Types of Shafts

The following two types of shafts are important from the subject point of view :

1. ***Transmission shafts. These shafts transmit power between the source and the machines*** absorbing power. The counter shafts, line shafts, over head shafts and all factory shafts are transmission shafts. Since these shafts carry machine parts such as pulleys, gears etc., therefore they are subjected to bending in addition to twisting.

2. ***Machine shafts. These shafts form an integral part of the machine itself. The crank shaft is*** an example of machine shaft.

Standard Sizes of Transmission Shafts

25 mm to 60 mm with 5 mm steps; 60 mm to 110 mm with 10 mm steps ; 110 mm to 140 mm with 15 mm steps ; and 140 mm to 500 mm with 20 mm steps.

The standard length of the shafts are 5 m, 6 m and 7 m.

Stresses in Shafts

The following stresses are induced in the shafts :

1. **Shear stresses due to the transmission of torque (*i.e. due to torsional load).***
2. **Bending stresses (tensile or compressive) due to the forces acting upon machine elements** like gears, pulleys etc. as well as due to the weight of the shaft itself.
3. **Stresses due to combined torsional and bending loads.**

Maximum Permissible Working Stresses for Transmission Shafts

According to American Society of Mechanical Engineers (ASME) code for the design of

transmission shafts, the maximum permissible working stresses in tension or compression may be taken as

(***a) 112 MPa for shafts without allowance for keyways.***

(***b) 84 MPa for shafts with allowance for keyways.***

The maximum permissible shear stress may be taken as

(a) 56 MPa for shafts without allowance for key ways.

(b) 42 MPa for shafts with allowance for keyways.

Design of Shafts

The shafts may be designed on the basis of

1. **Strength, and 2. Rigidity and stiffness.**

In designing shafts on the basis of strength, the following cases may be considered :

(***a) Shafts subjected to twisting moment or torque only,***

(***b) Shafts subjected to bending moment only,***

(***c) Shafts subjected to combined twisting and bending moments, and***

(***d) Shafts subjected to axial loads in addition to combined torsional and bending loads.***

Shafts Subjected to Twisting Moment Only

When the shaft is subjected to a twisting moment (or torque) only, then the diameter of the shaft may be obtained by using the torsion equation. We know that

$$T/J = \tau/r \qquad \text{...(i)}$$

where T = *Twisting moment (or torque) acting upon the shaft,*

J = *Polar moment of inertia of the shaft about the axis of rotation,*

τ = Torsional shear stress, and

r = Distance from neutral axis to the outer most fibre

= d / 2; where d is the diameter of the shaft.

The twisting moment (*T) may be obtained by using the following relation :*

We know that the power transmitted (in watts) by the shaft,

$P = 2\pi N.T/60$

or $T = P*60/2\pi N$

where *T = Twisting moment in N-m, and*

N = Speed of the shaft in r.p.m.

In case of belt drives, the twisting moment (*T) is given by*

$T = (T1 – T2) R$

where *T1 and T2 = Tensions in the tight side and slack side of the belt respectively, and*

R = Radius of the pulley.