

UNIT - IV

Shaft coupling:- Shaft are usually available up to 7 meter length due to inconvenience in transport. In order to have a greater length it become necessary to join two or more pieces of the shaft by means of a coupling.

Types of shafts coupling:-

1. Rigid coupling:- It is used to connect two shafts which perfectly aligned.

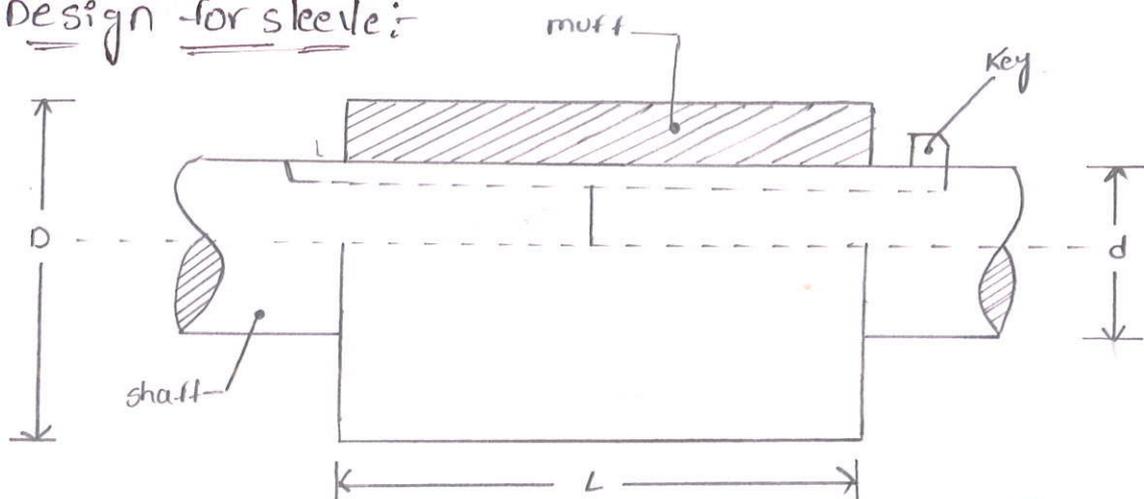
2. flexible coupling:- It is used to connect two shaft having both lateral and angular misalignment.

Sleeve or muff coupling:- It is simplest type of rigid coupling made of cast iron. It consist a hollow cylinder whose inner diameter is the same as that of the shaft.

Outer diameter of sleeve $D = 2d + 13 \text{ mm}$.

length of the sleeve $L = 3.5d$.

Design for sleeve:-



1. Design of muffs and Key:-

The muffs and Key are designed in the similar way as a discussed in muffs coupling.

2. Design of clamping bolts:-

T = Torque transmitted by the shaft.

d = diameter of shaft.

d_b = root (o) effective diameter bolt.

n = no. of bolts.

σ_t = permissible tensile stress for bolt material.

μ = coefficient of friction b/w the muffs and shaft

L = length of muffs.

We know that the force exerted by each bolt

$$= \frac{\pi}{4} (d_b)^2 \sigma_t$$

\therefore force exerted by the bolts on each side of shaft.

$$= \frac{\pi}{4} (d_b)^2 \sigma_t \times \frac{n}{2}$$

Let p be the pressure on the shaft and muffs surface due to force then for uniform pressure distribution over surface.

$$p = \frac{\text{force}}{\text{projected area}} = \frac{\frac{\pi}{4} (d_b)^2 \sigma_t \times \frac{n}{2}}{\frac{1}{2} L \times d}$$

-frictional force between each shaft and nutts.

$$F = \mu \times \text{pressure} \times \text{area} = \mu \times p \times \frac{1}{2} \times \pi d \times L$$

$$= \mu \times \frac{\frac{\pi}{4} (db)^2 \sigma \times \frac{N}{L}}{\frac{1}{2} L + d} \times \frac{1}{2} \pi d \times L$$

$$= \mu \times \frac{\pi}{4} (db)^2 \sigma \times \frac{N}{L} = \mu \times \frac{\pi}{8} (db)^2 \sigma \times n$$

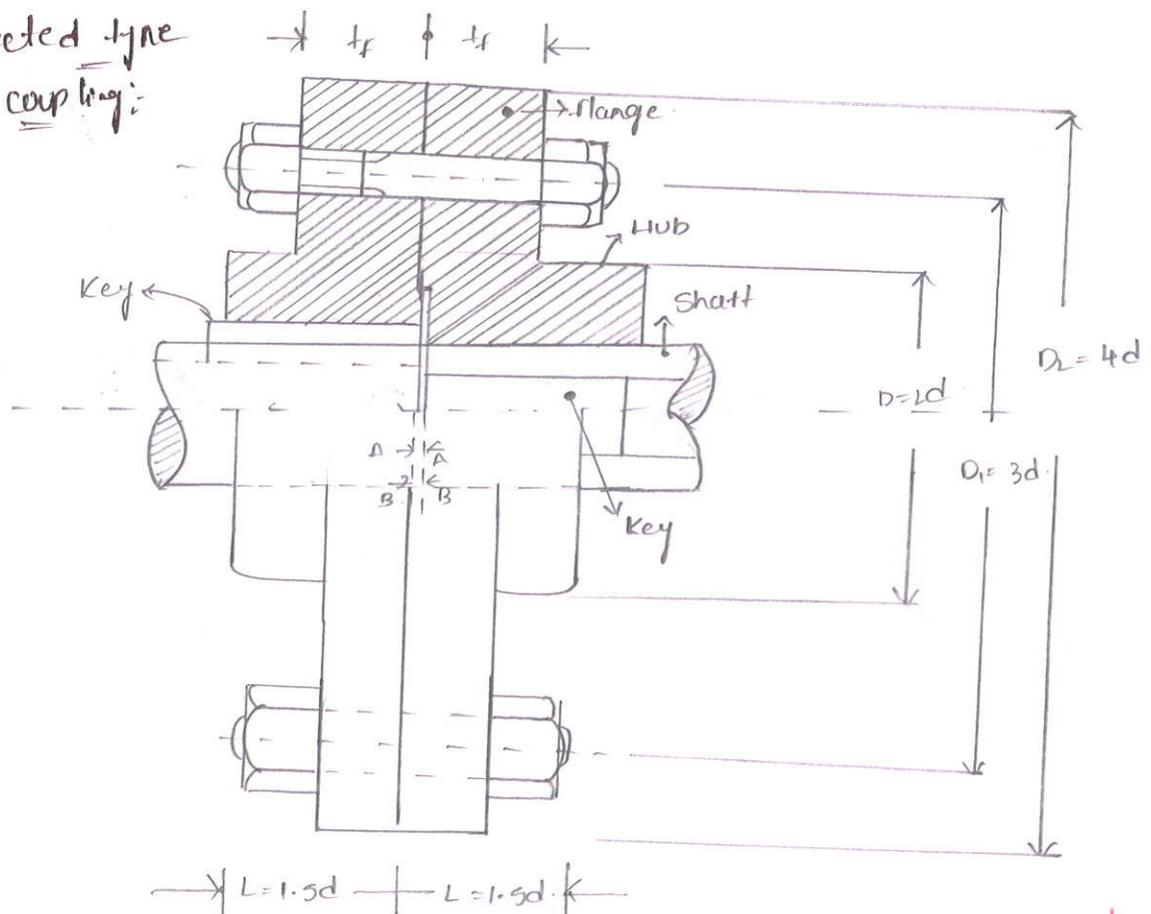
and the torque transmitted by coupling.

$$T = F \times \frac{d}{2} = \mu \times \frac{\pi}{8} (db)^2 \sigma \times n \times \frac{d}{2} = \frac{\pi}{16} \times \mu \times (db)^2 \times n \times d$$

flange coupling:-

A flange coupling usually applies to coupling having two separate cast iron flanges. Each flange mounted on the shaft keyed to it.

1) unprotected type flange coupling:-



length of hub = $L = 1.5d$.

pitch circle diameter bolts = $D_1 = 3d$.

Outside diameter flange = $D_2 = D_1 + (D_1 - D_0) = 2D_1 - D_0 = 4d$.

$t_f = 0.5d$.

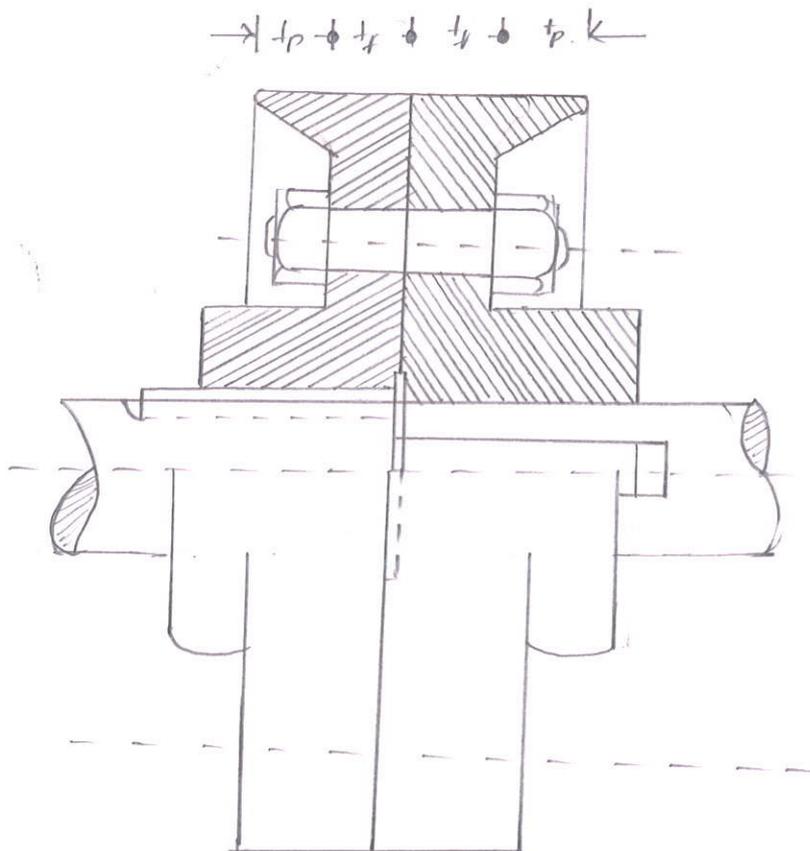
= 3, for d up to 40 mm.

= 4, for d up to 100 mm.

= 6, for d up to 180 mm.

2. protected type flange coupling:-

It protected type flange coupling shown the protruding bolts and nuts protected flanges on the two halves coupling in order to avoid danger to work man.



Marine type flange coupling:-

In marine type flange coupling the flange are forged integral with the shaft. The number of bolt may be chosen from the following table.

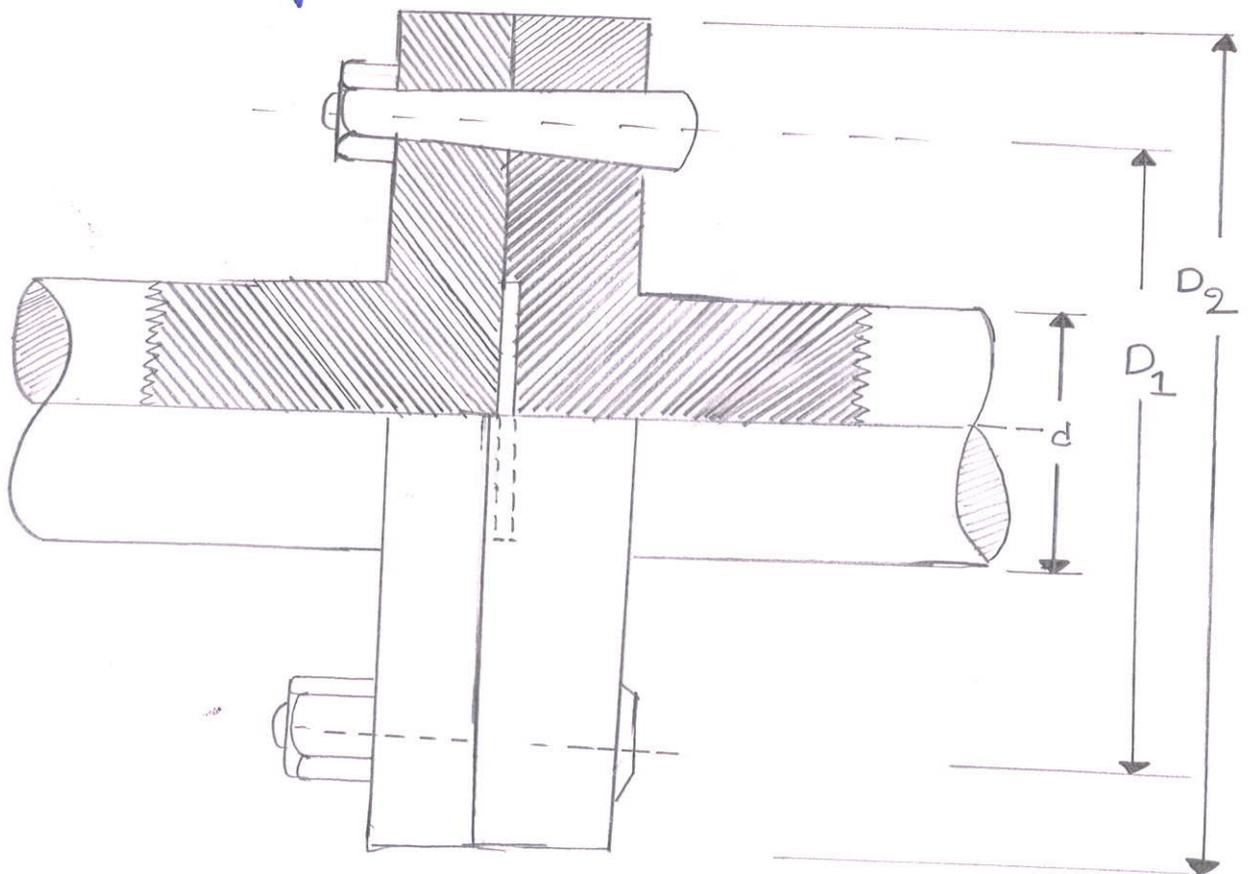
shaft diameter	35 to 55	56 to 150	151 to 230	231 to 390	Above 390
NO. of bolt	4	6	8	10	12

$$\text{Thick of flange} = d/3$$

$$\text{type of bolt} = \text{in } 20 \text{ to } 1 \text{ to } 40.$$

$$\text{pitch circle diameter } D_1 = 1.6d.$$

$$\text{outside diameter flange } D_2 = 2.2d.$$



$T =$ Torque to be transmitted by coupling and.

$\tau_c =$ permissible shear stress for the material of the sleeve which is cast iron.

The safe value of shear stress for cast iron may be taken as 14 MPa.

We know that torque transmitted by hollow section.

$$T = \frac{\pi}{16} \times \tau_c \left[\frac{D^4 - d^4}{D} \right] = \frac{\pi}{16} \times \tau_c \times D^3 (1 - k^4) \quad [\because k = d/D]$$

2. Design of Key's

The Key for the coupling may be designed in the similar way as discussed in Art 13.9. The width and thickness of the coupling key is obtained from the proportions:

$$d = \frac{L}{2} = \frac{3.5d}{2}$$

$$\begin{aligned} T &= d \times w \times l \times \frac{d}{2} \quad (\text{considering shearing of key}) \\ &= d \times \frac{d}{2} \times \tau_c \times \frac{d}{2} \quad (\text{considering crushing of key}) \end{aligned}$$

clamp (or) compression coupling:-

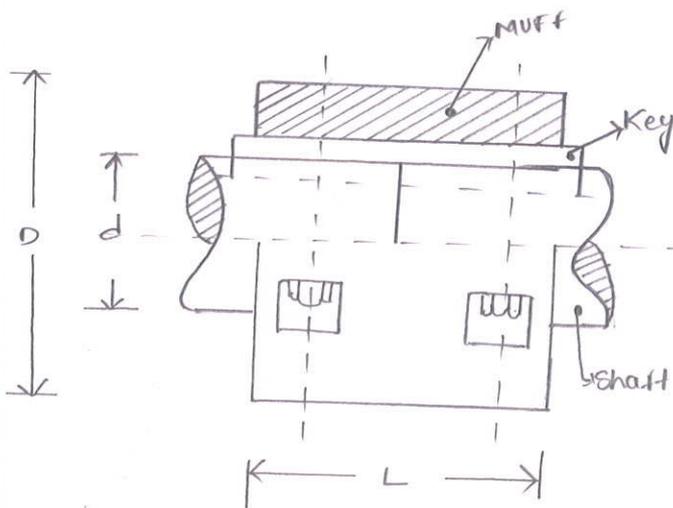
It is also known as split muff coupling. In this case the muffs (or) sleeve is made into two halves and are bolted together. The halves of the muffs are made of cast iron.

The usual proportions of the muffs for the clamp (or) compression coupling are:-

Diameter of the muffs or sleeve $D = 2d + 13\text{mm}$.

length of the muffs (or) sleeve $L = 3.5d$.

d = Diameter of the shaft.



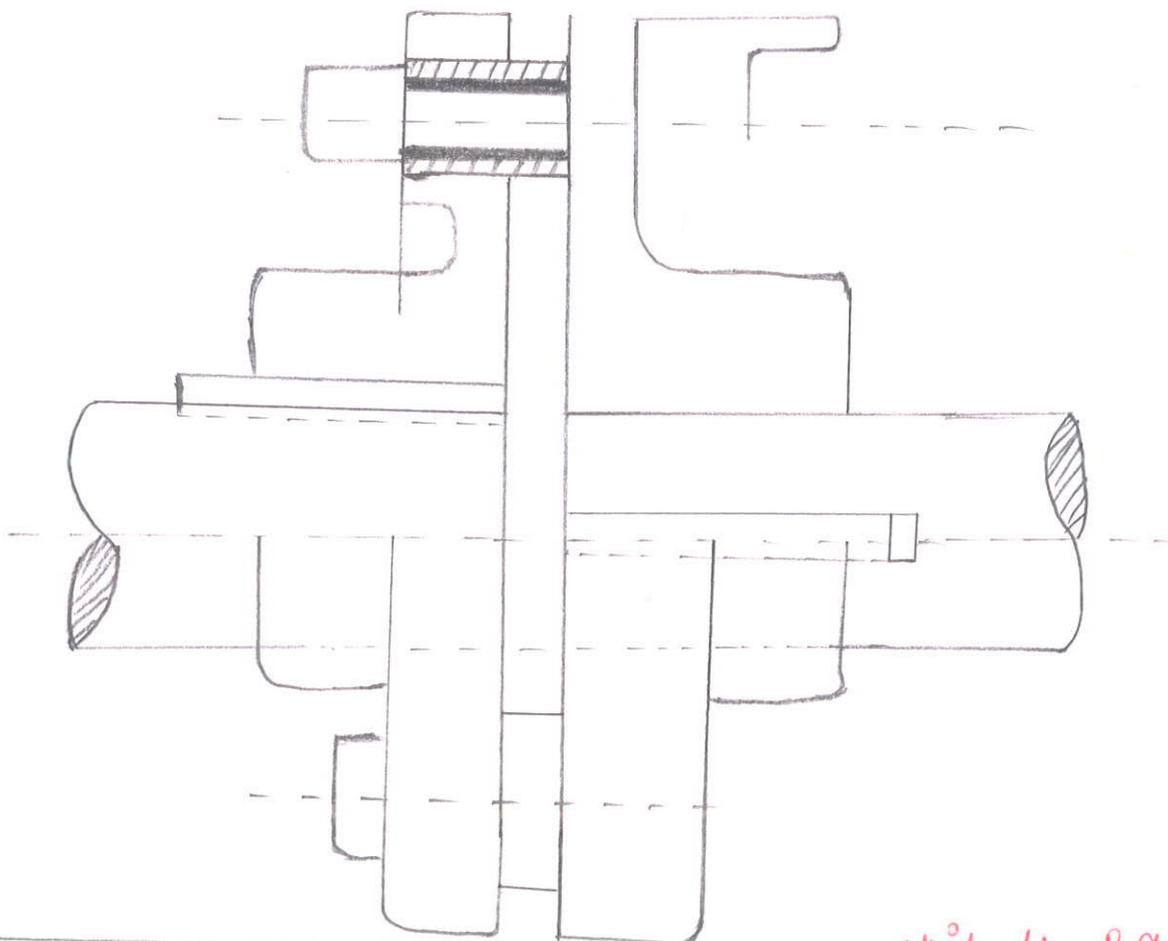
Flexible Coupling:

Flexible Coupling is used to join the abutting ends of shafts when they are not in exact alignment. In the case of direct coupled drive from a prime mover to an electric generator, we should have four bearings at a comparatively close distance.

Following are the different types of flexible Coupling

1. Bushed pin flexible Coupling
2. Oldham's Coupling,
3. Universal Coupling.

* Bushed pin flexible Coupling.



A bushed-pin flexible Coupling is a modification of the rigid type of flange Coupling. The coupling bolts are known as pins. The rubber or leather bushes are used over the pins. Two halves of the Coupling are dissimilar in construction.

l = length of bush in flange coupling.

d_2 = Diameter of bush.

P_b = Bearing pressure on bush.

n = number of pins.

D_1 = Diameter of pitch circle pins.

We know that loading acting each pin,

$$W = P_b \times d_2 \times l.$$

Total bearing load on the bush or pins.

$$= W \times n = P_b \times d_2 \times l \times n.$$

Torque transmitted by the coupling.

$$T = W \times n \left(\frac{D_1}{2} \right) = P_b \times d_2 \times l \times n \left(\frac{D_1}{2} \right).$$

Maximum principal stress

$$= \frac{1}{2} (\sigma + \sqrt{\sigma^2 + 4\tau^2}).$$

Maximum shear stress on the pin

$$= \frac{1}{2} \sqrt{\sigma^2 + 4\tau^2}$$