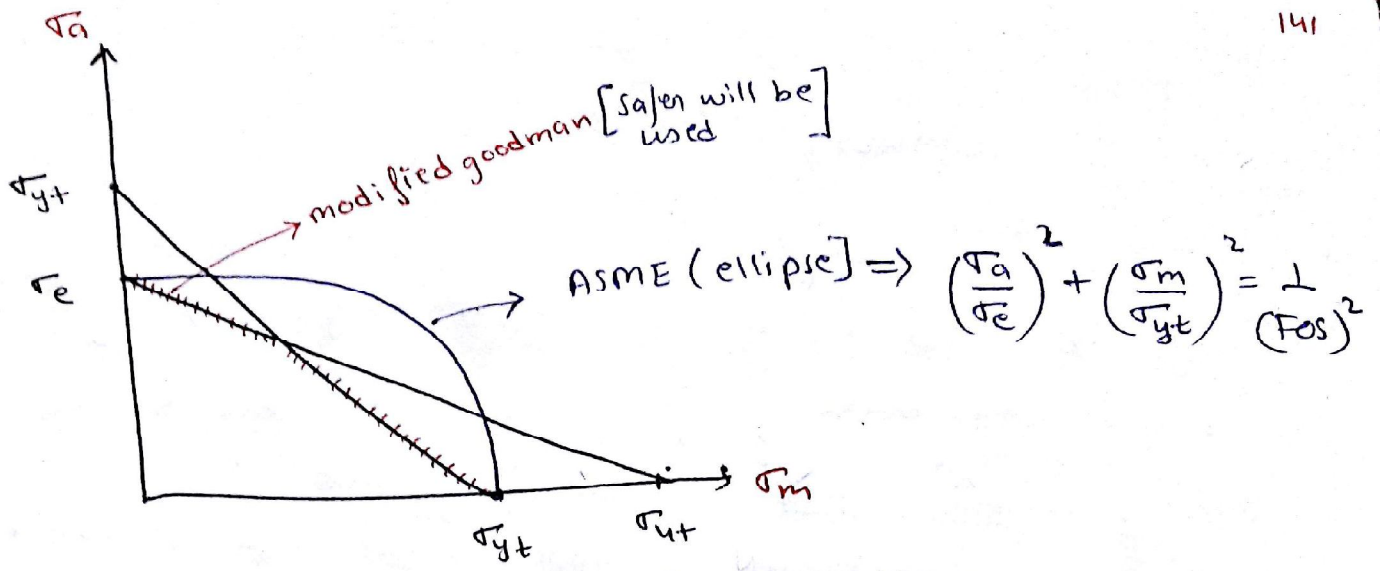
$$\frac{\sigma_a}{\sigma_e} + \frac{\sigma_m}{\sigma_{ut}} = \frac{1}{FOS}$$

Gerber's eqnⁿ

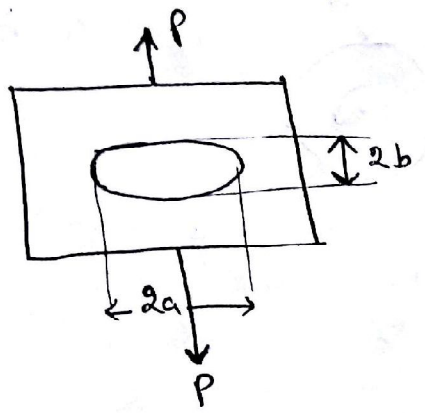
$$(FOS) \frac{\sigma_a}{\sigma_e} + \left[(FOS) \frac{\sigma_m}{\sigma_{ut}} \right]^2 = 1$$

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

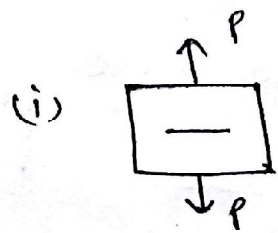
$$\sigma_e \Rightarrow \frac{K_s \cdot K_L \cdot \dots \cdot \sigma_e}{K_f} \quad \& \quad \sigma_m \Rightarrow K_t \sigma_m$$



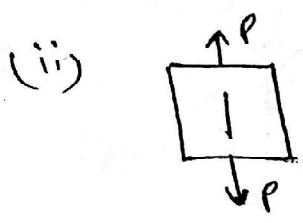
⇒ theoretical stress concentration factor (K_t)



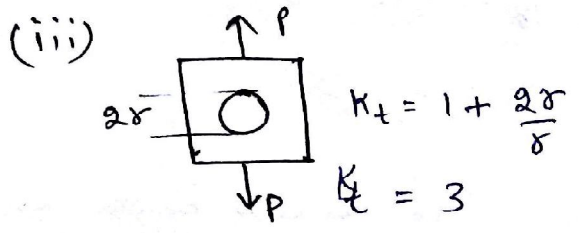
$$K_t = \left(1 + \frac{2a}{b}\right)$$



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



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



$$K_t = 1 + \frac{2r}{r} = 3$$

⇒ failure stress concentration factor (K_f)

$$K_f = \frac{(\sigma_e) \text{ without notch}}{[(\sigma_e) \text{ with notch}] \text{ practically}}$$

$$K_t = \frac{(\sigma_e) \text{ without notch}}{[(\sigma_e) \text{ with notch}] \text{ theoret.}}$$

$K_t > K_f$ always

$$\Rightarrow \text{notch sensitivity } (q) = \frac{(\sigma_{\max})_{\text{actual}} - \sigma_0}{(\sigma_{\max})_{\text{th.}} - \sigma_0} = \frac{K_f \sigma_0 - \sigma_0}{K_t \sigma_0 - \sigma_0}$$

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

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

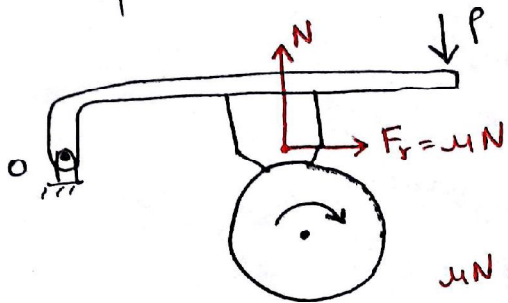
- $K_{\text{surface finish}} = 1$ for Cast iron

CHAPTER-3 [BRAKES]

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

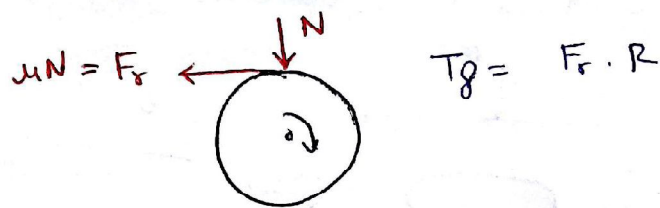
if F_f supports $P \Rightarrow$ called as self energising brake

1. Simple shoe brake

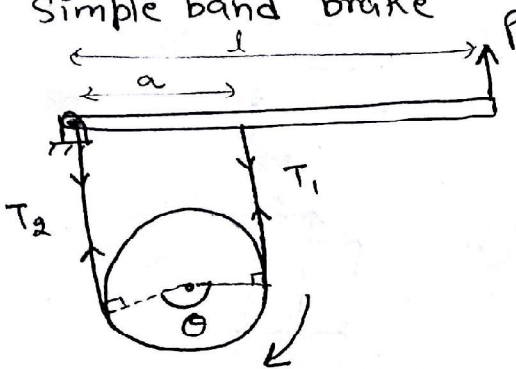


- Simply balance the torque on hing point

- Apply torque eqn on wheel/disc



2. Simple band brake

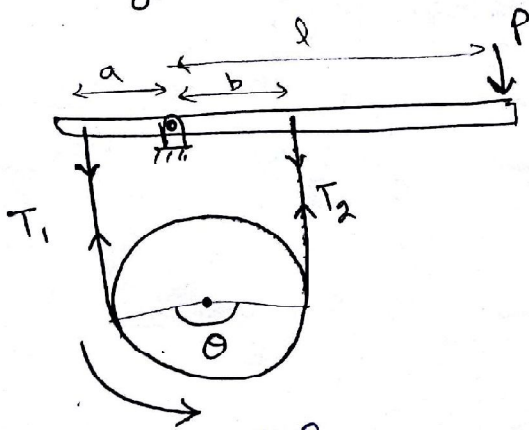


$$\Rightarrow \frac{T_1}{T_2} = e^{\mu \theta}$$

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

$$\Rightarrow T_1 a = P l$$

3. Differential Band Brake

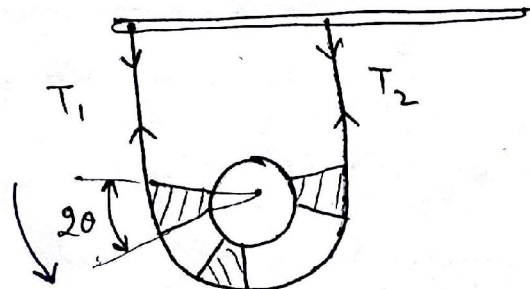


$$\frac{T_1}{T_2} = e^{\mu \theta}$$

$$T_1 a = T_2 b + P l$$

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

4. Band & Block Brake



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

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

$n =$ 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)

old Brakes
(Uniform wear theory)

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

$$\Rightarrow P = \frac{F}{2\pi(r_2 - r_1)\delta}$$

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

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

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

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

• Above formulas are for single pairing surface for 'n' pairs, multiply T_f by 'n' to get total torque transmitted.

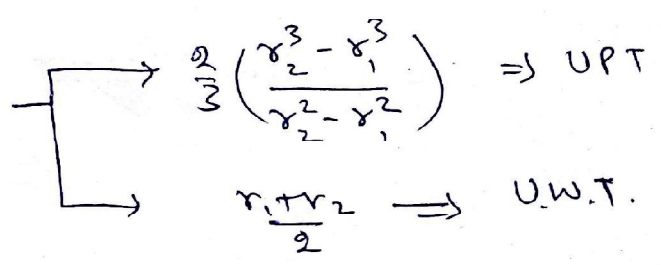
- F remain same for all pairs of clutches
- F is distributed for thrust bearings

$$T_{loss} = \mu \cdot n \times (F_{collor}) \times R = \mu \cdot n \times \left(\frac{F}{n}\right) \cdot R = \mu F R$$

↳ but still independent of no. of collar

⇒ Cone clutch

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



α = half cone angle

⇒ Centrifugal clutch

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

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

CHAPTER-5 [GEAR Design [spun]]

⇒ According to beam strength (S_b)

1) if material is same, design for pinion

if material is different then design for weaker

$$\left((\sigma_b)_{\text{pin}} \cdot Y \right)_g \text{ \& \ } \left((\sigma_b)_{\text{pin}} \cdot Y \right)_p \text{ smaller will}$$

be considered as weaker.

2) find beam strength.

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

$(\sigma_b)_{\text{pin}}$ = 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} .

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

P_t = tangential load on tooth

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

C_v = velocity factor

$$= \frac{3}{3+v} \quad 0 < v < 10 \text{ m/s}$$

$$= \frac{6}{6+v} \quad 10 \leq v \leq 20 \text{ m/s}$$

$$= \frac{5.6}{5.6 + \sqrt{v}} \quad 20 < v \text{ m/s}$$