

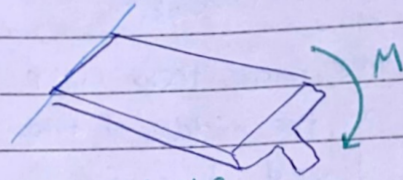
Sunday
12/3/2023

Normal stress
bending moment

σ : tension = 24 MPa

σ : compression = 30 MPa

*straight beam



largest M?

$C(\bar{x}, \bar{y})$

$\bar{x} = 0$
 $17.5 \text{ mm} = \bar{y} = \frac{\sum \bar{y}_i A_i}{\sum A_i}$

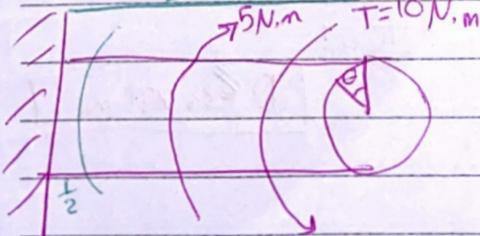
$\bar{I} = 61870 \times 10^{-12} \text{ m}^4$

$$+ \left(\frac{15}{1000} \times \frac{10}{1000} \right) + \frac{1}{12} \left(\frac{20}{1000} \right) \left(\frac{15}{1000} \right)^3 + 15 \times 20 \times \left(\frac{10}{1000} \right)^2$$

$24 \times 10^6 = -M_z \left(\frac{30 - 17.5}{1000} \right) \rightarrow M_z = -118.8 \text{ N.m}$ (tension)

$-30 \times 10^6 = -M_z \left(\frac{-17.5}{1000} \right) \rightarrow M_z = -106.06 \text{ N.m}$ (compression)

$T \rightarrow \tau = \frac{T r}{J}$
 $L = 1 \text{ m}$



$\tau = G \gamma$

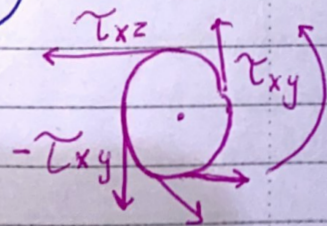
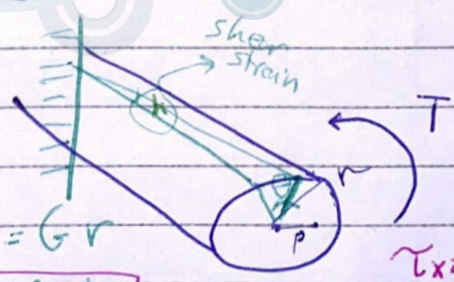
$\theta = \frac{T L}{G J}$

$\theta = 10 \times \frac{1}{2}$
 $\frac{1}{G J}$

$\theta = 10 \times \frac{1}{2} + 5 \times \frac{1}{2}$
 $\frac{1}{G J} \quad \frac{1}{G J}$

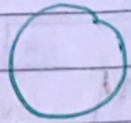
$\theta_2 = 5 \times \frac{1}{2}$
 $\frac{1}{G J}$

Torque
force & couple



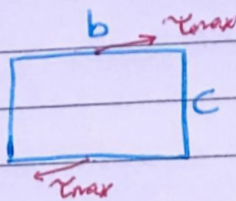
Five Apple

Circular



$$\tau = \frac{T r}{J}$$

$$\theta = \frac{TL}{JG}$$

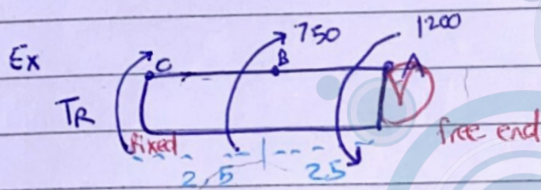


$$\frac{b}{c} \rightarrow \propto \text{Go table}$$

$$\tau_{max} = \frac{T}{\alpha b c^2}$$

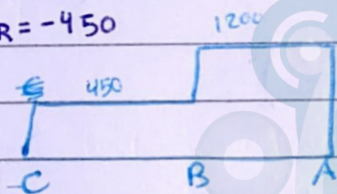
max shear stress occur as the middle of the longest dimension

Free/Fixed end -4°



$$\sum T = 0 \rightarrow 1200 - 750 + T_R = 0$$

$$T_R = -450$$

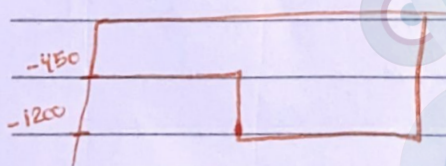


$$\theta_{\text{Free/Fixed end}} = \frac{T_1 L}{JG} + \frac{T_2 L}{JG}$$

$$\theta_A = \theta_{A/B} + \theta_{B/C}$$

$$\frac{4 \times \pi}{180} = \frac{1200 \times 2.5}{\frac{\pi}{32} D^4 \times 83 \times 10^9} + \frac{450 \times 2.5}{\frac{\pi}{32} D^4 \times 83 \times 10^9}$$

$$D \geq 51.9 \text{ mm}$$



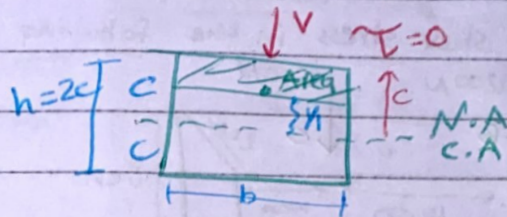
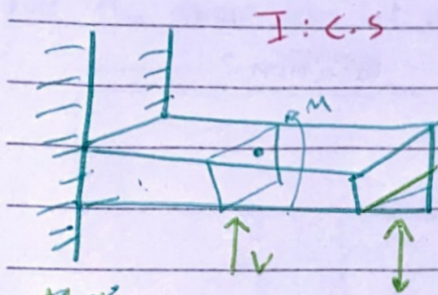
$$\tau = \frac{T r}{J} = \frac{1200 \times \frac{D}{2}}{\frac{\pi}{32} D^4} = 60 \times 10^6$$

$$D \geq 46.84 \text{ mm}$$

$$\frac{450 \times \frac{D}{2}}{\frac{\pi}{32} D^4} = 60 \times 10^6$$

$$D \geq 33.79 \text{ mm}$$

3-11 Shear Stresses for Beams in Bending



$$I = \frac{1}{12} (b) (2c)^3$$

$$\tau_{average} = \frac{V}{A}$$

$$\tau = \frac{V}{Ib} \int_{y_1}^c y \, dA$$

$$\tau_{max} = \frac{3}{2} \frac{V}{A}$$

for cross section rectangular

$$\tau = \frac{VQ}{Ib}$$

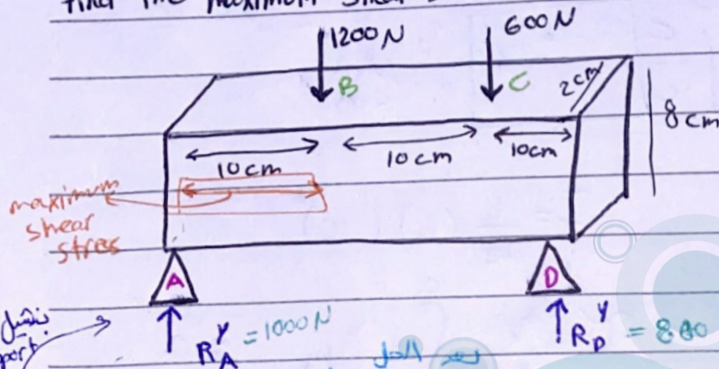


maximum load
 maximum shear

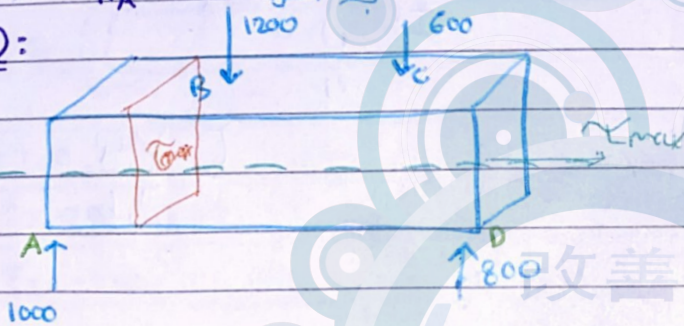
Sunday
 19/3/2023

*Example:-

Find the maximum shear stress in the following Beam? location?



support reaction
 FBD:



$$\sum M_A^Z = \sum M_R^Z$$

$$0 = R_D^Y \times 30 - 600 \times 20 - 1200 \times 10$$

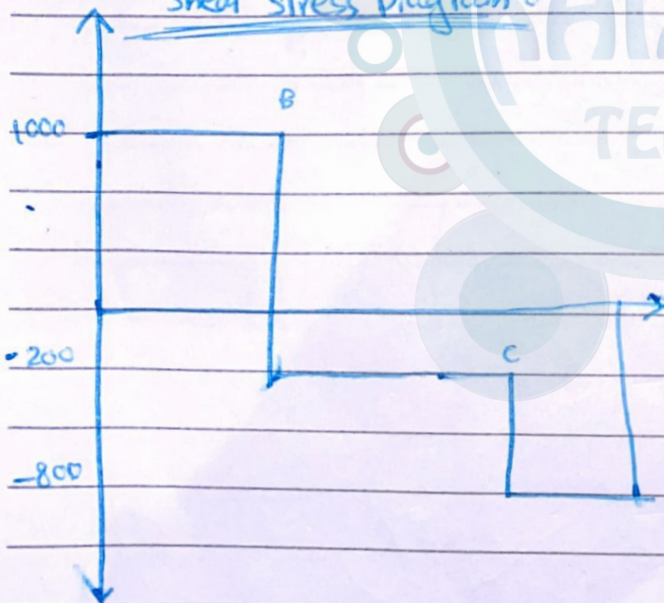
$$R_D^Y = 800 \text{ N}$$

$$\sum F_y = 0$$

$$R_A^Y - 1200 - 600 + 800 = 0$$

$$R_A^Y = 1000 \text{ N}$$

Shear Stress Diagram:-



$$\tau_{\text{max}} = \frac{3V}{2A} = \frac{3 \times 1000}{2 \times \frac{8}{100} \times \frac{2}{100}} = 93.75 \times 10^4 \text{ Pa}$$

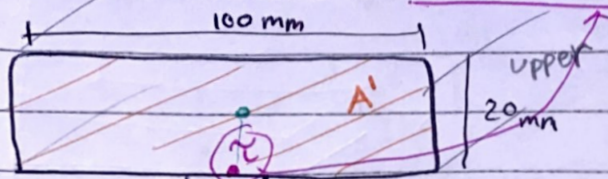
$$\tau_{\text{max}} = \frac{V}{A} = \frac{1000}{\frac{8}{100} \times \frac{2}{100}}$$

$$V_{\text{max}} = 1000 \text{ N} \quad \text{A-B}$$

* Example :-

it is a symmetric shape

Find the Shear Stress at the lower surface of the upper flange



$$\tau = \frac{VQ}{Ib}$$

Shear load
 $V = 500 \text{ N}$

$$Q = \bar{y}_A A' = \frac{60}{1000} \times \frac{20}{1000} \times \frac{100}{1000}$$

$$Q = 120 \times 10^{-6} \text{ m}^3$$

$$I = \sum I_i + A_i d_i^2$$

$$I = \left(\frac{1}{12} \left(\frac{100}{1000} \right) \left(\frac{20}{1000} \right)^3 + \frac{20}{1000} \times \frac{100}{1000} \times \left(\frac{60}{1000} \right)^2 \right) \times 2$$

$$+ \frac{1}{12} \times \frac{20}{1000} \times \left(\frac{100}{1000} \right)^3 \times 2$$

$$I_{C-S} = 16.2 \times 10^{-4} \text{ m}^4$$

$$\tau = \frac{500 \times 120 \times 10^{-6}}{16.2 \times 10^{-4} \times \frac{100}{1000}} = 30740 \text{ Pa}$$

from table $\tau_{\max} = \frac{V}{A} = \frac{500}{\frac{20}{1000} \times \frac{100}{1000}} =$

تو طلب τ خون يكون
Symmetric 4:30

改善

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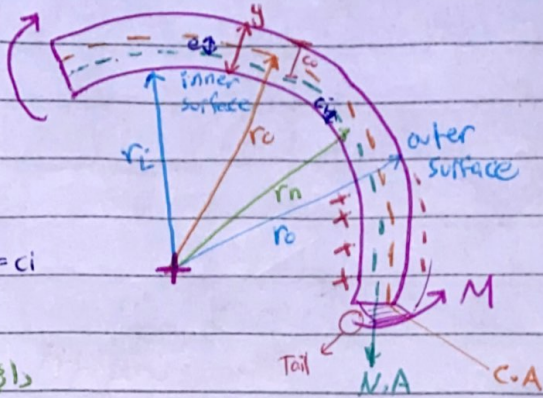
TEAM

Bending on Curved beams

Tuesday

21/3/2023

$$e = R - r_n$$



$$\sigma = \frac{My}{Ae(r_n - y)}$$

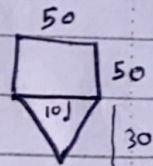
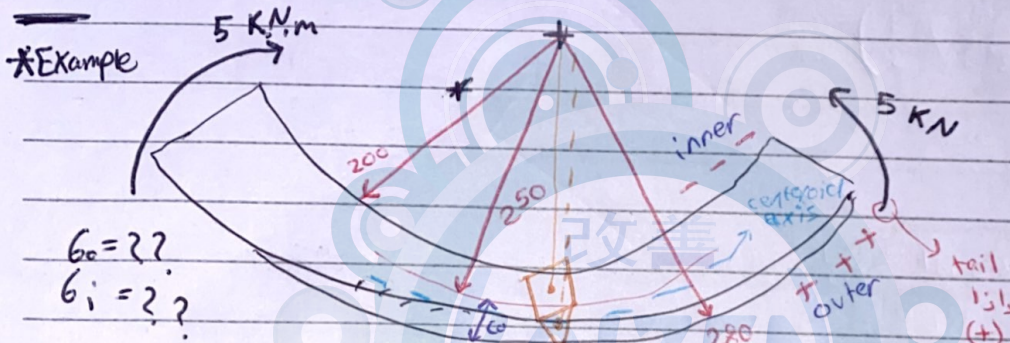
$$\sigma_i = \frac{M C_i}{A e r_i}$$

$r_n + c_o$

$$\sigma_o = \frac{-M C_o}{A e r_o}$$

دائري
 $r_o > r_n$

دائري (Circular)
(+) Tail



$\sigma_o = ??$
 $\sigma_i = ??$

$$r_c = \frac{\sum \bar{r}_o A_i}{\sum A_i} = \frac{225 \times 50 \times 50 + 260 \times \frac{1}{2} \times 50 \times 30}{50 \times 50 + \frac{1}{2} \times 50 \times 30} = 233.08 \text{ mm}$$

$$r_n = \frac{\sum A_i}{\sum \frac{dA}{r}} = \frac{50 \times 50 + \frac{1}{2} \times 50 \times 30}{11 + 2.886} = 231.42 \text{ mm}$$

من الجدول
from table

$$e = 233.08 - 231.42 = 1.66 \text{ mm}$$

$$\sigma_i = \frac{5 \times 10^3 \times (0.23142 - 0.2)}{(50 \times 50 + \frac{1}{2} \times 50 \times 30) \times 10^{-6} \times \frac{1.66}{1000} \times 0.2} =$$

$$\sigma_o = \frac{5 \times 10^3 \times (0.28 - 0.23142)}{(50 \times 50 + \frac{1}{2} \times 50 \times 30) \times 10^{-6} \times \frac{1.66}{1000} \times 0.28} =$$

من الجدول
(+)

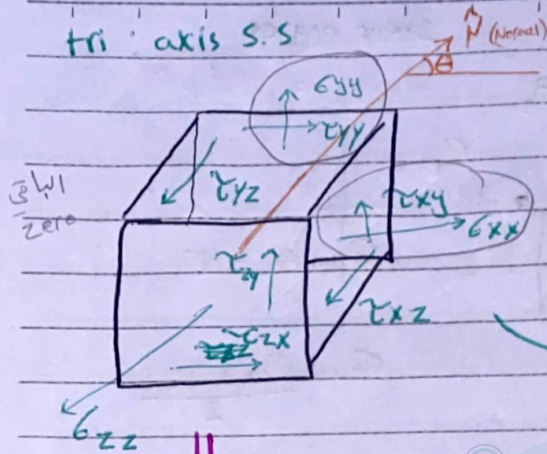
$$\frac{S dA}{r} = b \ln \left(\frac{r}{r_i} \right) = 50 \ln \left(\frac{250}{200} \right) = 11 \text{ mm}$$

$$\frac{S dA}{r} = \frac{b r_o}{r_o - r_i} \ln \left(\frac{r_o}{r_i} \right) - b = \frac{50 \times 280}{(280 - 250)} \ln \left(\frac{280}{250} \right) - 50 = 2.886 \text{ mm}$$

Five Apple

Stress components of stress state

Sunday
26/3/2023



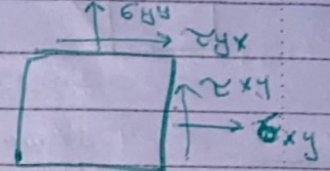
6 components

$$\tau_{xy} = \tau_{yx}$$

$$\tau_{yz} = \tau_{zy}$$

$$\tau_{xz} = \tau_{zx}$$

plane stress



plane

$$\begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ \tau_{yx} & \sigma_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & \sigma_{zz} \end{bmatrix}$$

symmetric

$$\begin{bmatrix} \sigma_{xx} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

P.S.S

$$\sigma_{x_1x_1} = \frac{\sigma_{xx} + \sigma_{yy}}{2} + \frac{\sigma_{xx} - \sigma_{yy}}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\sigma_{y_1y_1} = \frac{\sigma_{xx} + \sigma_{yy}}{2} - \frac{\sigma_{xx} - \sigma_{yy}}{2} \cos 2\theta - \tau_{xy} \sin 2\theta$$

$$\tau_{x_1y_1} = -\frac{\sigma_{xx} - \sigma_{yy}}{2} \sin 2\theta + \tau_{xy} \cos 2\theta$$

Principle stresses

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

$$\sigma_{\min} = \frac{\sigma_{xx} + \sigma_{yy}}{2} - \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \tau_{xy}^2}$$

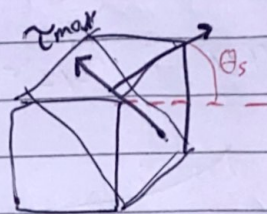
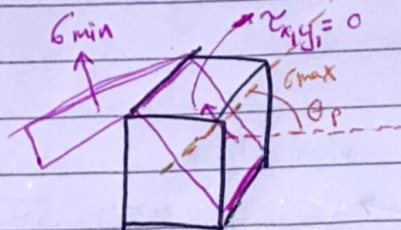
$$\tau_{\max} = \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \tau_{xy}^2}$$

max و min 90° دورے میں

principle stresses for shear free plane

shear angles

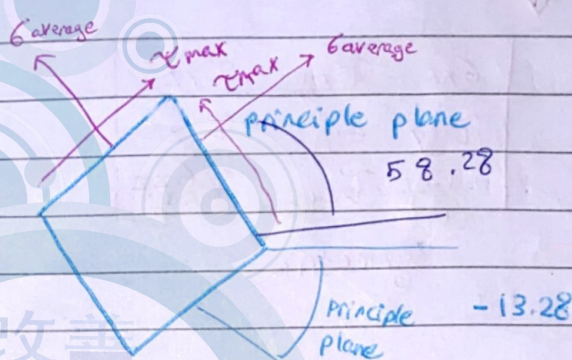
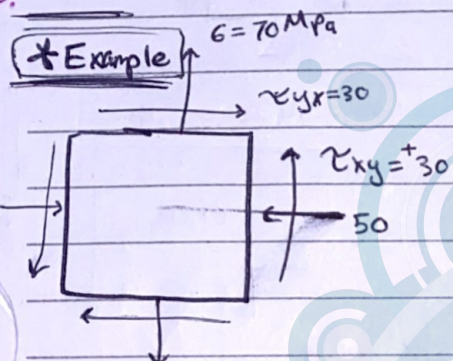
$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_{xx} - \sigma_{yy}} = \tan 2\theta_s$$



$$\theta_p + \theta_s = 45$$

$$\sigma_{av} = \frac{\sigma_{xx} + \sigma_{yy}}{2}$$

CCW +



$$\sigma_{max} = \frac{-50 + 70}{2} + \sqrt{\left(\frac{-50 - 70}{2}\right)^2 + (30)^2} = 77.08$$

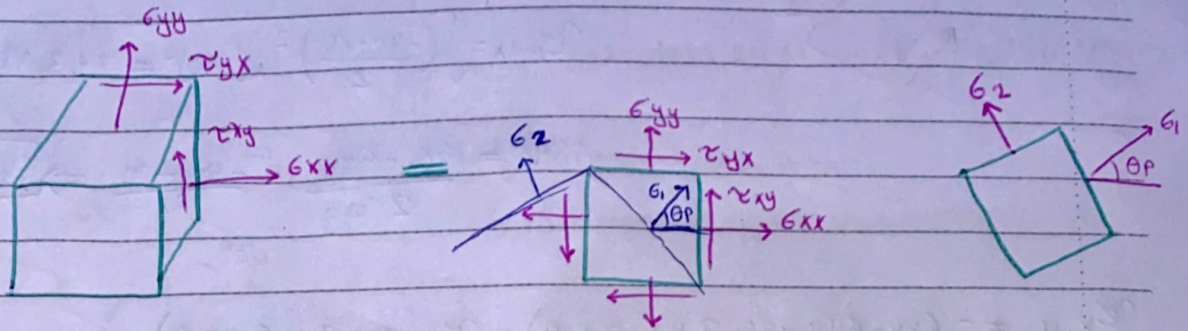
$$\sigma_{min} = \frac{-50 + 70}{2} - \sqrt{\left(\frac{-50 - 70}{2}\right)^2 + (30)^2} = -57.08$$

$$\tau_{max} = \sqrt{\left(\frac{-50 - 70}{2}\right)^2 + (30)^2} = 67.08$$

- location of the principle plane

$$\tan(2\theta_p) = \frac{2 \times 30}{-50 - 70} \Rightarrow \theta_p = -13.28$$

$$\tan 2\theta_s = \frac{-50 - 70}{2 \times 30} \Rightarrow \theta_s = 58.28$$



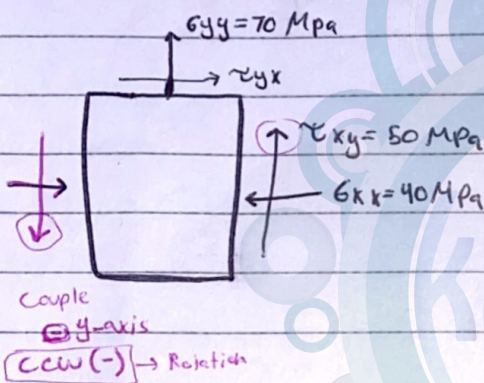
plane stress state

$$\sigma_{zz}=0, \tau_{zx}=0, \tau_{zy}=0, \\ \tau_{xz}=0, \tau_{yz}=0$$

* Principle Stress

$$\sigma_{max} = \sigma_1 \quad \theta_p \\ \sigma_{min} = \sigma_2 \quad \theta_p + 90 \\ \tau_{max} = \tau_s$$

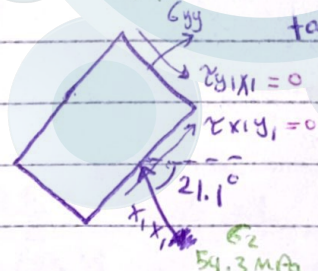
* Example : Determine the principle stresses of the max shear stress



$$\sigma_{1,2} = \frac{\sigma_{xx} + \sigma_{yy}}{2} \pm \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \tau_{xy}^2} \\ = \frac{-40 + 70}{2} \pm \sqrt{\left(\frac{-40 - 70}{2}\right)^2 + (-50)^2}$$

$$\sigma_1 = 89.3 \text{ MPa} \quad \sigma_2 = -59.3 \text{ MPa}$$

* location of the P.P → principle plane



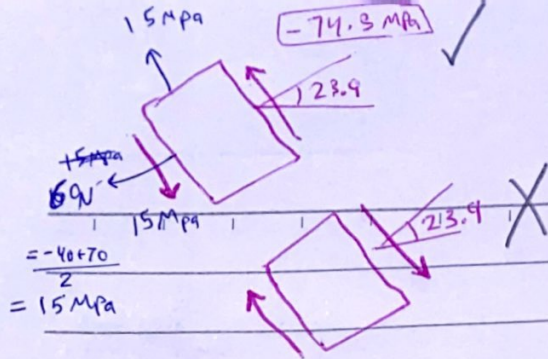
$$\tan 2\theta_p = \frac{\tau_{xy}}{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)} = \frac{-50}{\left(\frac{-40 - 70}{2}\right)}$$

$$\theta_p = 21.1^\circ \quad \oplus \rightarrow \text{C.W}$$

$$\sigma_{x_1 x_1} = \frac{\sigma_{xx} + \sigma_{yy}}{2} + \frac{\sigma_{xx} - \sigma_{yy}}{2} \cos 2\theta_p + \tau_{xy} \sin 2\theta_p$$

$$= \frac{40 + 70}{2} + \frac{-40 - 70}{2} \cos 2 \times 21.1 + (-50) \sin 2 \times 21.1$$

$$= -59.3 \text{ MPa}$$



$$= \frac{-40 + 70}{2}$$

$$= 15 \text{ MPa}$$

$$\tau_{\max} = \sqrt{\left(\frac{-40 - 70}{2}\right)^2 + (-50)^2} = 74.3 \text{ MPa}$$

$$\tan 2\theta_s = \frac{G_{xx} - G_{yy}}{2\tau_{xy}} = \frac{-40 - 70}{2 \times -50} \Rightarrow \theta_s = -23.9^\circ$$

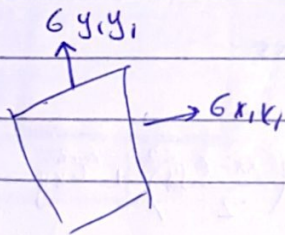
$$\tau_{x_1 y_1} = -\frac{G_{xx} - G_{yy}}{2} \sin 2\theta (-23.9) + \tau_{xy} \cos 2\theta (-23.9)$$

$$= \frac{-40 - 70}{2} \sin 2(-23.9) + -50 \cos 2(-23.9)$$

$$\tau_{x_1 y_1} = -74.3 \text{ MPa}$$

$$\frac{G_1 - G_2}{2} = \tau_{\max}$$

$$\frac{89.3 - -59.3}{2} =$$



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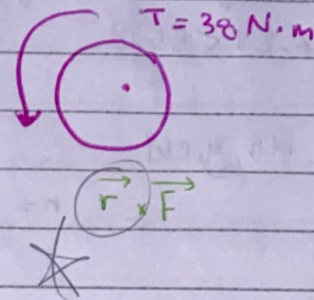
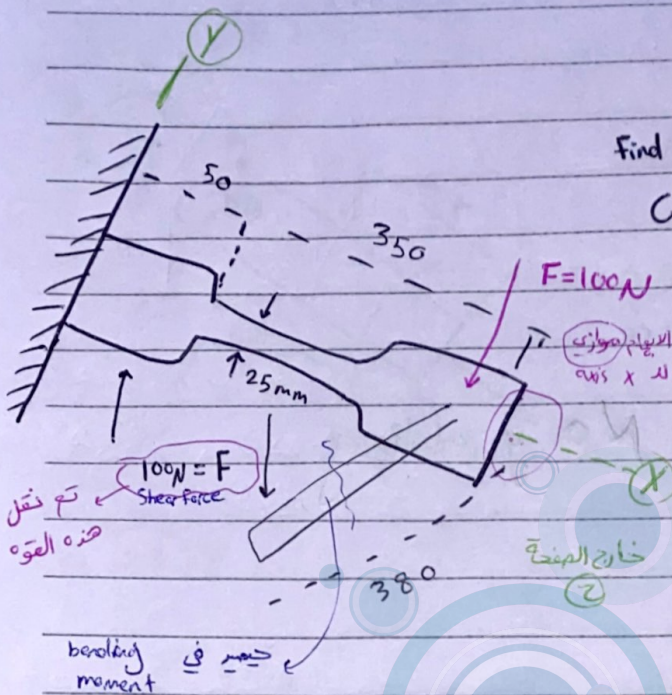
TEAM

Sunday
2/4/2023

Aisi 1035 steel $\rightarrow \sigma_y = 55.8 \text{ MPa}$

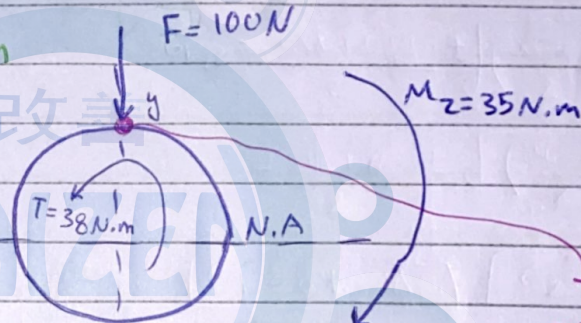
Find the maximum shear stress

C.S: maximum applied stress



$$* r \times F = \frac{380}{1000} \times 100 = 38 \text{ N.m}$$

$$G_{xx} = -\frac{M_{zy}}{I_z}$$



* maximum shear stress (critical)

$$* G_{xx} = -\frac{35 \times \left(\frac{25}{2000}\right)}{\frac{\pi}{64} \left(\frac{25}{1000}\right)^4} = 22.8 \text{ MPa}$$

$$M = \frac{350 \times 100}{100} = 35 \text{ N.m}$$

$$* \tau = \frac{T r}{J} = \frac{38 \times \frac{25}{2000}}{\frac{\pi}{32} \times \left(\frac{25}{1000}\right)^4} = 12.39$$

$$* \tau_{max} = \sqrt{\left(\frac{G_{xx} - G_{yy}}{2}\right)^2 + \tau_{xy}^2}$$

$$\tau_{max} = \sqrt{\left(\frac{22.8 - 0}{2}\right)^2 + 12.39^2}$$

$$= 16.84 \text{ MPa}$$

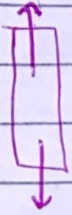
Five Apple

تابع

$$\sigma_y = 55.8$$

yielding Criteria

$$\frac{F}{A} = 6$$



$$\text{Tresca} \Rightarrow \tau_{\max} \geq \frac{\sigma_y}{2}$$

Vonmises

will it yield according to Tresca

$$16.84 < \frac{55.8}{2}$$

it will yield

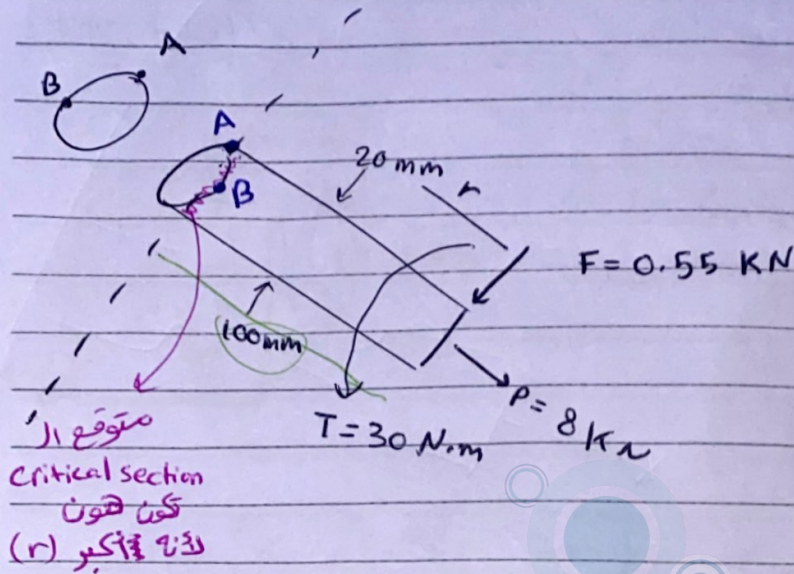
No yielding

$$n = \frac{\sigma_y}{2\tau_{\max}}$$

$$\rightarrow \text{vonmises} \Rightarrow \sigma_y = \frac{1}{\sqrt{2}} \sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2}$$

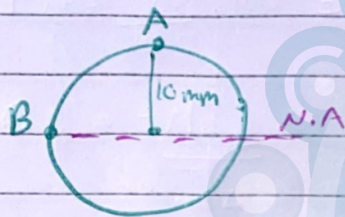
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* Example



$$\vec{M} = \vec{r} \times \vec{F}$$

$$= \frac{100}{1000} \times 0.55 \times 10^3 = 55 \text{ N.m}$$



$$G = \frac{P}{A} = \frac{8 \times 10^3}{\frac{\pi}{4} \left(\frac{20}{1000} \right)^2}$$

$$G_{xx} = \frac{-Mz_y}{I_z} = \frac{-55 \times \frac{10}{1000}}{\frac{\pi}{64} \left(\frac{10}{1000} \right)^4} =$$

$$G_{\text{total}} = \frac{8 \times 10^3}{\frac{\pi}{4} \left(\frac{20}{1000} \right)^2} + \frac{55 \times \frac{10}{1000}}{\frac{\pi}{64} \left(\frac{10}{1000} \right)^4} = 45.5 \text{ MPa}$$

$$G_y = 331 \text{ MPa}$$

$$\tau = \frac{Tr}{J} = \frac{30 \times \frac{10}{1000}}{\frac{\pi}{32} \left(\frac{10}{1000} \right)^4} = 19.1 \text{ MPa}$$

* Principle stresses

$$\sigma_{1,2} = \frac{G_{xx} + G_{yy}}{2} \pm \sqrt{\left(\frac{G_{xx} - G_{yy}}{2} \right)^2 + \tau_{xy}^2}$$

$$= \frac{95.5 + 0}{2} \pm \sqrt{\left(\frac{95.5 - 0}{2} \right)^2 + (19.1)^2}$$

(B) is the critical point

$$G_1 = 99.2$$

$$G_2 = -3.63$$

$$\tau_{\text{max}} = 99.2 + 3.63$$

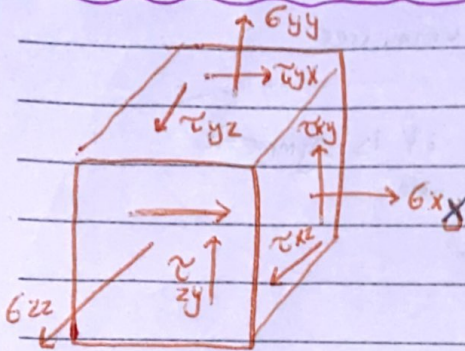
$$= 51.4 \text{ MPa}$$

331 > 101
will not yield

$$331$$

$$= \frac{1}{\sqrt{2}} \sqrt{(99.2 + 3.63)^2 + (99.2)^2 + (-3.63)^2}$$

triaxial stress state



$$\sigma^3 - I_1 \sigma^2 + I_2 \sigma - I_3 = 0$$

$$I_1 = \sigma_{xx} + \sigma_{yy} + \sigma_{zz}$$

$$I_2 = \sigma_{xx}\sigma_{yy} + \sigma_{xx}\sigma_{zz} + \sigma_{yy}\sigma_{zz} - \tau_{xy}^2 - \tau_{xz}^2 - \tau_{yz}^2$$

$$I_3 = \sigma_{xx}\sigma_{yy}\sigma_{zz} + 2\tau_{xy}\tau_{xz}\tau_{yz} - \sigma_{xx}\tau_{yz}^2 - \sigma_{yy}\tau_{xz}^2 - \sigma_{zz}\tau_{xy}^2$$

$$\sigma_{ij} = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ \tau_{yx} & \sigma_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & \sigma_{zz} \end{bmatrix}$$

σ_1

σ_2

σ_3

$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2}$$

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TEAM

Example: unit volume having the following stress state $\sigma_y = 500 \text{ MPa}$
 find f.s according to Tresca and vonmises

$$\sigma_{ij} = \begin{bmatrix} 200 & 0 & 0 \\ 0 & 100 & -30 \\ 0 & -30 & -50 \end{bmatrix}$$

* First we check if it is symmetric
 if yes $\rightarrow$ we continue

$$I_1 = 200 + 100 - 50 = 250 \text{ MPa}$$

$$I_2 = 200 \times 100 + 200 \times -50 + 100 \times -50 - 0 - 0 - (-30)^2 = 4100 \text{ MPa}$$

$$I_3 = 200 \times 100 \times -50 + 2 \times 0 - 200 \times (-30)^2 - 100 \times 0 - -50 \times 0 = -1180000 \text{ MPa}$$

$$\sigma^3 - 250\sigma^2 + 4100\sigma - 1180000 = 0$$

$$\sigma_1 = 200, \sigma_2 = 105.77, \sigma_3 = -55.77$$

$$\tau_{max} = \frac{200 + 55.77}{2} = 127.89$$

$$\frac{\sigma_y}{2} > \tau_{max}$$

it won't yield

Tresca:

$$f.s = \frac{\sigma_y/2}{\tau_{max}} = \frac{500/2}{127.89} = 1.95 > 1$$

for
f.safety

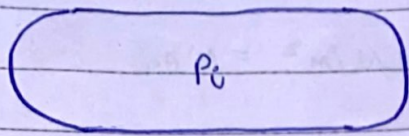
so it will not yield

$$f.s = 500$$

$$\sigma_y = \frac{1}{\sqrt{2}} \sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2}$$

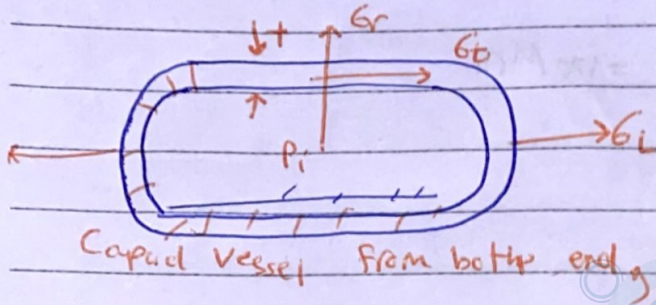
$$= \frac{1}{\sqrt{2}} \sqrt{(200 - 105.77)^2 + (200 + 55.77)^2 + (105.77 + 55.77)^2} = 2.2$$

Pressurized vessels :



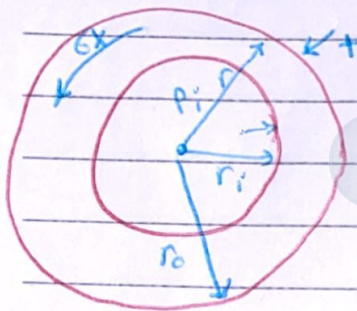
$$P_o = G_1 = 0$$

Pipe



Thick walled
 $\frac{r_i}{t} < 10$

~~Thin walled~~
 $\frac{r_i}{t} \geq 10$



$$G_r = \frac{P_i r_i^2 - P_o r_o^2 + r_i^2 r_o^2 (P_o - P_i) / r^2}{r_o^2 - r_i^2} = G_1$$

radial

$$G_t = \frac{P_i r_i^2 - P_o r_o^2 - r_i^2 r_o^2 (P_o - P_i) / r^2}{r_o^2 - r_i^2} = G_3$$

tangential

$$G_L = \frac{P_i r_i^2 - P_o r_o^2}{r_o^2 - r_i^2} = G_2$$

$\frac{r_i}{t} \geq 10$
* Thin walled

$$G_{max} = \frac{G_1 - G_3}{2} = \frac{G_r - G_t}{2}$$

$$G_t = \frac{P_i r_i}{t}$$

$$G_L = \frac{P_i r_i}{2t}$$

$$G_r = 0$$

$$\tau_{max} = \frac{G_1 - 0}{2}$$

The Apple

3-14

in slides

Cylindrical steel vessel

wall thickness = 20 mm

$$D_i = 4.5 \text{ MN/m}^2 = \text{MPa}$$

$$a - G_t = ?$$

$$G_L = ?$$

$$b - p = ?$$

$$G = 120 \text{ MN/m}^2 = 120 \text{ MPa}$$

$$\frac{r_i}{t} = \frac{200}{20} = 10$$

$$G_t = \frac{4.5 \times 200}{20} = 45 \text{ MPa}$$

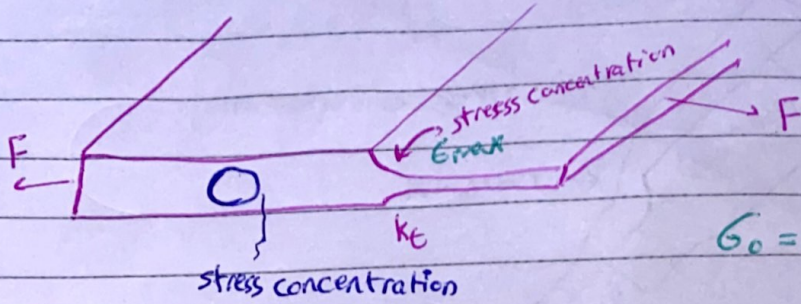
$$G_L = 22.5 \text{ MPa}$$

$$G_t = \frac{p_i r_i}{t}$$

$$G_L = \frac{p_i r_i}{2t}$$

$$120 = \frac{p_i}{2} \cdot 10 \rightarrow 12 \text{ MPa}$$

Stress concentration



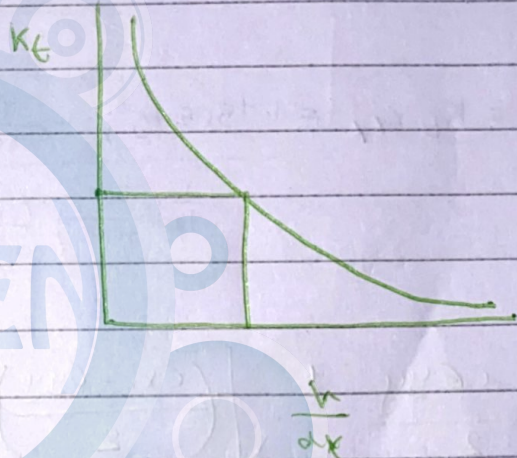
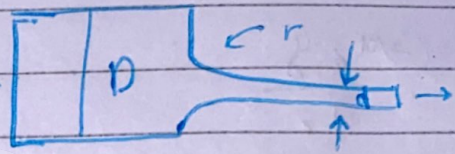
$$\sigma_0 = \frac{F}{A}$$

$$\sigma_{max} = K \sigma_0$$

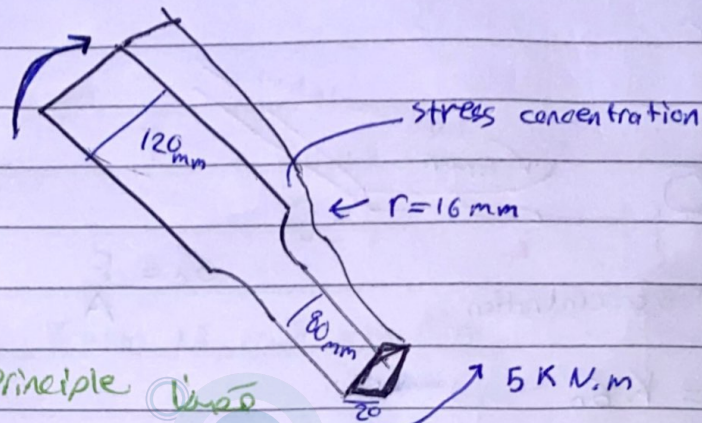
applied

1) Bredt's Principle

قوة
شد
التواء



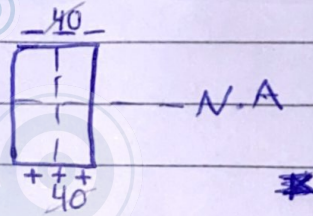
Slide 2990



Determine the maximum normal stress

$$K_t = 1.45$$

$$\sigma_{xx} = \frac{-M_z y}{I_z}$$



$$\sigma_{max} = K_t \sigma_{xx} = 1.45 \times 5 \times 10^3 \times \frac{40}{\frac{1}{12} \left(\frac{20}{1000} \right) \left(\frac{80}{1000} \right)^3} = 340 \text{ MPa} = \sigma_1$$

$$\frac{\sigma_{xx} + \sigma_{yy}}{2} \pm \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2} \right)^2 + \tau_{xy}^2}$$

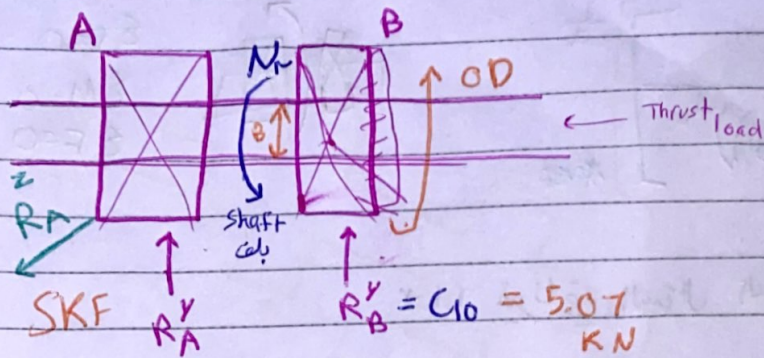
$$\text{Tresca } n = \frac{\sigma_y}{2}$$

$$\sigma_{max}$$

$$= \frac{250}{340} \times 2$$

Midexam II استاذنا

Chapter 11



SKF ball cylindrical bearing
Reliability - perfect = 90 %

$L_{10} = 10^6 \text{ rev}$
rated life

Related Reliability $R = 90\%$	Bore mm	OD	KN Deep Groove C_{10}
	10	30	5.07
	12	32	6.89
	15	35	7.8
	30	62	19.5
② $R \neq 90\%$	50		35.1

الجدول موجود في الكتاب

$$C_{10} L_{10}^{\frac{1}{a}} = F_D (L_D)^{\frac{1}{a}}$$

$a = 3$ ball bearing $R = 90\%$

$L_D = 5000 \text{ h}$ select a deep groove ball bearing
at $1725 \text{ rpm} = N_D$ load $F_D = 400 \text{ Ib}$
with a reliability 90 % $L_{10} = 10^6 \text{ rev}$

$$5000 \times 1725 \times 60 = L_{D \text{ rev}}$$

$$C_{10} (10^6)^{\frac{1}{3}} = 400 \times (5000 \times 1725 \times 60)^{\frac{1}{3}}$$

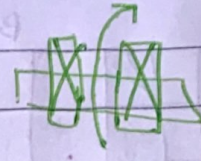
$C_{10} = 14.3 \text{ kN}$ calculated

Bore 30 mm OD = 62 mm

تعتمد على
 $\sum M=0$
 $\sum F=0$
 $\sum T=0$

unitless
 خالو وحدة في
 كتبت F_D

$$C_{10} = F_D \left[\frac{X_D}{X_0 + (\theta - X_0) \left(\ln \left(\frac{1}{R_D} \right) \right)^{\frac{1}{b}}} \right]^{\frac{1}{a}}$$



$\sum T=0$
 $\sum M=0$
 $\sum F=0$

* إذا غيرنا في السؤال السابق $R=90\%$ إلى $R=99\%$ سوف يصبح الحل ↓

$$X_0 = 0.02$$

$$\theta - X_0 = 4.439$$

$$b = 1.483$$

من
 الجدول
 في الكتاب

استخدم القانون الفوق

$$C_{10} = 400 \left[\frac{5000 \times 1725 \times 60}{10^6} \right]^{\frac{1}{3}} \left[\frac{0.02 + 4.439 \left[\ln \left(\frac{1}{0.99} \right) \right]^{\frac{1}{1.483}}}{1} \right]^{\frac{1}{3}}$$

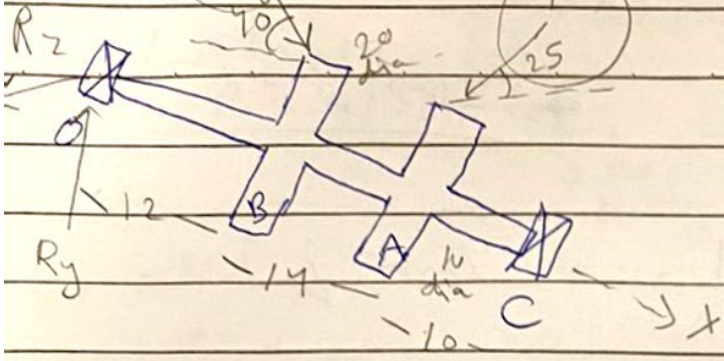
$$C_{10} = 23.7 \text{ kN}$$

* انشاء

يجب تقسيم الضواح على (calculator) لتجنب حدوث خطأ

35 mm Bore θ D 72 mm

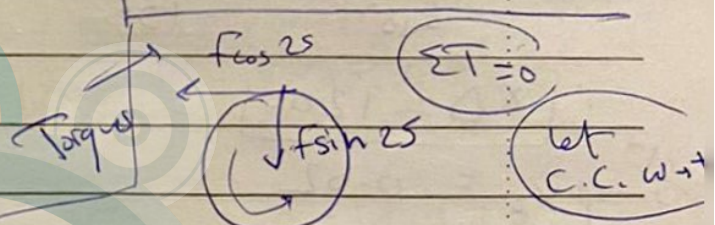
Subject



$$C_{10} = a_f F_D \left[\frac{X_D}{X_0 + (B - X_0) \left(\frac{1}{\ln R_0} \right)^{1/6}} \right]$$

Find 2 bearing reactions & angular contact bearing at o/c C

given
 $L_D = 50 \text{ Kh}$
 $N_D = 400 \text{ rev/min}$
 $a_f = 1.2$
 reliability for two bearings
 $= 0.98$



bearing

Moment $\rightarrow \sum M_0$ around Z =

Note: $\sum M_A$ $\sum M_B$ $\sum M_C$

$$+ 36 R_C^y - F \sin 25 \times 26 - 180 \sin 40 \times 12 = 0$$

$$R_C^y = 131.7$$

$$\sum F_y = 0 \rightarrow R_{Cy} + F \sin 25 - 180 \sin 40$$

$$R_{Cy} = 112.86$$

$\sum M_0$ around Y =

$$\sum M_0 = -36 R_C^z - 26 F \cos 25 + 180 \cos 40 \times 12 = 0 \quad R_C^z = -153.2$$

$$M = r \times F$$

$$\sum F_2 = 0 \rightarrow -153.2 + F \cos 25 - 180 \cos 40 + R_{Cz} = 0$$

$$R_{Cz} = 15.136$$

NOTEBOOK

Reaction at C

$$R_o^{ht} = \sqrt{(R_o^y)^2 + (R_o^z)^2}$$

$$= \sqrt{\quad} = 117$$

reaction
at C

Reaction at C

$$R_c^{ht} = \sqrt{(\quad)^2 + (\quad)^2} = 201.8 \leftarrow \text{choose this}$$

$$X_D = \frac{L_D}{L_{10}} = \frac{50 \times 1000 \times 100 \times 60}{10^6} \text{ rel. } \rightarrow \text{ND given}$$

reliability given is 0.98
for two bending

$$\therefore X_D = 1200$$

reliability

$$R_c R_o = 0.98$$

$$\therefore R_c = R_o = \sqrt{0.98}$$

$$\begin{cases} X_o = 0.02 \\ \theta - X_o = 4.439 \\ b = 1.483 \end{cases}$$

$$\therefore C_{10} = 1.2 \times 201.8 \left[\frac{1200}{0.02 + 4.439 (1 - 0.99)^{1/1.483}} \right]^{1/3}$$

$$\therefore C_{10} = 18.9 \text{ KN}$$

b in table $\rightarrow$ 18.9 $\rightarrow$

$$\left. \begin{array}{l} \rightarrow \text{Bore } 30 \text{ mm} \\ \rightarrow D = 62 \text{ mm} \end{array} \right\}$$

mostly) inner race rotating $\rightarrow V=1 \rightarrow$
 outer race rotating $\rightarrow V=1.2$

أشغال
 $V=1$

Subject

bearing

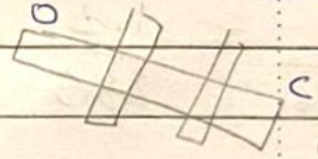
Date

No.

radial force
 (center)

radial + thrust force

force which is center bearing



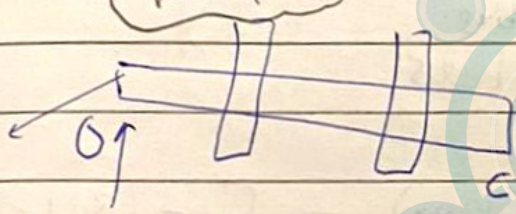
for radial & thrust force:-

(C) is the bearing

$F_a = 1200$
 thrust

$$F_{eq} = X_i V F_r + Y_i F_a$$

$i = 1 \text{ or } 2$
 from table



given $R_D = 0.99$
 $L_D = 10^6$

$$X_D = \frac{10 \times 10^3 \times 655 \times 60}{10^6} = 393.2$$

$F_a = 1200$

$F_{eq} \text{ at } C > F_r \text{ at } O$
 radial

$$F_{rc} = 1958.7 \text{ N} \quad F_{ro} = 2918.97 \text{ N}$$

disturbance force

F_a
 (thrust)

table:-

$\frac{F_a}{F_r}$	e	X_1	Y_1	X_2	Y_2
(Co)		1	0	0.56	2.3
		1	0	0.56	2.15

$$F_{eq} = X_i V F_r + Y_i F_a$$

$$F_{eq} = 0.56(1)(1958) + 1.63(1200)$$

$$F_{eq} = 3052.8 \text{ N at } C$$

if $\frac{F_a}{V F_r} \leq e \rightarrow \text{use } i=1$

if $\frac{F_a}{V F_r} > e \rightarrow \text{use } i=2$

check $F_{eq} > F_{ro}$

C is the bearing

$$F_{eq} \leq F_D$$

assume $i=2$

$$Y_2 = 1.63$$

$$X_2 = 0.56$$

$$C_{10} = (1.2)(3052.8)$$

$$C_{10} = 44.5 \text{ kN} \rightarrow \text{table}$$

$$C_0 = 28 \quad C_0 = 17.5$$

$$\frac{393.2}{0.044419 (1-0.99)^2} \rightarrow \text{table}$$

N O T E B O O K

Iteration ~~2~~ 2 → now we have $C_0 = 28 \text{ kN}$

$$\frac{F_a}{C_0} = \frac{1.2}{28.5} = 0.0421$$

check $K1 = 1 \text{ or } 2?$ → $\frac{F_a}{V F_r} = \frac{1.2}{(1)(1958.4)} = 0.61$

tables
 $e = 0.24$

$0.61 > 0.24$
∴ $\frac{F_a}{V F_r} > e \rightarrow \underline{C = 2} \rightarrow \gamma_2 = 1.85$ tables.

∴ $F_{eq} = 0.58(1)(1958) + 1.85(1200) \Rightarrow F_{eq} = 3316.82$
1.63 Wk Calc Assumption, F_r

$C_{10} = (1.2)(3316.82) \left[\begin{array}{c} \text{---} \\ \text{---} \\ \text{---} \end{array} \right]$
simplification

$C_{10} = 49.75 \text{ kN}$

$C_{10} \rightarrow 55.9 \text{ kN} \rightarrow C_0 = 35.5 \text{ kN}$
tables

Iteration ~~2~~ 3 1-

$$\frac{F_a}{C_0} = \frac{1.2}{35.5} = 0.034$$

$e = 0.23 \rightarrow \underline{C = 2} \rightarrow \frac{F_a}{C_0} > e \rightarrow \gamma_2 = 1.93$

$F_{eq} = 3412.82 \text{ N}$

$C_{10} = 49.75 \text{ kN}$

table $\rightarrow 55.9 \text{ kN} \rightarrow \text{bore } 60 \text{ mm}$
 $\text{OD} \rightarrow 110 \text{ mm}$

iteration 2
iteration 3
iteration 4
iteration 5
iteration 6
iteration 7
iteration 8
iteration 9
iteration 10
iteration 11
iteration 12
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iteration 94
iteration 95
iteration 96
iteration 97
iteration 98
iteration 99
iteration 100

$\text{if } X = 1$

thrust
2.5 kN

1.5 kN

0.5 kN

NOTEBOOK

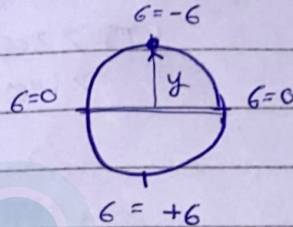
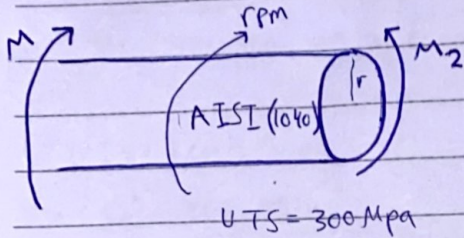
Chapter 6

Fatigue

تعب
ممكن تكسر

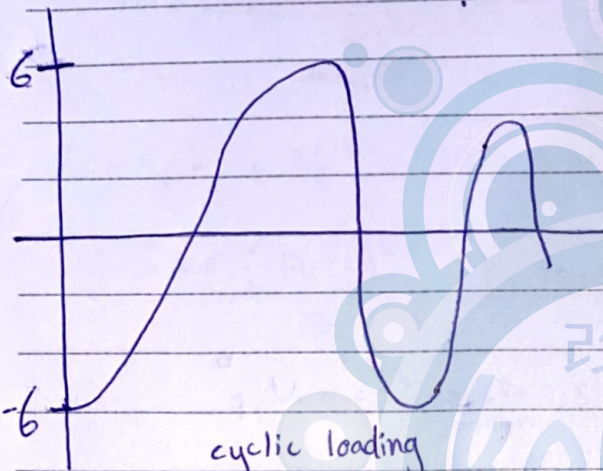
- Static loading $\sigma_{max} > \sigma_y$ failure
- dynamic loading

$$\sigma_{xx} = \frac{-Mz_r}{I_z} = -\sigma$$



n_f → Fatigue Factor of safety

$n_y = \frac{\sigma_y}{\sigma_{max}}$ → Factor of safety



cyclic loading
dynamic loading
variable loading
Fatigue analysis

* Analysis :-

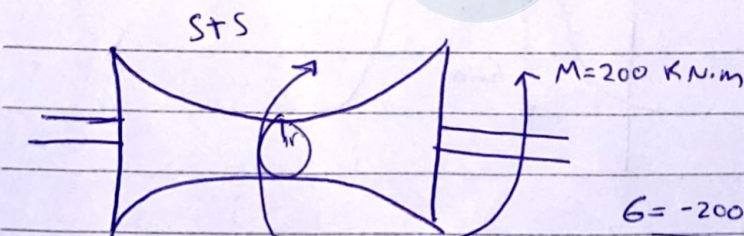
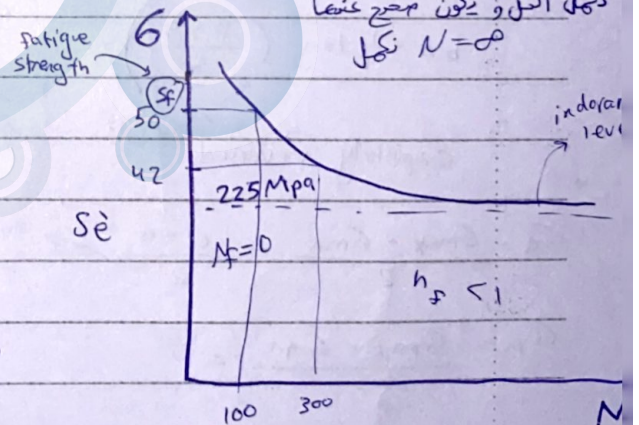
- 1- UTS = 300 Mpa
- 2- experimental endurance limit S_e

$$3- S_e = K_a K_b K_c K_d K_e K_f S_t$$

actual table

4- if failure occurs
فشل المكون يكون محقق
فشل $N = \infty$

N_f : Number of cycles to failure
↑
failure life



$$\sigma = \frac{-200 \times 10^3 \times r}{I}$$

$$= 50 \text{ Mpa}$$

$$N_f = 100$$

معدل الفشل والحدود
 $\sigma = 42 \text{ Mpa}$
 $N_f = 300 \text{ cycle}$

Five Apple

Table for S_e

$$S_e = \begin{cases} 0.5 UTS & UTS \leq 200 \text{ Kpsi} \\ & \leq 1400 \text{ Mpa} \\ 100 & UTS > 200 \text{ Kpsi} \\ 700 & > 1400 \text{ Mpa} \end{cases}$$

* Analysis

- 1- $UTS = 300 \text{ Mpa}$ ← أهم خطوة
عشان لما بين الح
على التي خطا
- 2- Experimental Endurance limit $\rightarrow S_e = 150$

$$3- S_e = K_a K_b$$

- 4- 1/5 Failure occurs
text: infinite is expected
 $b = -N_f$

failure في هذه الخطوة ففك! إذا في

$$a = \frac{(S_{UTS})^2}{S_e}$$

Figure 6-13¹⁸

$$b = -\frac{1}{3} \log \left(\frac{P S_{UTS}}{S_e} \right)$$

$$G_a = S_F = a N_f^b$$

amplitude

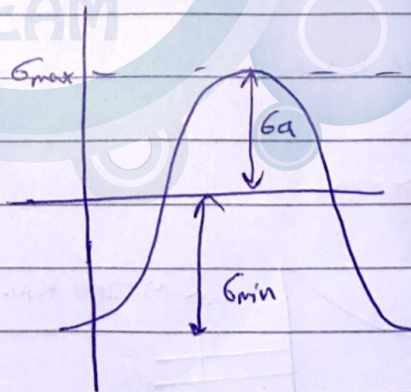
$$G_a = S_F$$

* لازم تفرق
zero
عشان تكون
reversed

completely reversed

$$G_a = \frac{G_{max} - G_{min}}{2} = \frac{6 + 6}{2} = 6$$

$$G_m = \frac{G_{max} + G_{min}}{2} = 0$$



اسی طرح سوال پیشہ
Final exam

یعنی standard

Life سب سے زیادہ
Failure سے زیادہ

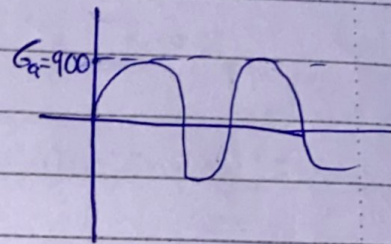
* Example

A test specimen has an ultimate tensile strength of 1600 Mpa. Estimate the life of the specimen at a completely reversed stress of 900 Mpa.

1- $UTS = 1600 \text{ Mpa}$

2- $S_e = 700 \text{ Mpa}$

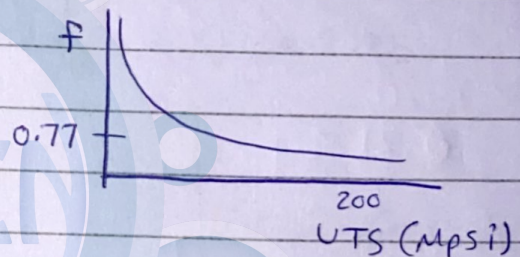
3- $S_e = K_a K_b K_c K_d K_e K_f S_e' = 700 \text{ Mpa}$
 $= 1$
 Standard



$G_a = S_f = a N_f^b = 900 = a N_f^b$

$a = \frac{(FUTS)^2}{S_e} = \frac{(0.77 \times 1600)^2}{700}$
 $= 2168.3 \text{ Mpa}$

Figure 6-18



$b = \frac{1}{3} \log \left(\frac{0.77 \times 1600}{700} \right)$
 $= -0.081838$

$G_a = S_f = a N_f^b = 900 = 2168.3 (N_f)^{-0.0818} \Rightarrow N_f = 46400 \text{ cycle}$

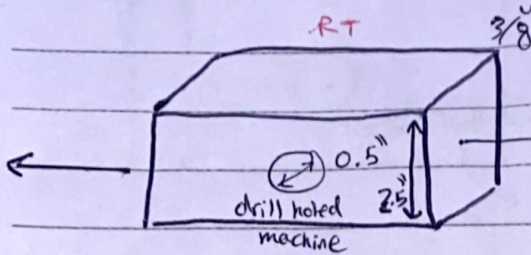
لہذا بنوقف

fatigue life

Example: AISI 1020 CD

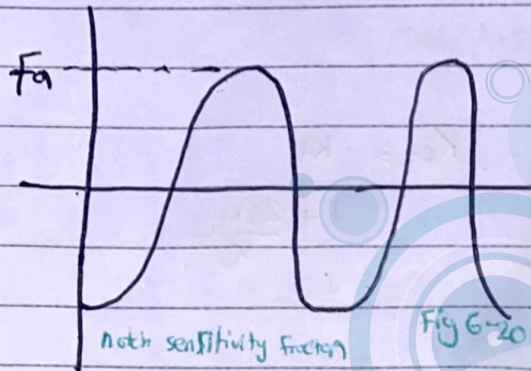
$n_d = 2$
fatigue

use modified Goodman criteria



$K_b = 1$ for axial only
 $F_a = ??$
normal stress
Tension

- 1- $UTS = 68 \text{ Kpsi}$
- 2- $S_e = 0.5 \times 68 = 34 \text{ Kpsi}$
- 3- $S_e = K_a K_b K_c K_d K_e K_f$



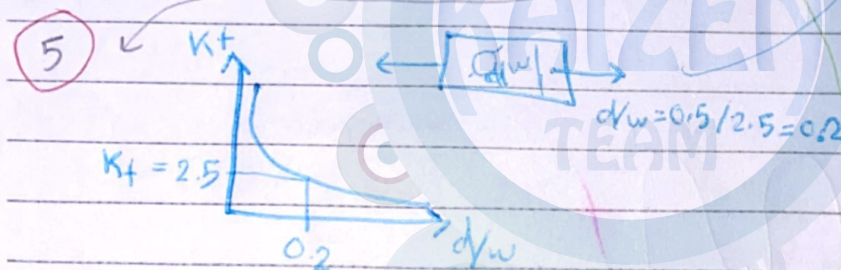
$K_a = a S_{UTS}^b \Rightarrow$ table 6-2
 $K_a = 2.7 (68)^{-0.265} = 0.88$
machined $a = 2.7$
 $b = -0.265$

$K_b = 1$
 $K_c = 0.85$
 $S_e = (0.88)(1)(0.8)(1)(1)(1)(1)(34) = 25.4 \text{ Kpsi}$

4- if failure occurs $\rightarrow X$

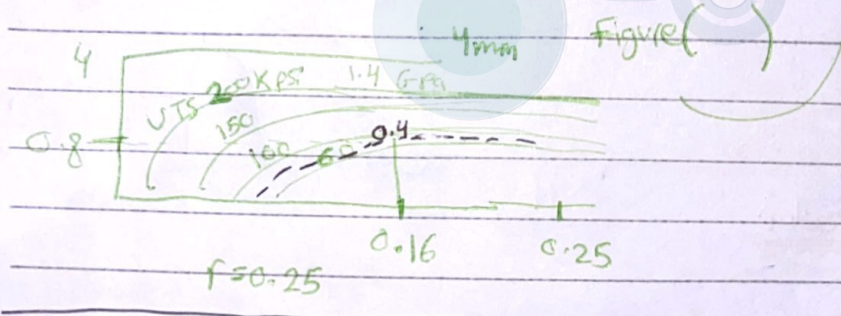
5- $K_f = 1 + \frac{0.8}{2.5 - 1} = 2.25$

$K_f = 1 + q(K_t - 1)$
 $K_{fs} = 1 + q_s(K_{ts} - 1)$



6- $G_a = \frac{G_{max} - G_{min}}{2}$
 $G_m = \frac{G_{max} + G_{min}}{2}$

$G_a = \frac{F_a}{(w-d)t}$
 $G_{max} = K_f G_a = 2.25 \times F_a$
 $G_{min} = 2.25 \times F_a$



$G_a = 2.25 \frac{F_a \times 4}{3}$
 $G_m = 0$

8- use Fatigue Criteria (6-46)
 $\frac{G_a + G_m}{S_e S_u} = \frac{1}{n_f}$

Factor of safety
 $n_f = \frac{S_{yield}}{G_a + G_m}$

7- check for yielding
 $G_a + G_m < S_{yield}$

$\frac{2.25 F_a \times 4}{3} / 25.4 + 0 = \frac{1}{2}$
 $F_a = 4.23 \text{ Kpsi}$

7- $\frac{2.25 \times 4.23 \times 4}{3} + 0 < S_y$

قوانين في الكتاب

modified Newmark equation

لكن لا فضل
نقل الخطوات
(8) ← (1)
القبل

$$K_F = K_t$$

$$\frac{1 + 2(1 + \nu) \sqrt{a}}{K_t \sqrt{r}}$$

احتمالية الخطأ أكبر

normal stress

$$\sqrt{a} = 0.246 - 3.08(10^{-4}) S_{ut} + 1.5 \times 10^{-5} S_{ut}^2$$

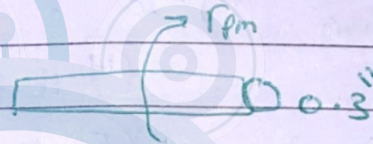
$$\sqrt{a} = 0.19 - 2.5(10^{-4}) S_{ut} + 1.35 \times 10^{-5} S_{ut}^2$$

Shear stress

$$K_{FS} = \frac{K_t}{1 + \frac{2(K_t - 1)}{K_{FS}}}$$

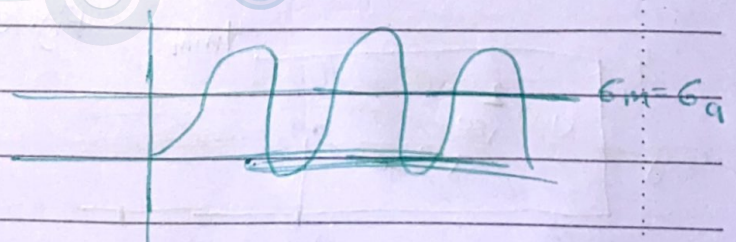
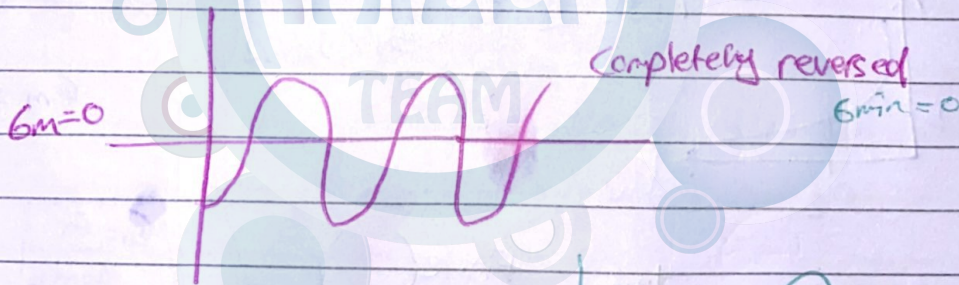
K_b

- 1- circular cross section
- 2- rotating



$d = \text{d actual}$
 $d = \text{d defective}$

table 6.20
6.21



shaft → by defect
Rotating + circular

6-25

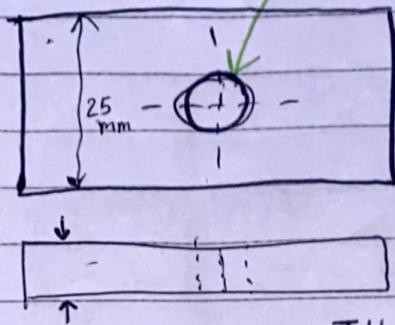
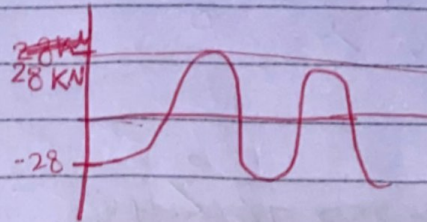


Table A-20



أسئلة في Fatigue
يجب التركيز على (Text)

axial loading

1- $UTS = 590 \text{ MPa}$, $S_y = 490 \text{ MPa}$

2- $S_e = 0.5 \times 590 = 295 \text{ MPa}$

3- $S_e = K_a K_b K_c K_d K_e K_f S_e$
 $K_a = a \frac{S_{UTS}}{S_e}^b = 4.51 (590)^{-0.265} = 0.832$

$K_b = 1$

$K_c = 0.85$

في السؤال انه infinite life

$S_e = (0.832)(1)(0.85)(1)(1)(1) 295 = 208.6 \text{ MPa}$ (8) لأننا نلزم اكمل الخطوة

4- X No failure

5- $K_f = 1 + q(K_t - 1)$
 $= 1 + 0.8(2.45 - 1) = 2.16$



$\frac{d}{w} = \frac{6}{25} = 0.24$

$K_t = 2.43 - 2.4$

$[K_f < K_t] \rightarrow$ لا يوجد

Figure 6-8

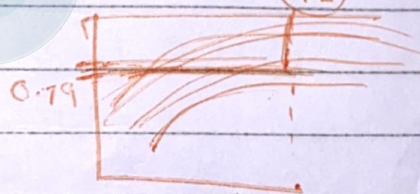
$q = 0.79 - 0.82$

6- $G_a = \frac{G_{max} - G_{min}}{2}$

$G_m = \frac{G_{max} + G_{min}}{2} = 0$

$G_{max} = K_f \frac{28 \times 10^3}{(25 - 6) 10} = G = 324.2 \text{ MPa}$

$G_{min} = K_f \frac{-28 \times 10^3}{(25 - 6) 10}$



7- check for yielding

$$\frac{\sigma_{\text{axial}}}{S_e} + \frac{\sigma_m}{S_y} < 1$$

↑ zero

$$\frac{K_t \times 28 \times 10^3}{(25-6)10} = 353.76 < 490$$

∴ No yielding

$$n_y = \frac{490}{353.76}$$

في yielding لزج اكمل
ما في yielding طافي ثاني اكمل

صافي صافي

8- $\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{UTS}} = \frac{1}{n_f}$

$$\frac{324.2}{208.6} = \frac{1}{n_f}$$

completely reversed

$$n_f < 1 \quad 324.2 = S_f = \sigma N_f$$

الشيء الثاني
مختلف

في الكتاب

3- $K_c = 1 \rightarrow$

معارك

6-55

6-56

Torsion
axial
bending

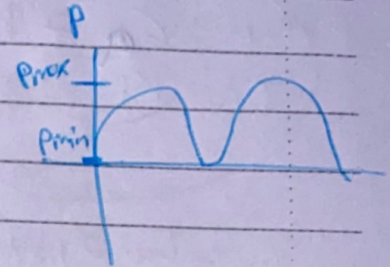
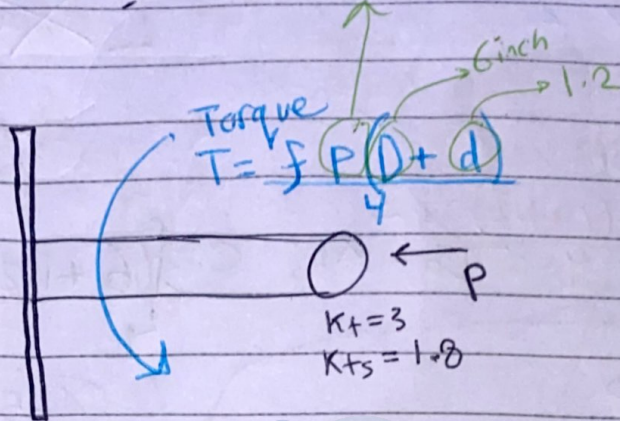
$$\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{UTS}} = \frac{1}{n_f}$$

7- $\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_y} < 1$

8- $\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{UTS}} = \frac{1}{n_f}$

* سؤال في الكتاب

الكتاب



1- $UTS = 145 \text{ Kpsi}$ $S_y = 120 \text{ Kpsi}$

2- $S_e = 0.5 \times 145 = 72.5 \text{ Kpsi}$

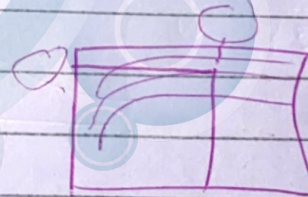
3- $S_e = K_a K_b K_c K_d K_e K_f S_e'$
 machined

$K_a = a S_{UTS}^b = 2.7(145)^{-0.765} = 0.722$

$K_b = 0.879(1.2)^{-0.07} = 0.862$
 and circular rotating actual

$S_e = (0.722)(0.879)(1)(1)(1)(1) 72.5$
 $= 45.12 \text{ Kpsi}$

4- X → failure
 أكبر من n_f



3- $K_f = 1 + 0.82(3-1) = 2.64$

$K_{fs} = 1 + 0.92(1.8-1) = 1.79$

$q = 0.81 - 0.84$

لنظم هاي
 أكبر من هاي

(shaft) →

Surface finish
machined
Rotating
K_e = 1

Bending
Torsion
axial

$$\sigma_a = \frac{K_p P}{\frac{\pi}{4} (1.2)^2} / 2$$

axial

$$\sigma_m = \sigma_a = 1.238 P$$

$$\tau_a = \frac{K_{fs} \cdot 0.3 P (6 + 1.2)}{4} / 2$$

$$\tau_a = K_{fs} \cdot 0.3 P (6 + 1.2) / 4$$

$$\tau_n = \tau_a = 1.385 P$$

$$\tau_n = \tau_a$$

$$\sigma_a = 2.81 P$$

$$\sigma_m = 2.7 P \quad 2.81 P + 2.7 P < 120$$

$$8 = \frac{\sigma_a}{s_e} + \frac{\sigma_m}{UTS} = \frac{1}{3}$$

$$P = 4.12$$

بزرگ
مغوص
فوق

Shaft Design

Shaft design

Aisi 1020 - 1050

$d < 3"$ CD
 $d \geq 3"$ HR

Aisi 1040 HR

دستگاه انتقال وین دند
analysis

bending moment
diagram

$$\frac{F}{d} \quad \frac{D}{d}$$

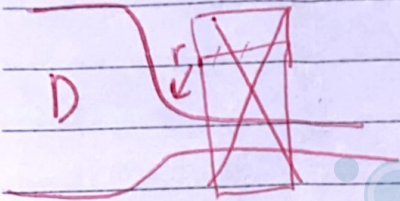
table 7-1

bending
(Kt)

Torsional
(Kts)

axial
x

$$\frac{F}{d} = \checkmark$$



ED 1d

$n=2$ $d=\checkmark$

$n=\checkmark$

$d=?$

- 1✓
- 2✓
- 3✓
- 4✓
- 5✓

$$M_a = 2$$

$$M_m = 0$$

$$T_a = 0$$

改善

KAIZEN

TEAM

جاي في القائل
سؤال سؤال

shaft → machine

chapter 7

Q3

in the slides

$$\begin{aligned} R_A^y & \quad \sum T = 0 \\ R_A^z & \quad \sum M^z = 0 \\ R_C^y & \quad \sum F_z = 0 \\ R_C^z & \quad \sum F_y = 0 \end{aligned}$$

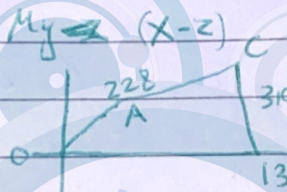
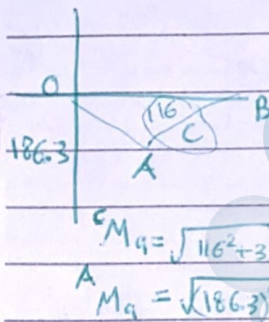
$$\begin{aligned} M_A &= \checkmark \\ M_A &= 0 \\ T_A &= 0 \end{aligned}$$

$$\begin{aligned} R_C^y &= 0.45 \text{ kN} \\ R_C^z &= 0.76 \text{ kN} \\ R_C^z &= -2.68 \text{ kN} \\ R_C^y &= -0.627 \text{ kN} \end{aligned}$$

Reaction بنظارة

حول (y) و (z) bending moment

$M_z (x-y)$



$$\begin{aligned} M_A &= \sqrt{116^2 + 319^2} = 339 \\ M_A &= \sqrt{(186.3)^2 + 228^2} = 292 \end{aligned}$$

$$T_m = F_B \cos 20^\circ \times \frac{110}{2}$$

$$T_m = 2.27 \times 10^3 \times \cos 20^\circ \times \frac{55}{1000} = 2.27 \times \cos 20^\circ = 117.3 \text{ N.m}$$

A+C:

$$(1) \text{ UTS} = 590 \text{ MPa}, S_y = 490 \text{ MPa}$$

$$(2) S_e = 0.5 \times 590 = 295$$

$$(3) S_e = K_a K_b K_c K_d K_e K_f S_e'$$

$$K_a = 4.51 (590)^{-0.265} = 0.83$$

$$K_b = 1.24 (35)^{-0.107} = 0.847$$

طبيعي
(d) actual

$$K_c = 1 \quad K_d = K_e = K_f = 1 \quad \log_{10}$$

$$S_e = (0.83) (0.847) (1) 295 = 207.4 \text{ MPa}$$

$$(5) K_f = 1 + q(K_t - 1)$$

$$K_{fs} = 1 + q_s(K_{ts} - 1)$$

Figure 6.20
q = 0.7

Figure 6.21
q_s = 0.72

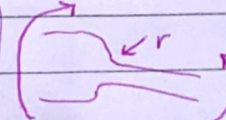
$$1 + C \frac{r}{a} = 0.15$$

$$\frac{P}{d} = \frac{50}{35} \rightarrow K_t = 2.2$$

$$\rightarrow K_{ts} = 3$$

$$K_f = 1.84$$

$$K_{fs} = 2.44$$

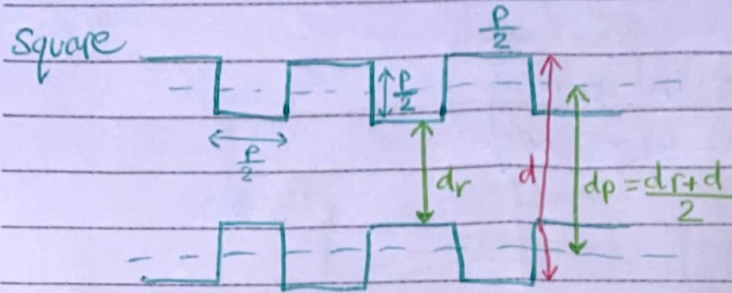


$$\begin{aligned} \frac{1}{n} &= \frac{16}{\pi (35)^2} \rightarrow 207.4 \left[4 \times (1.84 \times 2.44) \right]^{\frac{1}{2}} + \\ &+ \frac{1}{590} \left[\frac{\text{Five Apple}}{3 (2.44 \times 1.84)} \right]^{\frac{1}{2}} \end{aligned}$$

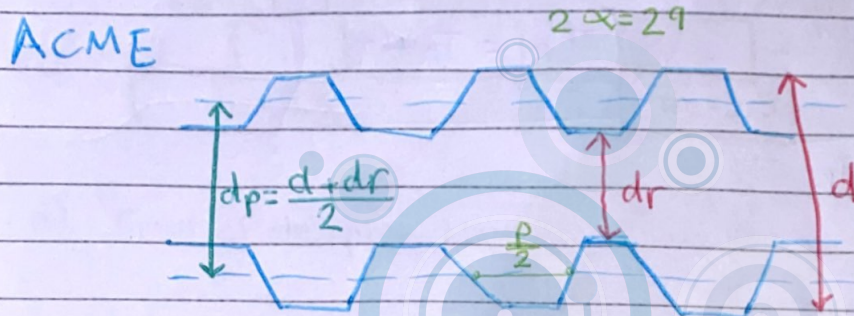
Chapter 8

Power screw :

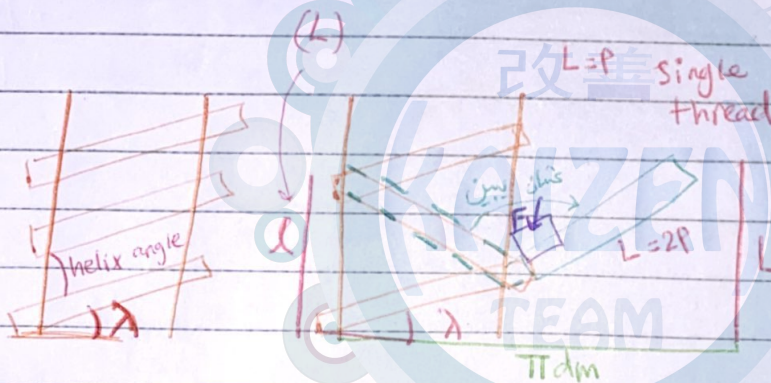
Creo 8.1
8.2
ماتهم علاقة
في هذا
الدرس



Square
table
ACME
table

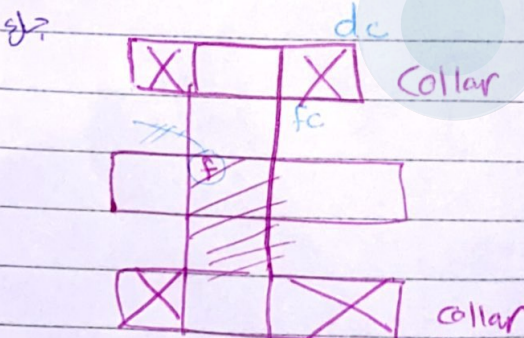


هذا المقال ما ذكر اشي
يكون (Single)
thread



$$\tan \lambda = \frac{L}{\pi d_m}$$

For
square
and
ACME



$$P_R = F \left[\frac{L}{\pi d_m} + f \right] \frac{1}{1 - (fL/\pi d_m)}$$

$$P_L = F \left[f - \frac{L}{\pi d_m} \right] \frac{1}{1 + (fL/\pi d_m)}$$

For
Square
only

$$\pi f d_m - L > 0$$

$$f > \frac{L}{\pi d_m}$$

Self
locking

$$T_R = \frac{d_m}{2} P_R = \frac{F d_m}{2} \left[\frac{L + \pi f d_m}{\pi d_m - fL} \right]$$

$$T_L = \frac{d_m}{2} P_L = \frac{F d_m}{2} \left[\frac{\pi f d_m - L}{\pi d_m + fL} \right]$$

Five Apple

> 0

ACME

$$T_R = \frac{F d_m}{2} \left(\frac{L + \pi F d_m \sec \alpha}{\pi d_m - F L \sec \alpha} \right)$$

$$\alpha = \frac{29}{2}$$

$$T_C = \frac{F d_c f_c}{2}$$

cellar
torque

$$T_{R \text{ total}} = T_R + T_C$$

$$e = \frac{T_{RO}}{T_{R \text{ total}}} = \frac{F L}{2 \pi T_R}$$

改善

KAIZEN

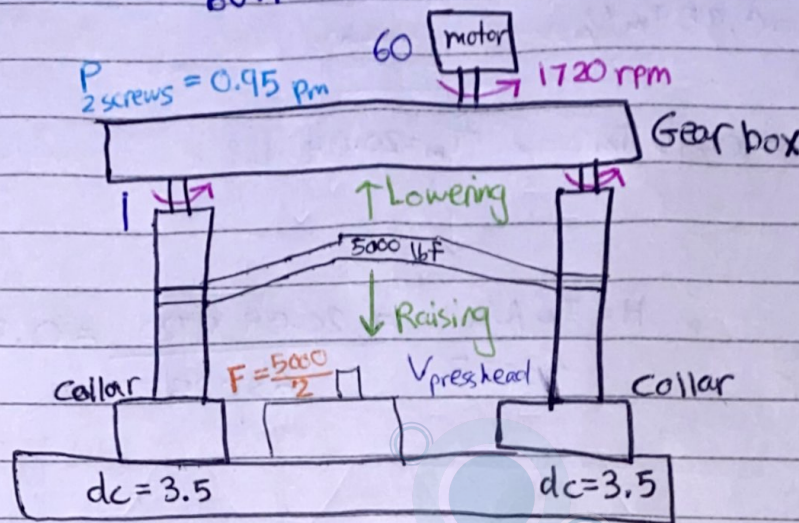
TEAM

28/5/2023
Sunday

8-6

23.90°
23.90°

60:1



HP = ?
f = 0.05

ACME
d = 2
P = 1/4 inch

single

L = P

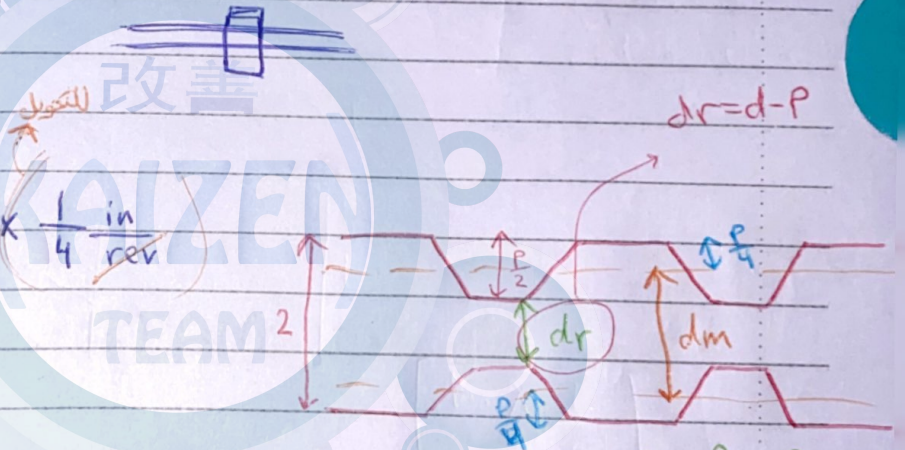
a) Speed of the press head

$N_{\text{power screw}} = \frac{1720}{60} \text{ rpm}$

$\frac{1}{4} \text{ in/rev}$

$= \frac{1720}{60} \frac{\text{rev}}{\text{min}} \times \frac{1}{4} \frac{\text{in}}{\text{rev}}$

$V_{\text{press head}} = 7.17 \frac{\text{in}}{\text{min}}$



$2\alpha = 29^\circ$

$dm = 2 - \frac{P}{4} - \frac{P}{4}$
 $= 2 - \frac{4}{4} - \frac{4}{4} = 1.8$

$T_{R \text{ total}} = \frac{F dm}{2} \left[\frac{L + \pi f dm \sec \alpha}{\pi dm - f L \sec \alpha} \right] + \frac{F d c f_c}{2}$

$= \frac{2500 \times 1.875}{2} \times \left[\frac{0.25 + \pi (0.05) (1.875) \sec \left(\frac{29}{2} \right)}{\pi (1.875) - (0.05) (0.25) \sec \left(\frac{29}{2} \right)} \right] + \frac{2500 \times 3.5 \times 0.05}{2}$
 $= 221 \text{ lbf in/screw} + 350 \text{ lbf in/screw}$

$\Sigma = 571$

Five Apple

$$T_{2 \text{ screws}} \times N_{\text{screw}} = 0.95 T_m N_m$$

$$(221 + 350) \times 2 \times \frac{1}{60} = 0.95 T_m \Rightarrow T_m = 20.04 \text{ lbf in}$$

Table CP 215 $\rightarrow$

$$H = \frac{T_m N_m}{63025} = \frac{20.04 \times 1720}{63025} = 0.547 \text{ hp}$$



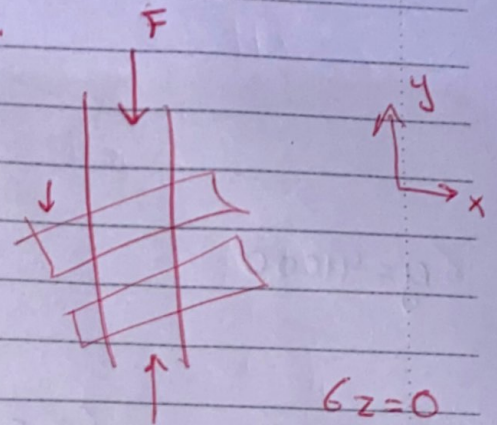
* Stresses in Power Screw:

axial

$d_r =$

$$\sigma_y = \frac{F}{A_r} = \frac{F}{\frac{\pi d_r^2}{4}}$$

$$\sigma_x = \sigma_{\text{bending}} = \frac{6F}{\pi d_r n + P}$$



$\sigma_z = 0$

← $\sigma_z = 0$ (تجاه المحور z)

* يفتقر عن Thread واحد

$$\tau_{yz} = \frac{16TR}{\pi d_r^3}$$

$$\tau_{yx} = 0$$

$$\tau_{xz} = 0$$

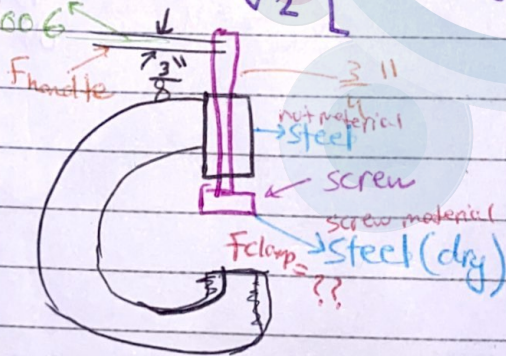
Vonmises

→ صيغة في الكتاب

$$\sigma = \frac{1}{\sqrt{2}} \left[(\sigma_x - \sigma_y)^2 + (\sigma_y)^2 + (\sigma_x)^2 + 6\tau_{yz}^2 \right]^{\frac{1}{2}}$$

→ صيغة

AISI 1006



10 UNC

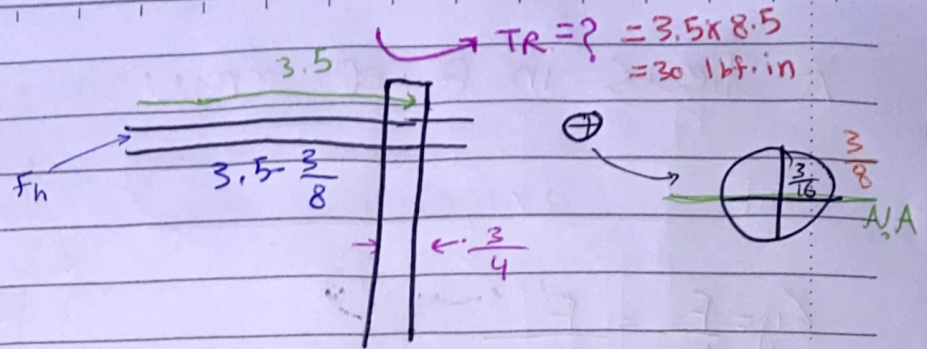
$$P = \frac{1}{10} = 0.1$$

$n = 4$

from $F \rightarrow$ table

f is average Range

bending moment
is in the
Normal stress



$$\sigma_y = 41000$$

$$\sigma_{xx} = \frac{M_{zy}}{I_z} = \frac{(3.5 - \frac{3}{8}) F_h \times \frac{3}{16}}{\frac{\pi}{64} \times (\frac{3}{8})^4} = 41000$$

$$F_h = 8.5 \text{ lbf}$$

$$T_R = \frac{F_{dm}}{2} \left[\frac{0.1 + \pi \times 0.2 \times (\frac{3}{4} - \frac{0.1}{2}) \sec(\frac{29}{2})}{\pi (\frac{3}{4} - \frac{0.1}{2}) - 0.2(0.1) \sec(\frac{29}{2})} \right] + T_c$$

zero

$$F_{clamp} = 309.38 \text{ lbf}$$

نقل
نقل
↓

$$dr = \frac{3}{4} - 0.1$$

$$n+4 \rightarrow \infty$$

$$\sigma_y = \frac{F}{A_r} = \frac{F}{\frac{\pi}{4} dr^2}$$

$$\sigma_x = \sigma_{bending} = \frac{6F}{\pi dr n + P}$$

$$\sigma_z = 0$$

$$\tau_{yx} = 0$$

$$\tau_{yz} = \frac{16 T_R}{\pi dr^3}$$

$$\tau_{xz} = 0$$