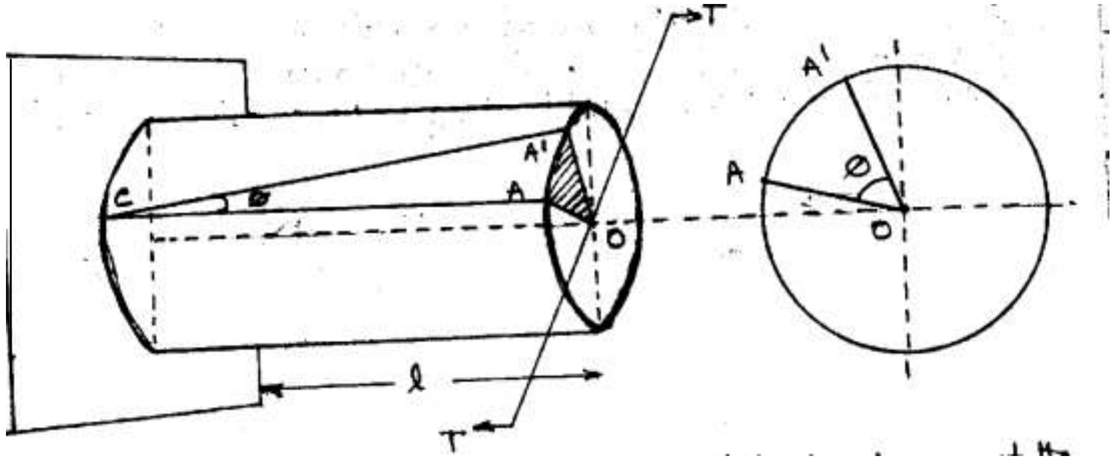
# TORSION OF SHAFTS

# TORSION

- In workshop and factories, a turning force is always applied to transmit energy by rotation. This turning force is applied either rim of a pulley, keyed to the shaft, or to any other suitable point at some distance from the axis of the shaft. The product of this turning force and the distance between the point of application of the force and the axis of the shaft is known as torque, turning moment or twisting moment. The shaft is said to be subjected to torsion. Due to this torque every cross section is subjected to a shaft stress.



# ASSUMTION FOR FINDING OUT SHEAR STRESS IN A CIRCULAR SHAFT SUBJECTED TO TORSION

- Following assumption are made while finding out shear stress in a circular shaft subjected to torsion.
- The material of the shaft is uniform through out.
- The twist along the shaft is uniform.
- Normal cross section of the shaft which were plane and circular before twist, remain plane and circular after twist.
- All diameters of the normal cross section which were straight before twist, remain straight with there magnitude unchanged after twist.
- A little consideration will show that the above assumption is justified. If the torque applied is small and the angle of twist is also small.

# STRENGTH OF A SHAFT

- By the strength of shaft is meant, the maximum torque or horse power it can transmit.

If 'T' is the torque which is subjected on a shaft

Then,

$$T = \frac{\pi}{16} f_s D^3$$

Where, fs = Shear stress

D = Diameter of the shaft

# STRENGTH OF HOLLOW SHAFT

- If ‘T’ is the torque which is subjected to a hollow shaft

Then,

$$T = \frac{\pi}{16} \cdot \frac{fs\,(D4 - d4)}{D}$$

Where, fs = Shear stress

D = External diameter of the hollow shaft.

d = Internal diameter of the hollow shaft.

# POLAR MOMENT OF INERTIA

- The moment of inertia of a plane area with respect to and axis perpendicular to the plane of the figure is called polar moment of inertia with respect to the point where the axis intersect the plane the plane. In a circular plane this point is always the center of the circle.

Mathematically represented by 'J'

$$J = \frac{\pi}{32} D^4$$ : for solid shaft ,

[where D = Diameter of the shaft]

$$J = \frac{\pi}{32} (D^4 - d^4)$$ : for hollow shaft

where, D = Outer dia of the shaft.

d = Inner dia. of the shaft]

# HORSE POWER TRASMITED BY A SHAFT

- A rotating shaft is considered which transmit power from one of it's end to another.

Let, N= Number of revolution per minute.

T = Average torque in Kg.m.

Therefore,

Work done per minute

= Force × Distance

= Average torque × Angular displacement.

= T × π N

= 2 π N T Kg.m.

- Now we know horse power,

$$= \frac{\text{Work done per minute}}{4500} = \frac{2\pi NT}{4500} \text{ H.P.}$$