Torsion bar Spring

* This is a straight bar of circular or square section fixed to the frame at one end and lever connected its other end to the wheel.
* Used in old cars, tanks

Design of torsion bar

* A rod or tube acting in torsion can work as torsion bar springs.

Let

$L \rightarrow$ Length of the effective part of torsion bar

$T \rightarrow$ Moment or Torque applied on torsion bar.

W = Load acting on the lever arm of the torsion bar causing the moment on torsion bar

l = length of the lever arm

d = diameter of the bar

θ = angular deflection of the bar

f_s = torsional stress.

G = Modulus of Rigidity, 73575×10^6 Pa (or) 73575 MPa

J = Polar moment of Inertia of circular section of bar

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

* Torsion bar should design under maximum dynamic load consideration and corresponding allowable stresse

* For passenger car, the maximum bump load is about 165 % of the maximum static load.

* But in practise it is assumed 200 % based on the fact that the load rate increases quite rapidly with the approach of the point of maximum deflection.

* The maximum allowable stress in torsion bar springs varies from 73575 to 93195 pa.

$$\theta = \frac{TL}{GJ} = \frac{32TL}{\pi d^4 G} \text{ radian}$$

$$\theta_{max} = \frac{5760TL}{\pi^2 d^4 G} \text{ degree}$$

$$\text{Torsional Stress } f_s = \frac{16T_{max}}{\pi d^3}$$

Bar diameter $d = \sqrt[3]{\frac{16 T_{max}}{\pi f_{s_{max}}}}$

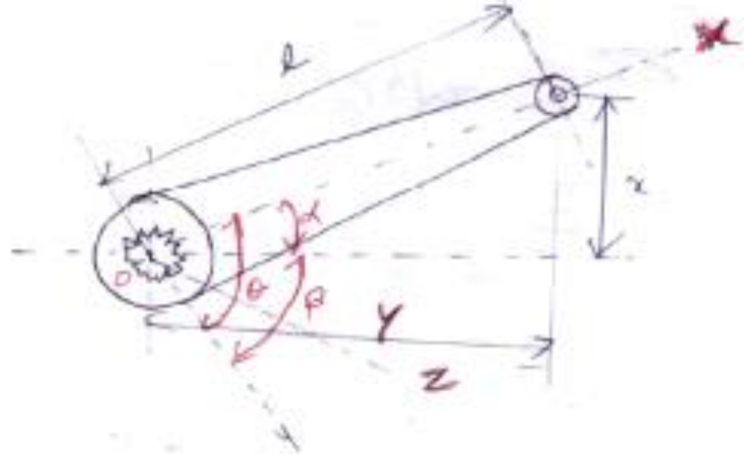
Shear stress $f_s = \frac{G \theta d}{2L}$

$$f_{s_{max}} = \frac{G \theta_{max} d}{2L}$$

$$L = \frac{G \theta_{max} d}{2 f_{s_{max}}}$$

Leverarm

If the arm of the torsion bar is inclined upward considerably instead of making it horizontal, Increase in deflection with increase in load is smaller.



Let

α → Upward Inclination of the arm

θ → Wind-up angle or angular deflection

β → Wind up angle when arm is horizontal

x → Linear deflection from horizonal

$$x = l \sin \alpha$$

y → Effective arm length

$$\boxed{y = l \cos \alpha}$$

$$T = W \times y$$

Spring rate (or) load rate :

$$r = \frac{\pi d^4 G + 32 L W_x}{32 L (l^2 - x^2)} \text{ N/m}$$