1. Static And Variable Stresses

Design

Machine element

Design of machine element

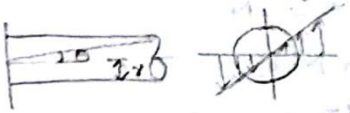
Factors influencing machine design

Procedures to design a machine element

Mechanical Properties of elements

Direct Tensile and Compression Stress :-

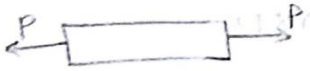
$$\frac{T}{J} = \frac{\tau}{r} = \frac{C\theta}{l}$$



Torsion

$$T = \frac{\pi}{16} \times \tau \times d^3$$

$$\sigma_t = P/A$$

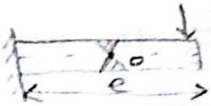


Tensile

Direct Compressive load

$$\sigma_c = -P/A$$

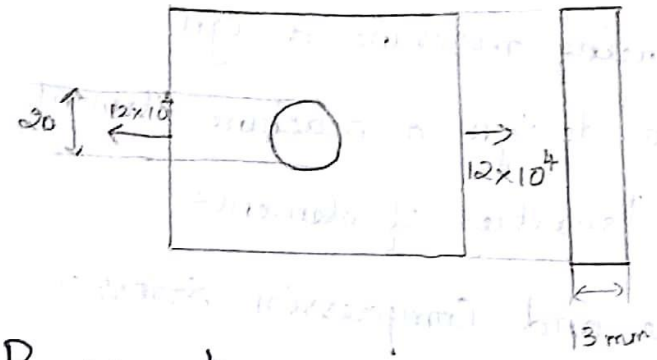
Direct Bending load



$$\sigma_{bt} = \frac{P \times e}{z} = \frac{M}{z}$$

$$\sigma_{bc} = -\frac{P \times e}{z}$$

1. A tie bar carry a load of 12×10^4 N. What must be the width of the bar 13 mm thick, if hole of 20 mm diameter on its centre. Working stress of the bar is 75 MPascal.



$P = 12 \times 10^4$ N

$\sigma = 75$ MPa

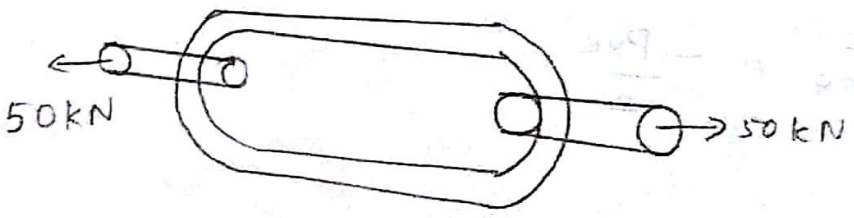
$= 75$ N/mm²

$\sigma_t = P/A = \dfrac{12 \times 10^4}{(W-20) \times 13}$

$75 = \dfrac{12 \times 10^4}{(W-20)13}$

$W = 143.07$ mm

2. Find the diameter of line stock if the permissible tensile stress of the material is not to exceed 75 MPascal?



$$\sigma = P/A$$

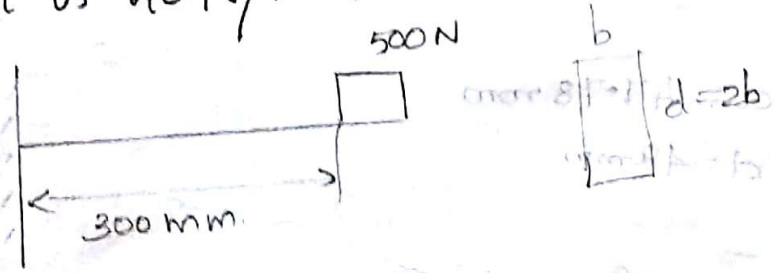
$$75 = \frac{50 \times 10^3}{\pi/4 \times d^2}$$

$$d^2 = \frac{50 \times 10^3 \times 4}{\pi \times 75}$$

$$d = 29.15 \text{ mm}$$

3/7/16 Bending Stress

1. An electric motor weighing 500 N is mounted on a sharp cantilever beam of uniform rectangular cross section. The weight of the motor acts at a distance of 300mm from the support. The depth section is twice the width. Determine the cross section of beam - Allowable stress in the beam is 40 N/mm^2.



$$\sigma_b = M/Z = \frac{P \times e}{Z}$$

PS & DB 6.1

$$\text{Rectangle} = \frac{bd^2}{6}$$

$$40 = \frac{500 \times 300}{\frac{b \times (2b)^2}{6}}$$

$$b^3 = \frac{500 \times 300 \times 6}{40 \times 4}$$

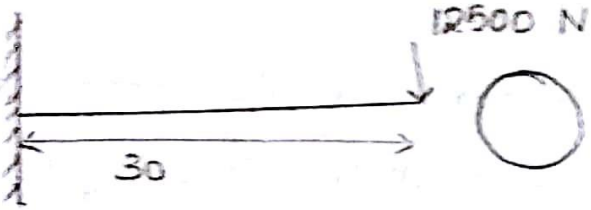
$$b = 17.78 = 18 \text{ mm}$$

$d = 2b$

$= 2 \times 18$

$= 36$ mm

2. A trunion of mixing machine has a effective length is 30 mm and weight which comes on the trunion is 12500 N. What should if the diameter of trunion stress not to exceed 35 N/mm²



PSG DB 61

$Z = \pi/32\ d^3$

$$35 = \frac{12500 \times 30}{\pi/32\ d^3}$$

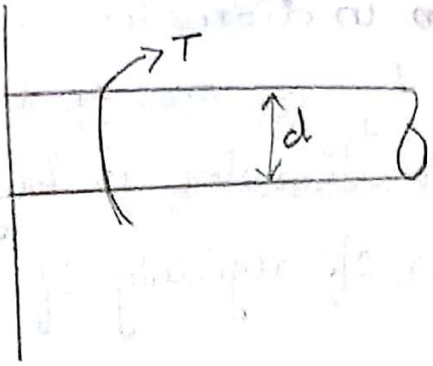
$$d^3 = \frac{12500 \times 30 \times 32}{35 \times \pi}$$

$d = 47.78$ mm

$d = 48$ mm.

Problem on Shear Stress

1. A shaft transmitting 100 kW at 1400 rpm find the suitable diameter for shaft the maximum torque transmitted exceed mean by 25%. Take minimum allowable shear stress of 70 MPa.



$P = 100 \times 10^3$ W

$N = 1600$ rpm

$\sigma = 70$ MPas

$$P = \frac{2\pi NT}{60}$$

$$100 \times 10^3 = \frac{2\pi \times 1600}{60} \times T$$

$$T = \frac{100 \times 10^3 \times 60}{2\pi \times 1600}$$

$$= 596.83 \text{ N-m} = 596.8 \times 10^3 \text{ N-mm}$$

$$T = \frac{\pi}{16} \times \tau \times d^3$$

$$T_{max} = T_{mean} \times 1.25$$

$$= 1.25 \times 596.8 \times 10^3$$

$$= 746 \times 10^3$$

$$746 \times 10^3 = \frac{\pi}{16} \times 70 \times d^3$$

$$d = 38 \text{ mm}$$

1; 2, 9, 14, 15, 18

26, 22, 23, 32, 35

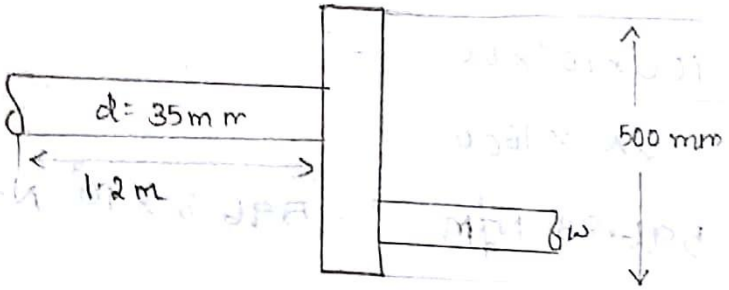
32, 51, 54, 501, 502

504, 505, 506

2. A steel shaft $\phi 35$ mm in diameter and 1.2 m long held rigidly at one end as a handwheel 500 mm in diameter is keyed to other end modulus of rigidity of steel is 80 GPas.

Case i) What load applied tangent to the rim of the wheel produce a torsional shear of 60 MPas.

Case ii) How many degree will wheel turn when load is applied.



$$T = W \cdot R$$
$$= W \cdot 250 \cdot N\text{-}mm.$$

$$J = \frac{\pi}{32} d^4$$
$$= \frac{\pi}{32} \times 35^4$$
$$= 147.323 \times 10^3 \ mm^4$$

$$\frac{T}{J} = \frac{60}{147.5} \frac{\tau}{r}$$

$$\frac{250\,W}{147.323\times10^{3}} = \frac{60}{17.5}$$

$$W = 2020\,N$$

$$T = 250 \times 2020$$
$$= 505.109\times10^{3}\,N\text{-}mm$$

$$\frac{T}{J} = \frac{C\theta}{l}$$

$$\frac{505.109\times10^{3}}{147.323\times10^{3}} = \frac{80\times10^{3}\times\theta}{1200}$$

$$\theta = 0.05^{\circ}$$

1. A shaft transmitting 97.5 kW at 1800 rpm if allowable shear stress in the material is 60 MPas Find the suitable dia of the shaft if the shaft is not to twist more than 1° if the length of 3m. Take C = 80 GPas

Soln:-

$P = 97.5\times10^{3}\,W$
$N = 1800$ rpm
$\tau = 60$ MPas
$\theta = 1^{\circ}$
$l = 3000$ mm
$C = 80$ GPas

$$P = \frac{2\pi NT}{60}$$

$$97.5\times10^{3} = \frac{2\pi\times1800\times T}{60}$$

$$T = 517.25\times10^{3}\ N\text{-}mm$$

$$J = \frac{\pi}{32} d^4$$

$$= \frac{\pi}{32} d^4$$

$$\frac{T}{J} = \frac{C\theta}{l}$$

$$\frac{517.25 \times 10^3}{\frac{\pi}{32} d^4} = \frac{80 \times 10^3 \times 0.0174}{3000}$$

$$d^4 = \frac{517.25 \times 10^3 \times 32 \times 3000}{80 \times 10^3 \times 0.0174 \times \pi}$$

$$d = 59 \text{ mm}.$$