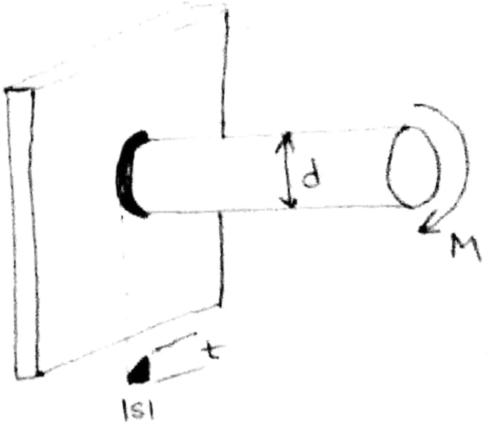
Govt Poly. college Kasauli

IInd mid term test - 2017-18
Branch: mechanical - IIIrd year
Sub. ME 308 (MACHINE DESIGN) MM:15
Time 1hr

Que:4 Show that the Normal stress in case of circular fillet weld subjected to bending is given by $\sigma = \frac{5.66 M}{\pi s d^2}$ 5 MARKS

where. M = Bending moment s = weld size and d = Diameter of cylindrical element




Solution: →

d = diameter of rod
m = Bending moment acting on the rod
s = size (or leg) of weld.
t = throat thickness
z = section modulus of the weld section

we know that bending stress

$$\sigma_b = \frac{M}{Z}$$

section modulus of weld section $Z = \frac{\pi t d^2}{4}$

$$\sigma_b = \frac{M}{\frac{\pi t d^2}{4}} = \frac{4M}{\pi t d^2}$$

This bending stress occurs in a horizontal plane along a leg of the weld. The maximum bending stress occurs on the throat of the weld which is inclined at 45° to the horizontal plane


Length of throat $t = s \sin 45°$
$t = 0.707s$

and maximum bending stress

$$(\sigma_b)_{max} = \frac{4M}{\pi \times .707 s \times d^2}$$

$$(\sigma_b)_{max} = \frac{5.66 M}{\pi s d^2}$$

Que 2. The turning moment diagram for a Petrol engine is drawn to the following scales

Turning moment 1 mm = 5 N-m

Crank angle 1 mm = $1^\circ$

The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270 $mm^2$

Determine the mass of 300 mm diameter flywheel rim when the coefficient of fluctuation of speed is 0.3% and the engine runs at 1800 rpm. Also determine the cross-sectional of the rim when the width of the rim is twice of thickness. Assume density of rim material as 7250 kg/m3

5 MARKS

Solution: Given $D = 300$ mm or $R = 150$ mm $= 0.15$ m

$C_s = 0.3\% = 0.003$, $N = 1800$ rpm or $\omega = \frac{2\pi \times 1800}{60}$

$= 188.5$ rad/s.

$\rho = 7250$ kg/m3

mass of flywheel :-

$m =$ mass of the flywheel in kg.

the scale of turning moment in $mm^2$ is

$= 5 \times \frac{\pi}{180} = .087$ N-m

Let the total energy at A = E

Energy at B = E + 295

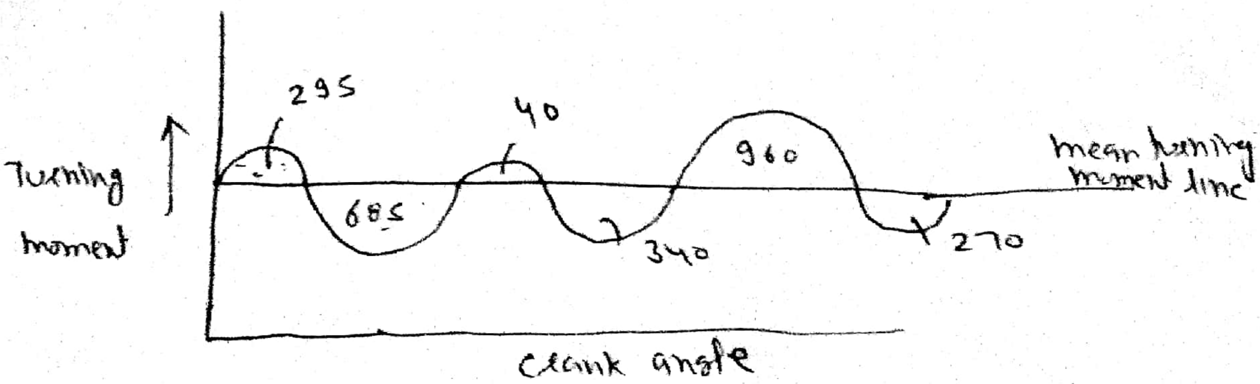
at C = E + 295 − 685 = E − 390

at D = E − 390 + 40 = E − 350

at E = E − 350 − 340 = E − 690

at F = E − 690 + 960 = E + 270

at G = E + 270 − 270 = E



from this energy is maximum at B and minimum at E

Maximum energy = $E + 295$

minimum energy = $E - 690$

Maximum fluctuation of energy

$\Delta E$ = Maximum energy − minimum energy

$= (E + 295) - (E - 690) = 985 \text{ mm}^2$

$= 985 \times .087 = 86 \text{ N-m}$

We also know that maximum fluctuation of energy ($\Delta E$)

$86 = mR^2\omega^2 . C_S = m(0.15)^2(188.5)^2(.003)$

$86 = m \times 2.4$

$m = 86/2.4 = 35.8 \text{ kg.}$ Ans.

Cross section of the flywheel rim.

Let $t$ = thickness of rim

$b$ = width of rim in metres.

cross section area of rim:

$A = b \times t = 2t \times t = 2t^2$

mass of flywheel rim (m).

$35.8 = A \times 2\pi R \times \rho$

$35.8 = 2t^2 \times 2\pi R \times \rho$

$35.8 = 2t^2 \times 2\pi \times 0.15 \times 7250$

$t^2 = .0026$ or $t = .051 \text{ m}$

$t = 51 \text{ mm}$

$\left\{ \rho = \frac{m}{V},\ m = \rho \times V,\ m = A \times 2\pi R \times \rho \right\}$

$b = 2t = 2 \times 51 \text{ mm}$

$= 102 \text{ mm}$ Ans

Que: 3. Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5

The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm$^2$ 5 MARKS

Take Wahl's factor, $K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$, C = spring index.

Solution:- $W = 1000$ N, $\delta = 25$ mm, $C = D/d = 5$, $\tau = 420$ MPa $= 420$ N/mm$^2$

$G = 84$ kN/mm$^2$ $= 84 \times 10^3$ N/mm$^2$

(i) Mean diameter of the spring coil:-

D = mean diameter.

d = diameter of spring wire.

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{4\times5-1}{4\times5-4} + \frac{0.615}{5} = 1.31$$

and maximum shear stress ($\tau$)

$$420 = K \times \frac{8WC}{\pi d^2} = 1.31 \times \frac{8\times1000\times5}{\pi d^2}$$

$$d^2 = 16677/420 = 39.7$$

$$d = 6.3 \text{ mm.}$$

We shall take standard wire of size SWG 3 having diameter $d = 6.401$ mm

$$D = C\times d = 5\times6.401 = 32.005 \text{ mm}$$

outer diameter $D_o = D + d = 32.005 + 6.401 = 38.406$ mm Ans

(ii) Number of turn of the coils.

n = Number of active turns of the coil.

and compression of spring ($\delta$)

$$25 = \frac{8WC^3 n}{G.d} = \frac{8\times1000(5)^3 n}{84\times10^3\times6.401} = 1.86\,n$$

$$n = \frac{25}{1.86} = 13.44 \simeq 14$$ Ans

(iii) free length of the spring

$$L_f = n'\times d + \delta + 0.15\delta$$

$$= 16\times6.401 + 25 + 0.15\times25$$

$$= 131.2 \text{ mm}$$

{ $n' = n+2$, $n' = 14+2 = 16$, for squar and ground end }

(iv) Pitch of the coil.

$$P = \frac{\text{free length}}{n'-1} = \frac{131.2}{16-1} = 8.75 \text{ mm}$$ Ans