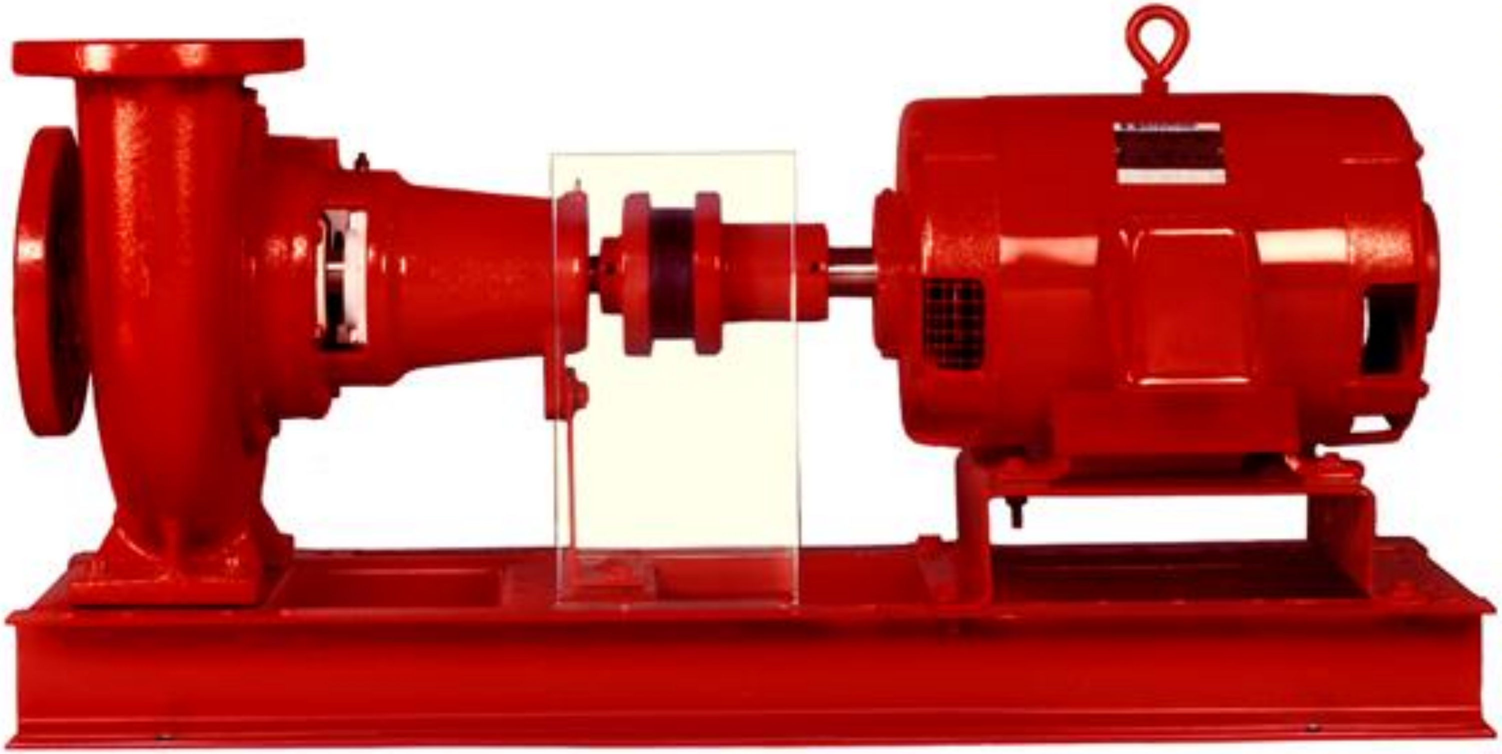
Introduction To Couplings

* Couplings are used to connect two rotating shafts to transmit torque from one to the other.

* For example coupling is used to connect the output shaft of an electric motor to the input shaft of a hydraulic pump.



Types of Shafts Couplings

1- Rigid Couplings

Rigid Couplings are used to connect two shafts which are perfectly aligned. These are simple and inexpensive.

A- **Sleeve or Muff Coupling** •

B- Clamp or Split-muff or Compression Coupling

C- Flange Coupling

2- Flexible Couplings

Flexible couplings are used to connect two shafts having lateral or angular misalignment. Flexible elements provided in flexible coupling absorb shocks and vibrations.

A- Bushed pin type Coupling

B- Universal Coupling

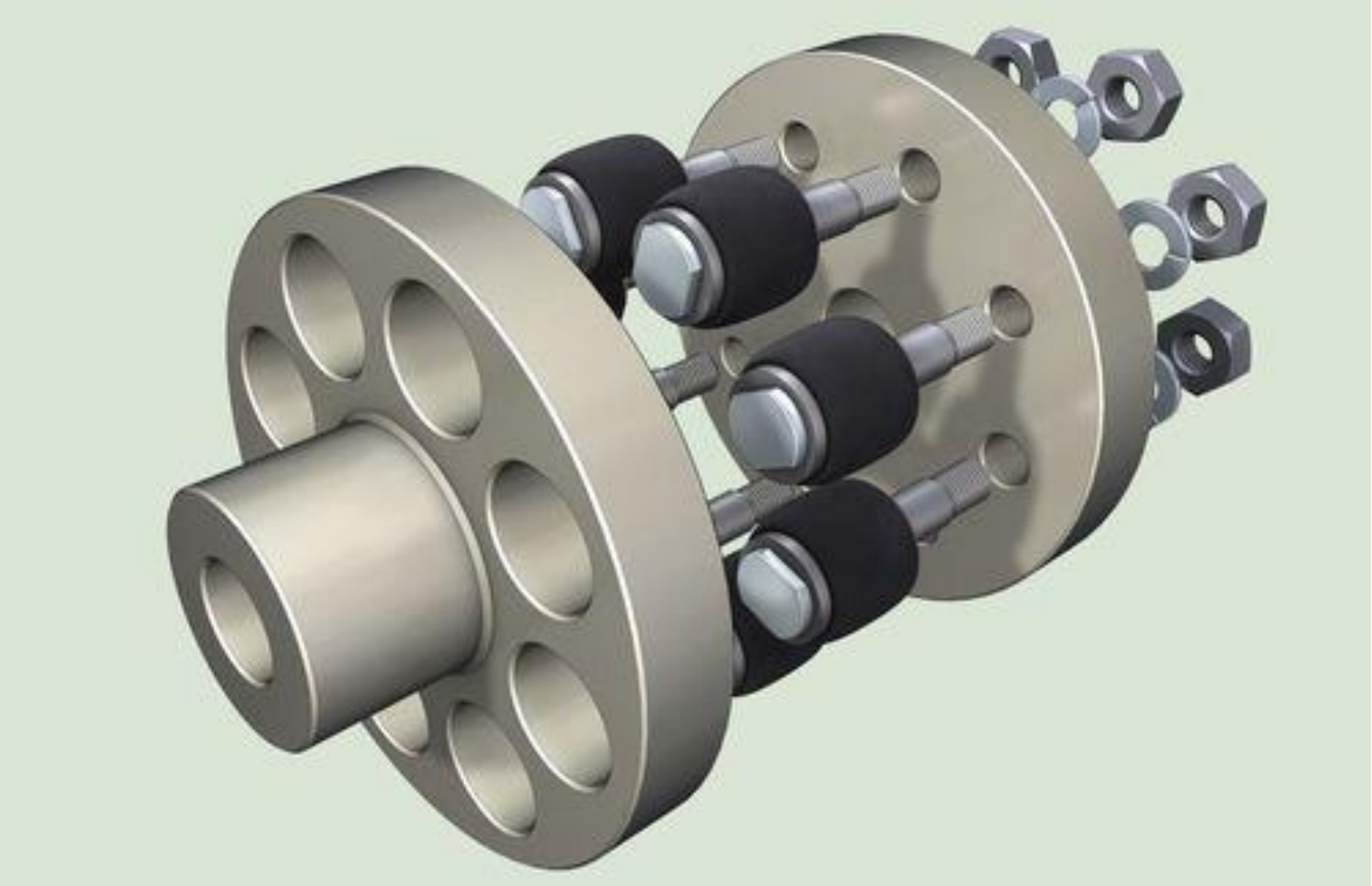
C- Oldham Coupling

Muff Coupling (Sleeve Coupling)

Clamp or Compression Coupling

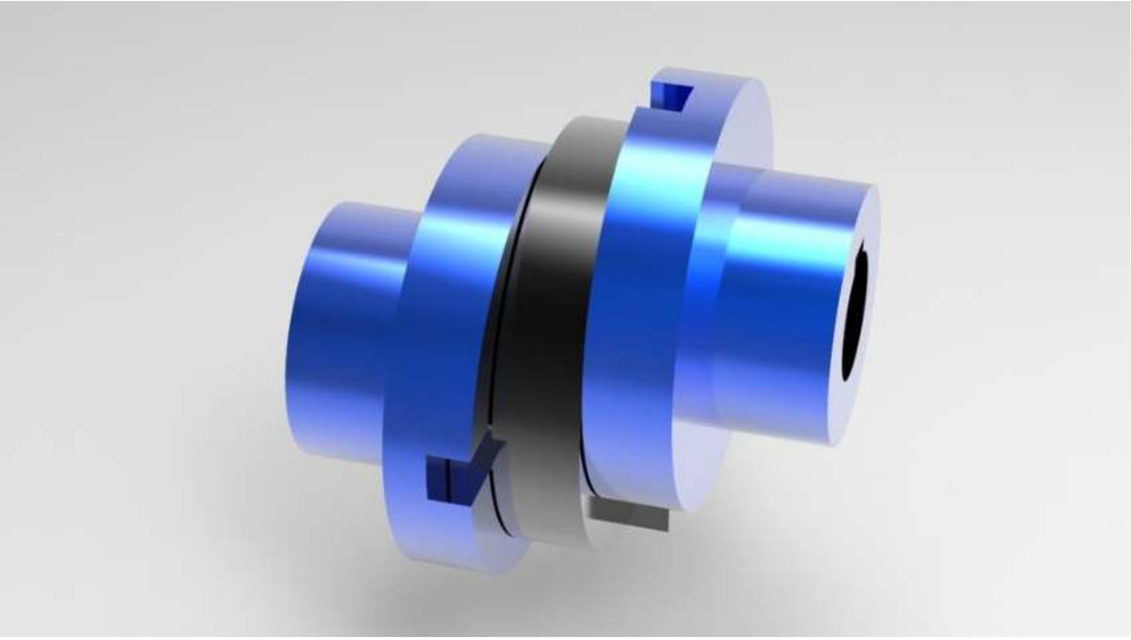
Flange Coupling

Bushed Pin Coupling



Universal Coupling (Hook Joint)

Oldham Coupling



Muff Coupling

* It consists of a Sleeve which is a hollow cylinder fitted on the ends of input and output shaft with the help of a sunk key.

* Torque is transmitted from input shaft to the sleeve through key and from the sleeve to the output shaft through the key again.

* **Sleeve is made of cast iron and for it a larger factor of safety of 6-8 is used on the ultimate strength**.

* Standard proportions used for sleeve are:

Outer diameter of the sleeve, $D = 2d + 13$

Length of the sleeve, $\mathbf{L = 3.5\ d}$

where d is the diameter of the shaft.

So the muff coupling has three main components: shafts, sleeve and key.

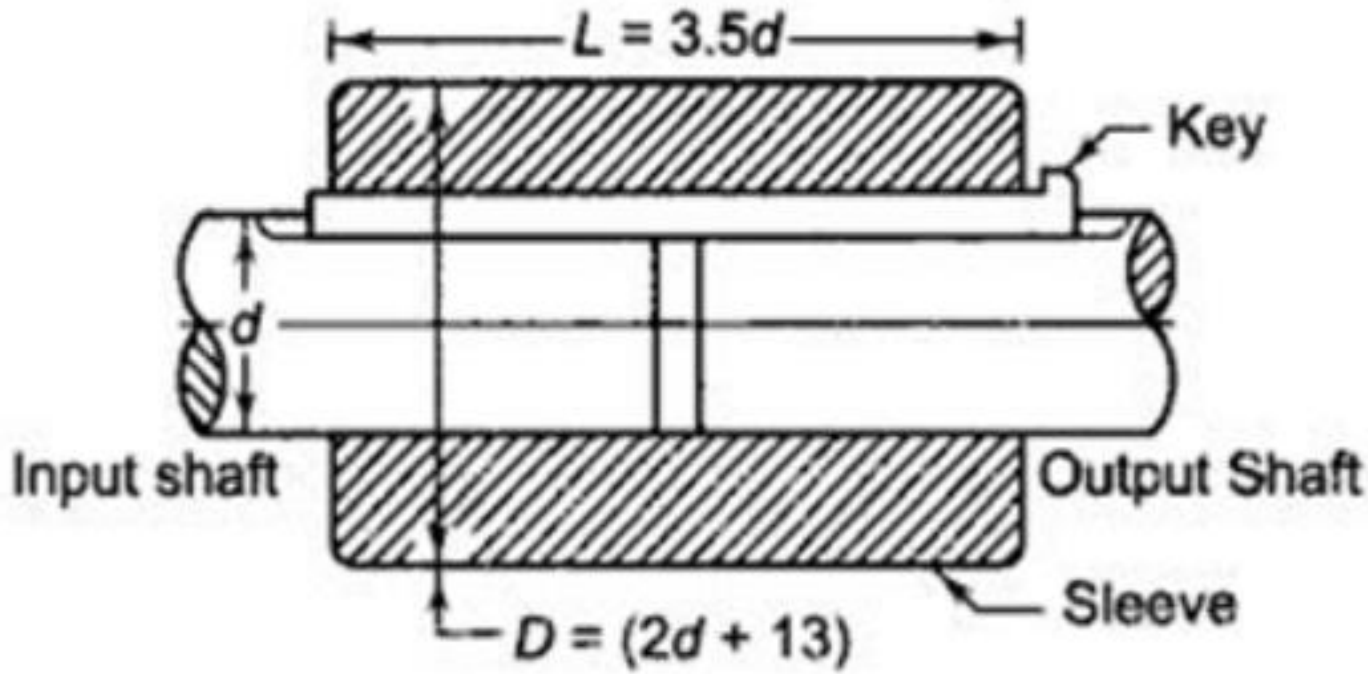


Figure 16.1 Muff Coupling

Sleeve Design

* The following relations are used to calculate the dimensions.

$D = 2d + 13$ $L = 3.5d$

Then the torsional shear stress in the sleeve is checked considering it as a hollow shaft.

Shear stress, $$\tau = \frac{T\,r}{J} \leq [\tau]$$

where, T= Twisting moment (or torque) to be transmitted

J = Polar moment of inertia about the axis of rotation

r = Distance from neutral axis to outer most fibre = D/2

Design of Key

* Cross-section of the key is taken from the table corresponding to the shaft diameter or relations (square key) or (rectangular key)

* The design of key is to find the cross-section, where **w** is width and **h** is the height of the key.

Length of key **l** in each shaft is taken as 1.5 shaft diameter

The keys are then checked in shear and crushing.

Shear stress, $$\tau = \frac{P}{wl} \leq [\tau]$$

Crushing stress, $$\sigma_{crushing} = \frac{P}{l\ h/2} \leq [\sigma_c]$$

Flange Coupling

- Flange coupling consists of two flanges keyed to the shafts.

- The flanges are connected together by means of bolts arranged on a circle concentric to shaft.

- Power is transmitted from driving shaft to flange on driving shaft through key, from flange on driving shaft to the flange on driven shaft through bolts and then to the driven shaft through key again.

- Flange of a protected type flange coupling has three distinct regions – inner hub, flanges and protective circumferential flanges.

- Following standard proportions are used in the design of flange coupling:

Outer diameter of hub, $D = 2\,d$

Pitch circle diameter of bolts, $D_1 = 3\,d$

Outer diameter of flange, $D_2 = 4\,d$

Length of the hub, $L = 1.5\,d$

Thickness of flange, $t_f = 0.5\,d$

Thickness of protective circumferential flange, $t_p = 0.25\,d$

where, **d** is the diameter of shafts to be coupled.

Design of Hub

Shear stress, $\tau = \frac{T\,r}{J} \leq [\tau]$

Where T = Twisting moment (or torque) to be transmitted

J = Polar moment of inertia about the axis of rotation

r = Distance from neutral axis to the outer most fibre = D/2

Design of Flange

If T is the torque to be transmitted, tangential force,

$$F = \frac{T}{d/2}$$

Shear stress,

$$\tau = \frac{F}{\pi D t_f} \leq [\tau]$$

Design of Bolts

Force acting on each bolt,

$$F_b = \frac{T}{n\,D_1/2}$$

where D_1 is the pitch circle diameter of bolts.

Area resisting shear

$$= \frac{\pi}{4} d_c^2$$

where, d_c = core diameter of bolts

Shear stress,

$$\tau = \frac{F_b}{\frac{\pi}{4} d_c^2} \le [\tau]$$

Area under crushing

Crushing stress,

$$\sigma_{crushing} = \frac{F_b}{d_c t_f} \le [\sigma_c]$$