ID = 15266

QNo1

Solution The moment of Section A is

$M = 11000 \times 15 = 165,000$

and the torque on the shaft is

$T = 11000 \times 0.15 = 1650$

The normal stress due to M at A is

$$\sigma = \frac{64md}{2\pi d^4} = \frac{32M}{\pi d^3}$$

Maximum Shear Stress due to T at A is

$$\tau = \frac{32Td}{2\pi d^4} = \frac{16}{\pi d^3}$$

The Shear Stress due to Shear force f is zero at A

$$\sigma_{ns} = \tfrac{1}{2}\sigma \pm \tfrac{1}{2}(\sigma^2 + 4\tau^2)^{1/2}$$

Maximum Shear Stress theory

$$\tau_{max} = \tfrac{1}{2}(\sigma_1 - \sigma_2)$$

$$\tau_{max} = \tfrac{1}{2}\,\frac{32}{\pi d^3}(M^2 + T^2)^{1/2}$$

$$= \frac{16}{\pi d^3}(M^2 + T^2)^{1/2}$$

$$= \frac{16}{\pi d^3}(165000^2 + 1650^2)^{1/2}$$

$$= \frac{2640131.99}{\pi d^3} = \frac{840806.36}{d^3}$$

ID = 15266

$N_{time} = \frac{840806.36}{d^3}$ Pa

This Should not exceed the maximum ~~the~~ Shear Stress value at yeilding in uniaxial tension Test This

$$\frac{1}{d^3}\, 840806.36 = \frac{\delta_4}{2}$$

$$\frac{1}{d^3}\, 840806.36 = \frac{207 \times 10^{-6}}{2} = 103.5 \times 10^{-6}$$

$$d^3 = \frac{840806.36}{103.5} \times 10^{-6} = 8123.73 \times 10^{-6}$$

$$d = 20.10 \times 10^{-6}$$

$$d = 20.1 \text{ cm}$$

ii) Octahedral Shear Stress theory

$$T = \frac{1}{3}\left[(\delta_1-\delta_2)^2 + (\delta_2-O_3)^2 + (\delta_3-\delta_1)^2\right]^{1/2}$$

with $\delta_2 = 0$

$$T = \frac{1}{3}\left[2\delta_1^2 + 2\delta_3^2 - 2\delta_1\delta_3\right]^{1/2}$$

$$T = \frac{\sqrt{2}}{3}\left(\delta^2 + 3\gamma^2\right)^{1/2}$$

$$T = \frac{\sqrt{2}}{3\pi d^3}\left(4M^2 + 3T^2\right)^{1/2}$$

$$T = \frac{\sqrt{2}}{3\pi d^3}\left[4(165000)^2 + 3(1650)^2\right]^{1/2}$$

$$T = \frac{\sqrt{2}}{3\pi d^3}\left[330012.37\right]$$

$$T = \frac{\sqrt{2}}{3A}\,\delta_4$$

Scanned with CamScanner

ID = 15266

Equating this Octahydal Shear Stress at yielding of an uniaxial Tension bar & using factor = 15

$$\frac{\sqrt{15}}{3} = \delta_4$$

$\Rightarrow 15 \times 330012.37 = \pi d^3 \delta_4$

$d^3 = 4950.13 \times 10^{-6}$

$d = 1704.27 \times 10^{-6}$

$d = 1704.27$ cm

ID= 15266

Q No2

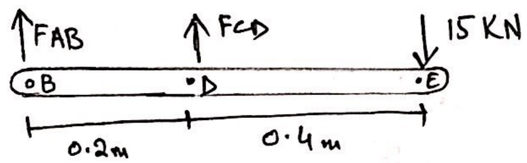
Solution

→ Apply a free body analysis to the bar BDE to find the forces exerted by link AB & DC

→ Evaluate the deformation of links AB & DC or the displacements of B and D

→ Work out the geometry to find the deflection at E. given the deflection at B and D

Free body: Bar BDE



$\Sigma M_B = 0$

$0 = -(15 \times 0.6m) + F_{CD} \times 0.2m$

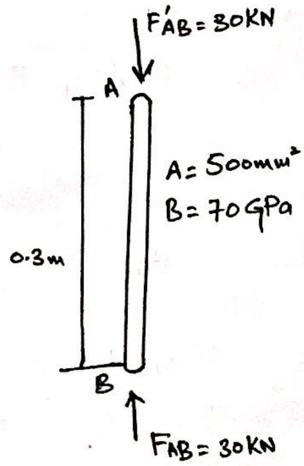
$F_{CD} = 45 KN$ (tension)

$\Sigma M_D = 0$

$0 = -(15 \times 0.4) - F_{AB} \times 0.2m$

$F_{AB} = -30 KN$ (Compression)

Displacement of B



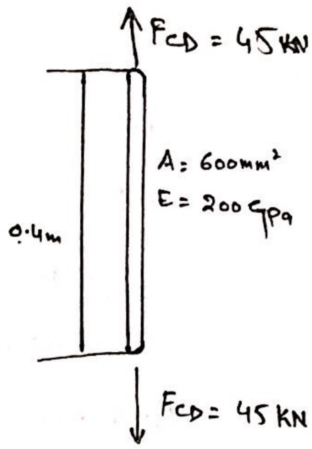
$$\delta_B = \frac{PL}{AE}$$

$$\delta_B = \frac{(-30 \times 10^3 N)(0.3m)}{(500 \times 10^{-6} m^2)(70 \times 10^9 Pa)}$$

$\delta_B = -2.57 \times 10^{-4}$

$\delta_B = 0.25 \uparrow$

Displacement of D



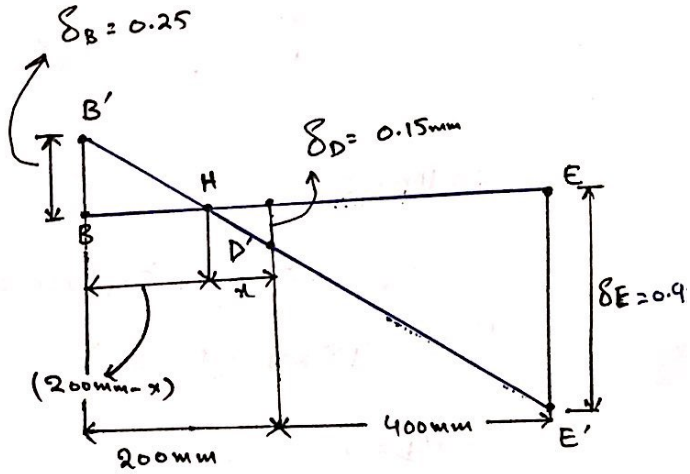
$$\delta_D = \frac{PL}{AE}$$

$$\delta_D = \frac{(45\times10^3 N)(0.4m)}{(600\times10^{-6} m^2)(200\times10^9 Pa)}$$

$$\delta_D = 1.5\times10^{-4}$$

$$\delta_D = 0.15 mm \downarrow$$

Displacement of D



$$\frac{BB'}{DD'} = \frac{BH}{HD}$$

$$\frac{0.25}{0.15} \times \frac{(200mm) - x}{x}$$

$$0.25x = (200-x)0.15$$

$$0.25x = 30 - 0.15x$$

$$0.25 + 0.15x = 30$$

$$0.4x = 30$$

$$x = 30/0.4 = 75$$

$$\frac{EE'}{DD'} = \frac{HE}{HD}$$

$$\frac{\delta_E}{0.15} = \frac{400+75}{75}$$

$$\delta_E = 0.95$$

QNo3

Given Data:

$G = 15 \times 10^6$

Allowable Shearing Stress = 10ksi

$x = 15 + 10$

$x = 25$

Solution:

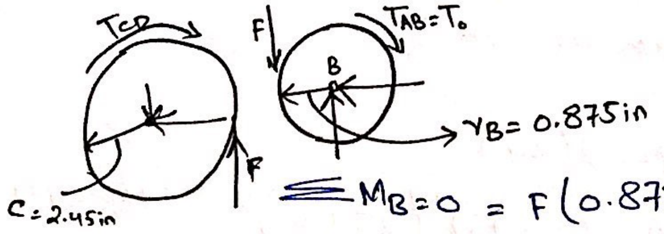
1* Apply a Static equilibrium analysis on the two Shafts to find a relationship b/w T_{CD} & T_o

2* Apply a Kinematic analysis to relate the angular rotations of the gears

3* Find the maximum allowable torque on each shaft - choose the Smallest

4* Find the Corresponding angle of twist for each Shaft & the net angular rotation of end A

1* Apply a Static Equilibrium analysis on the two Shafts to find a relationship b/w T_{CD} & T_o



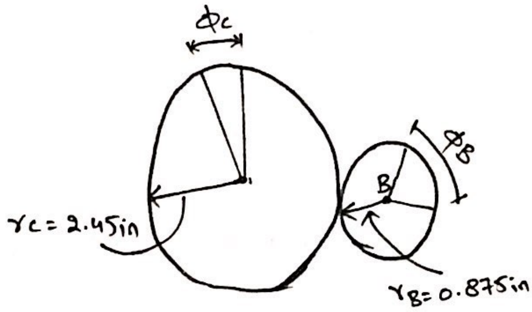
$\Sigma M_B = 0 = F(0.875in) - T_o$

$\Sigma M_C = 0 = F(2.45in) - T_{CD}$

$T_{CD} = 2.8 T_o$

ID= 15266

2* Apply a Kinametic analysis to relate the angular rotations of the gears



$$r_B \phi_B = r_c \phi_c$$

$$\phi_B = \frac{r_c}{r_B}\phi_c = \frac{2.45in}{0.875in}\phi_c$$

$$\phi_B = 2.8\phi_c$$

3* Find the T_o for the max allowable torque on each shaft - Choose the Smallest

$$\tau_{max} = \frac{T_{ABC}}{J_{AB}} \qquad 10000\ Psi = \frac{T_o(0.375in)}{\pi/2(0.375in)^4}$$

$$\underline{T_o = 827.9}$$

$$\tau_{max} = \frac{T_{CDc}}{J_{CD}} \qquad 10000Psi = \frac{2.8T_o(0.5in)}{\pi/2(0.5in)^4}$$

$$\frac{10000 \times 0.0981}{2.8 \times 0.5} \Rightarrow T_o = \frac{981.25}{1.4} = 700\ lb.in$$

4* Find the Corresponding angle of twist for each shaft & the net angular rotation of end A

$$\phi_{A/B} = \frac{T_{AB}L}{J_{AB}G} = \frac{(700)(24)}{\pi/2(0.375)^4(25\times10^6)} = \frac{16800}{1.57\times0.0197\times25\times10^6}$$

$$\phi_{A/B} = \frac{16800}{773255} = 0.0217 \text{ radians}$$

$$\phi_{A/B} = 1.24^\circ$$

ID = 15266

$$\phi_{C/D} = \frac{T_{CD}L}{J_{CD}G} = \frac{2.8 \times 700 \times 24}{\pi/2\,(0.5\,in)^4\,(25\times10^6)}$$

$$= \frac{47040}{1.57\times0.0625\times25\times10^6} = 0.019\,rad = 1.08^\circ$$

$$\phi_B = 2.8\,\phi_C = 2.8\times1.08 = 3.024$$

$$\phi_A = \phi_B + \phi_{A/B} = 3.024 + 1.24^\circ = 4.264$$

ID = 15266

Q No 4 : Determine the location for the Shear Centre of the channel Section

~~Solution~~ Given Data.

$b = 4$ inches

$h = 6$ in

and $t = 0.15$ in

Req: Determine the Shear Stress distribution for $V = 15 + 3$ kips

$V = 18$

Solution

$$e = \frac{FH}{I}$$

* where

$$F = \int_0^b q\,ds = \int_0^b \frac{VQ}{I}\,ds = \frac{V}{I}\int_0^b st\frac{h}{2}\,ds$$

$$= \frac{Vthb^2}{4I}$$

$$I = I_{web} + 2I_{flange} = \frac{1}{12}th^3 + 2\left[\frac{1}{12}bt^3\left(\frac{h}{2}\right)^2\right]$$

$$= \frac{1}{12}th^2(6b+h)$$

* Combining

$$e = \frac{b}{2 + h/3b} = \frac{4\text{in}}{2 + \frac{6\text{in}}{3(4\text{in})}}$$

$$\boxed{e = 1.6\text{in}}$$

ID = 15266

* Determine the Shear Stress distribution for $V = 15+3 = 18$ Kips

$$\tau = \frac{q}{t} = \frac{VQ}{It}$$

* Shearing Stresses in the flanges,

$$\tau = \frac{VQ}{It} = \frac{V}{It}(st)\frac{h}{2} = \frac{Vh}{2I}s$$

$$\tau_B = \frac{Vhb}{2\left(\frac{1}{12}th^2\right)(6b+h)} = \frac{6Vb}{th(6b+h)}$$

$$= \frac{6(18\text{ Kips})(4in)}{(0.15in)(6in)(6\times 4in+6in)} = 8 \text{ Kips/in}^2$$

* Shearing Stressess in the web

$$\tau_{max} = \frac{VQ}{It} = \frac{V\left(\frac{1}{8}ht\right)(4b+h)}{\frac{1}{12}th^2(6b+h)t} = \frac{3V(4b+h)}{2th(6b+h)}$$

$$= \frac{3(18\text{ Kips})(4\times 4in+6in)}{2(0.15in)(6in)(6\times 6in+6in)} = 16.6 \text{ Kips/in}^2$$

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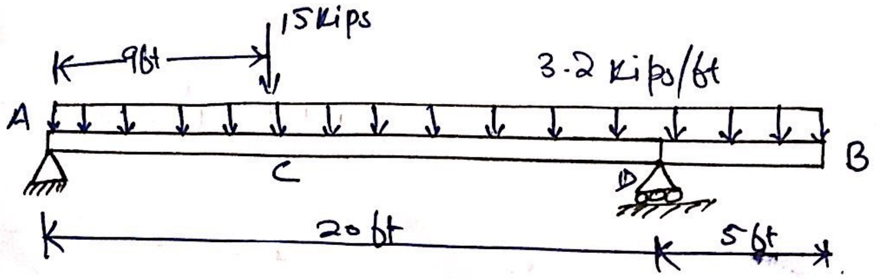
Q No 5

Given Data : $\delta_{all} = 15 + 4 = 19$ Ksi

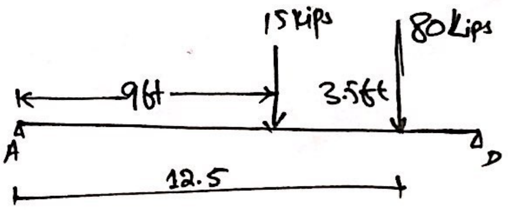
$\tau_{all} = 15 + 1 = 16$ Ksi



Soll.

1) Reaction at A & D

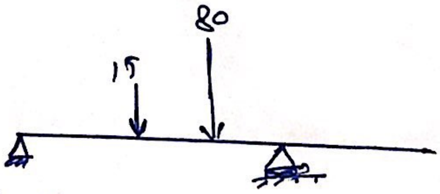
$= 3.2 \times 25 = 80$ K



Taking M at A (+)

$15 \times 9 + 80 \times 12.5 - R_D \times 20 = 0$

$R_D = 56.75$



Now M at D (+)

$R_A \times 20 - 15 \times 11 - 80 \times 7.5 = 0$

$R_A = 38.25$

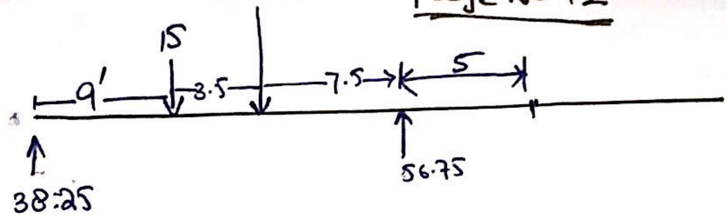
Check

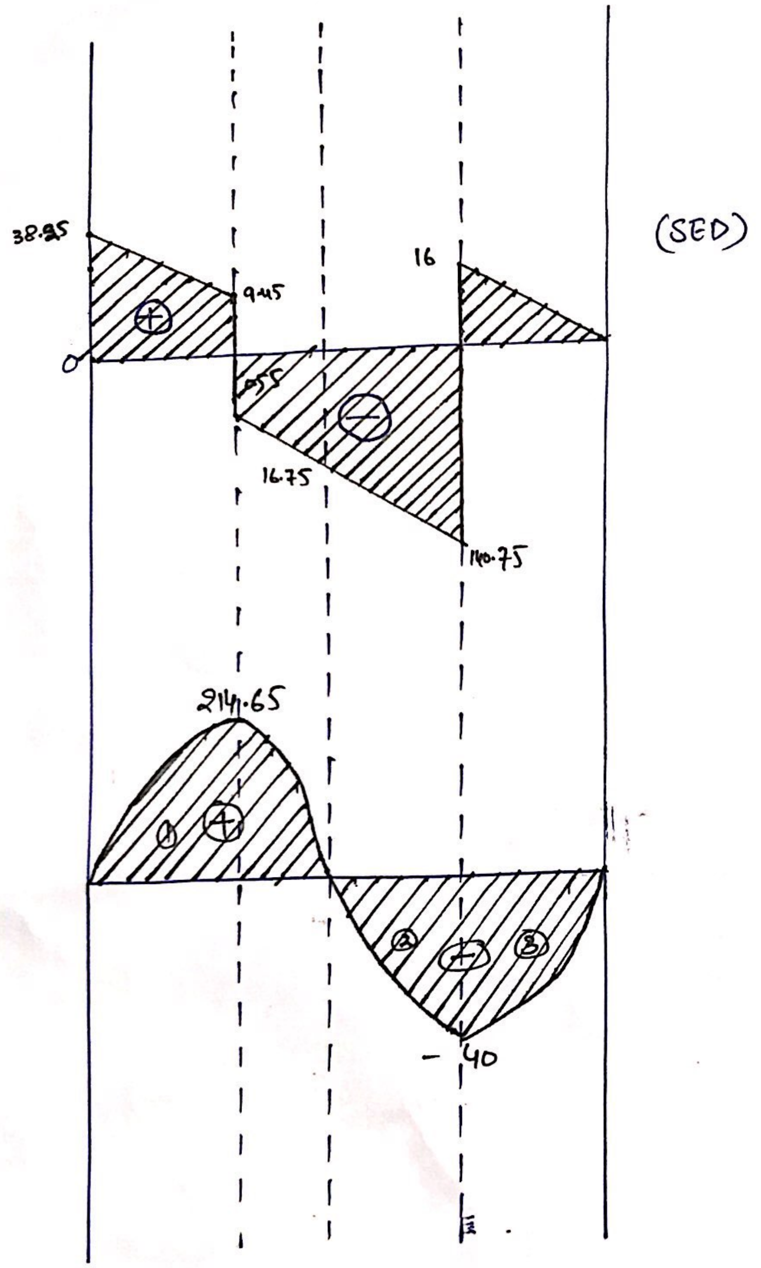
$15 + 80 = 56.75 + 38.255$

$95 = 95$

ID- 15266

2)





1) +ve = (38.25 - 9.45) x (9x0.5) + (9.45x9) = 214.65

2) -ve = (40.75 - 5.5) x 11x0.5 + 5.5x11 = 254.65

3) =(16 x 5) x 0.5 = 40

4) Max normal Stress = 214.6

5) Max Shear = 40.75