IQRA NATIONAL UNIVERSITY PESHAWAR

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Program	**MS Transportation Engineering**
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IQRA NATIONAL UNIVERSITY

PESHAWAR

Q No 01 Given Data: page #01 ID = 14374

$F = 14N$

Elastic limit $= 207000\ kPa$

$E = 223 \times 10^6\ kPa$

$n = 0$

F.os $N = 1$

$X = 14 + 5 = 19\ cm$

$Y = 14$

Required data: Determine diameter of shaft = ?

Sol: The moment at section A is

$M = 11000 \times 14 = 154000$

and the Torque on the shaft is $T = 11000 \times 0.14 = 1540$

The normal stress due to M at A is

$$S = \frac{64Md}{2\pi d^4} = \frac{32M}{\pi d^3}$$

Maximum shear stress due to T at A is

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

The shear stress due to shear force t is zero at A

$$S_{ns} = \frac{1}{2} S \pm \frac{1}{2} (S^2 + 4\tau^2)^{1/2}$$

Maximum shear stress Theory

$$T_{max} = \frac{1}{2} (\sigma_1 - \sigma_2)$$

$$T_{max} = \frac{1}{2} \left(\frac{32}{\pi d^3}\right) (M^2 + T^2)^{1/2}$$

02 QNo 01 page # 02

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

$$= \frac{16}{\pi d^3}(154000^2+1540^2)^{1/2}$$

$$= \frac{2464123.197}{\pi d^3}$$

$$\tau_{time} = \frac{784752.61}{d^3} \text{ pa}$$

This should not exceed the maximum shear stress volume at yeilding in uniaxial shear stress valume at yielding in ~~un~~ Tension Test.

$$\frac{1}{d^3} 784752.61 = \frac{\delta_4}{2} \Rightarrow \frac{1}{d^3} 784752.61 = \frac{207\times10^{-6}}{2}$$

$$\Rightarrow 103.5\times10^{-6}$$

$$d^3 = 7582.15\times10^{-6}$$

$$d = 19.64\times10^{-6} m^3$$

$$d = 19.64 cm^3$$

(ii) octa shear stress Theory

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

with $\delta_2 = 0$

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

$$T \frac{\sqrt{2}}{3}(\delta^2+3\tau^2)^{1/2}$$

بعدالت جناب

Q No 02 Page # 03

$$= \frac{19\sqrt{2}}{3\pi d^3}\left(4M^2+3T^2\right)^{1/2}$$

$$= \frac{19\sqrt{2}}{3\pi d^3}\left[4(154000)^2+3(1540)^2\right]^{1/2}$$

$$= \frac{19\sqrt{2}}{3\pi d^3}\left[4(154000)^2+3(1540)^2\right]$$

$$= (9.4864\times10^6+7114800)^{1/2}$$

$$= \frac{19\sqrt{2}(308011.54)}{3\times3.14d^3} = \frac{\sqrt{2}}{3\pi d^3}(308011.54)$$

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

Equating this oct shear stress at yielding of an Unioxal Tension bar's and using factor = 14

$$\frac{\sqrt{14}}{3}\delta_4 = \frac{\sqrt{14}}{3\pi d} = 14\times308011.54$$

$$= 14\times308011.54 = \pi d^3\sigma_n = \pi d^3\times207\times10^6$$

$$d^3 = 162.72\times10^{-6}$$

$$d = 162.72\ cm^3$$

QNo 2 Page #01 ID = 14374

Solution: Apply a free body analysis to the bar BDE to find the forces exerted by links AB and DC

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

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

Data:

$E_{Al} = 70 GPa$

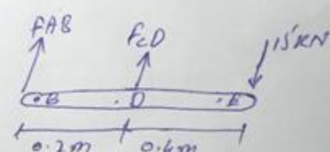
$A_{Al} = 500 mm^2$

$E_{st} = 200 GPa$

$A_{st} = 60 mm^2$

Required Data: Deflection a) of B, b) of D and c) of E

Free body BAR BDE



$\Sigma MB = 0$

$0 = -(14 \times (0.2) + 0.4)) + FCD \times 0.2$

$0 = 8.4 = FCD \times 0.2$

$FCD = \frac{8.4}{0.2} \Rightarrow FCD = \boxed{42 KN}$

$\Sigma MD = 0$

$0 = -(14 \times 0.4) - FAB \times 0.2 m$

$0 = -(5.6) - FAB \times 0.2 m$

$\Rightarrow -5.6 = -FAB \times 0.2 m$

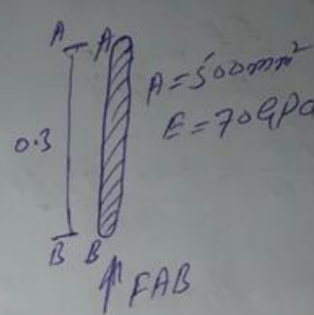
QNo 2 Page #02 ID= 14374

$$F_{AB} = \frac{-5.6}{0.2}$$

$$= -28KN$$

Displacement of B $\delta_B = \frac{PL}{AE}$

$$= \frac{(-28KN \times 10^3)(0.3)}{(500 \times 10^{-6})(70 \times 10^9)}$$

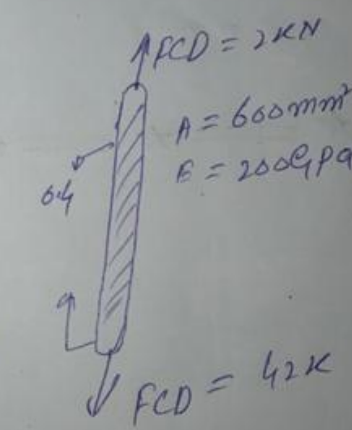


$$= \frac{8400}{35000,000}$$

$$= 2.4 \times 10^{-04} m$$

$$\delta_B = \boxed{0.24mm}$$

Displacement of D



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

$$= \frac{(42 \times 10^3)(0.4)}{(600 \times 10^{-6})(200 \times 10^9)}$$

$$= \frac{16800}{120000000} = 1.4 \times 10^{-0.4}$$

$$\delta_D = 0.14mm$$

Displacement of D

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

$$\frac{0.24}{0.14} = \frac{(200mm) - x}{x}$$

$$0.24 \times x = (200 - x)(0.14)$$

$$0.24x = 28 - 0.14x$$

Q.No 2

page # 03 $\quad$ ID = 14374

$0.24x + 0.14x = 28$

$0.38x = 28$

$\Rightarrow x = \dfrac{28}{0.38}$

$x = 73.68mm$

Dia

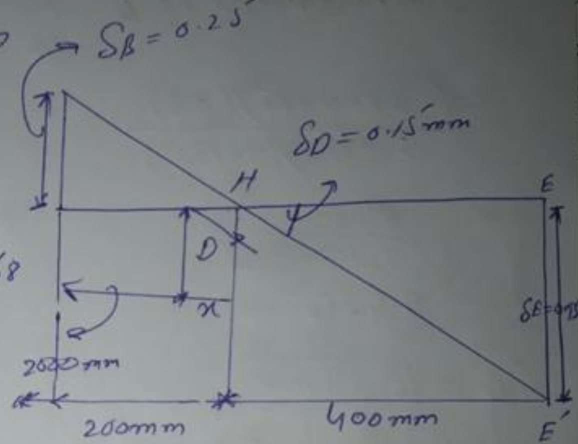
Now

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

$\dfrac{\delta E}{0.14} = \dfrac{400+73.68}{73.68}$

$\delta E = 0.14 \times 6.42$

$\delta E = \boxed{0.9mm}$



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Q No 03 ID = 14374 1 page # 01

Given Data:

$G = 14\times10^6$

Allowable shearing stress = ~~π~~ 10 ksi

$x = 14+10$

$x = 24$

Required Data: Largest Torque $T_0 = {}^{AB}?$

Sol Apply a static equilibrium analysis on the two shafts to find a relation between T_{CD} and T_0

→ Apply a kinematic analysis to relate the angular rotation of gear's.

$\Sigma M_B = 0 = F(0.875\text{in}) - T_0$

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

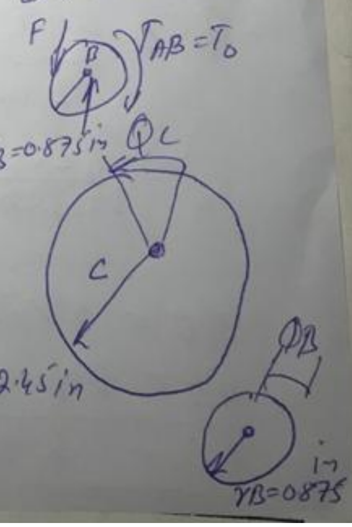
$T_{CD} = 2.8\,T_0$

now $r_B\phi_B = r_C\phi_C$

$\phi_B = \frac{r_C}{r_B}\phi$

$\frac{2.45}{0.875\text{in}}\phi$

$\phi_B = 2.8\,\phi_C$



QNo. 3

(2) page # 02 ID = 14374

$\tau_{max} = \frac{T_{ABC}}{J_{AB}}$ $10000 = \frac{T_0 (0.375in)}{\pi/2 (0.375in)^4}$

$= \frac{10000 (0.3104)}{0.375} = T_0 = \boxed{827.9}$

$\tau_{max} = \frac{T_{CD}c}{J_{CD}}$. $10000 = \frac{2.8 T_0 (0.5in)}{\pi/2 (0.5in)^4}$

$\frac{10000 \times 0.0981}{2.8 \times 0.5} = T_0 = \frac{981.25}{1.4}$

$= 700 lb.in$

$\phi A/B = \frac{T_{ABC}}{J_{AB}G} = \frac{(700)(24)}{\pi/2 (0.375)^4 (24 \times 10^6)} = \frac{16800}{1.57 \times 0.0197 \times 24 \times 10^6}$

$\frac{16800}{742296} = \phi A/B = 0.02263$ radian

$= 1.2^\circ$

$\phi C/D = \frac{T_{CD}L}{J_{CD}G} = \frac{2.8 \times 700 \times 24}{\pi/2 (0.5in)^4 (24 \times 10^6)} = \frac{47040}{1.57 \times 0.0625 \times 24 \times 10^6}$

$= \frac{47040}{2355000} = 0.019$ radian

$= 1.14^\circ$

$\phi D = 2.8 \phi C = 2.8 \times 1.14 = 3.192$

$\phi A = \phi B + \phi A/B = 3.192 + 1.2$

$\boxed{\phi = 4.392}$

Q No 04 page # 01 ID = 14374

Given Data:

$b = 4in$
$h = 6in$
$t = 0.15in$

Required Data:

Shear stress distribution for $V = ?$

Sol

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

Now

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

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

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

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

Combining $e = \dfrac{b}{2 + \frac{h}{3b}} = \dfrac{4in}{2 + \frac{6in}{3in}}$

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

find The Shear stress Distribution for $V = 14 + 3ID/K$

* Shear Stress in The flange $= 17$ KIPS

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

★ Q No 04

Shear stress in The flanges: page # 02 ID = 14374

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

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

$$= \frac{6\,(17\,kips)\,(4in)}{(0.15in)\,(6in)\,(6\times4in\times6in)}$$

Shear stress in The web:

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

$$= \frac{3(kips)\,(4\times4in+6in)}{2(0.15in)(6in)(6\times6in+6in)}$$

$$= \frac{3\,(16+6)}{(0.3)(06)(42)}$$

$$= \frac{66}{75.6}$$

$$= \boxed{0.873\ kips}$$ 0.873 kip/in²

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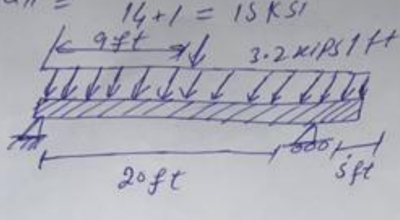
QNo 05 page # 01

Sol

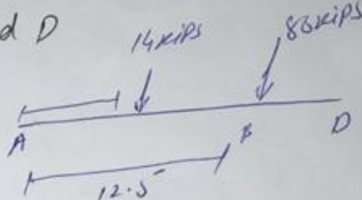
$\delta_{all} = 14+4 = 18\,ksi$

$T_{all} = 14+1 = 15\,ksi$



Solution: Reaction at A and D

$3.2 \times 25 = 80k$



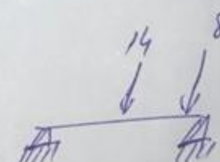
Taking M at A

$14 \times 9 \times 80 \times 12.5 - RD \times 20 = 0$

$RD = \frac{1126}{20}$

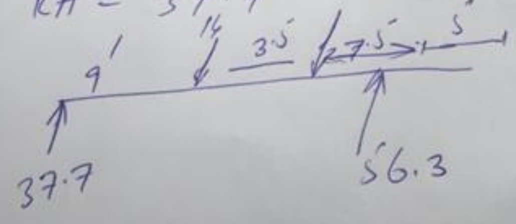
$RD = 56.3$

Now M at D



$RA \times 20 - 14 \times 11 - 80 \times 7.5 = 0$

$RA = 37.7$

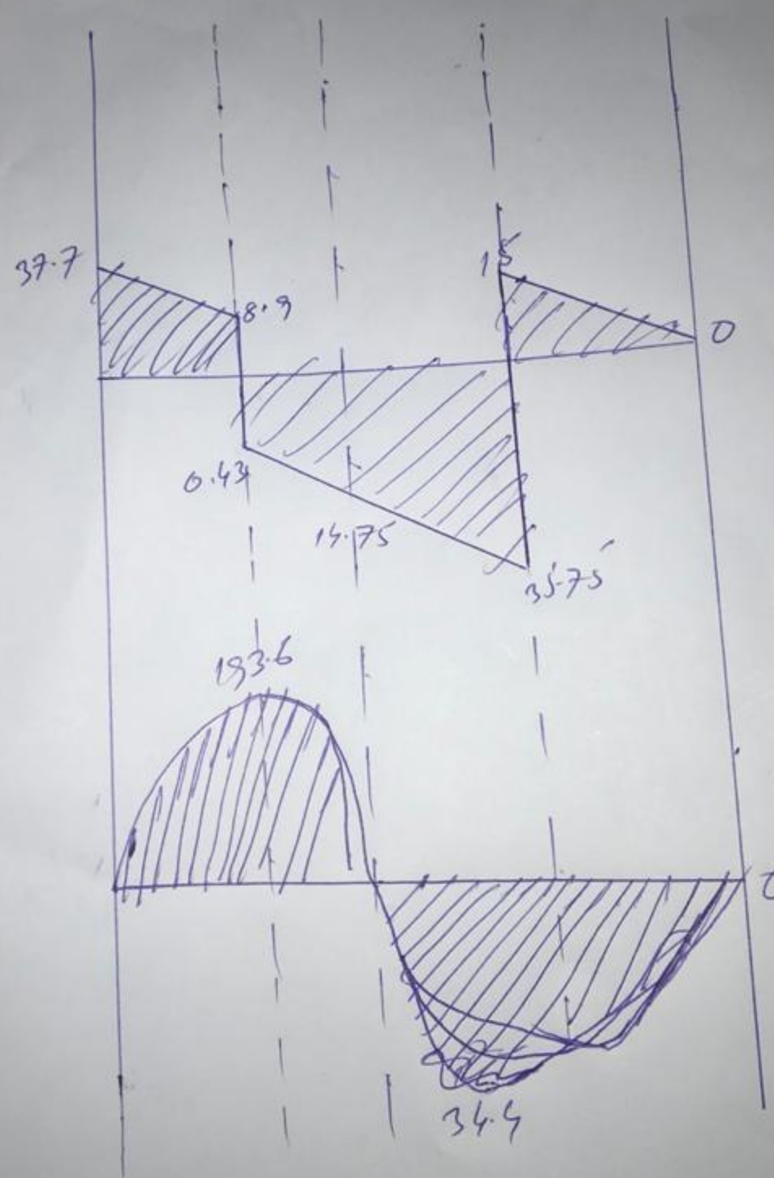


Check

$14+80 = 56.3+37.7$

$94 = 94$

Q.5 ②



3

1) +ve = $(37.25 - 8.9) + (9 \times 0.43) + (8.9 \times 9)$
$= 193.6$

2) −ve = $(35.75 - 5.5) \times 11 \times 0.43 + 5.5 \times 11$
$= 203.58$

3) $(16 \times 5) \times 0.43 = 34.4$

4) Maximum normal stress = 193.6

5) Max shear = 34.4