

Bearings

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Bearing is a machine element which supports another moving machine element known as journal.

* Bearing permits relative motion between contact surface of the members, while carrying the load e.g. shaft and housing with minimum friction.

Function of Bearing :-

- i) Bearing ensures free rotation of the shaft or axle with minimum friction.
- ii) Bearing supports the shaft or axle and hold it in correct position.
- iii) Bearing takes up the forces that act on shaft or axle and transmits them to frame or foundation.

Classification of Bearing :- Bearings are classified in many ways, but following are the important from subject point of view.

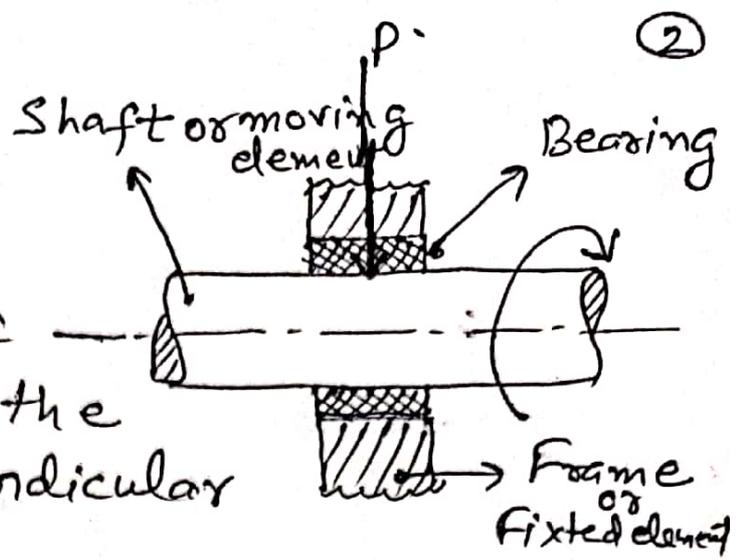
1. Classification upon direction of force or load that act on bearing :-

Bearing under this group are classified as :

- i) Radial Bearing
- ii) Thrust Bearing.

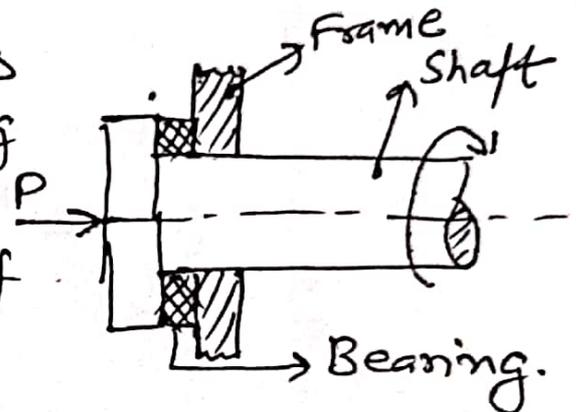
Radial Bearing:-

In radial bearing, the load acts perpendicular to direction of motion of shaft or it supports the load that act perpendicular to axis of shaft.



Thrust Bearing:-

A thrust bearing supports the load, which acts along axis of shaft or the load acts along axis of rotation.

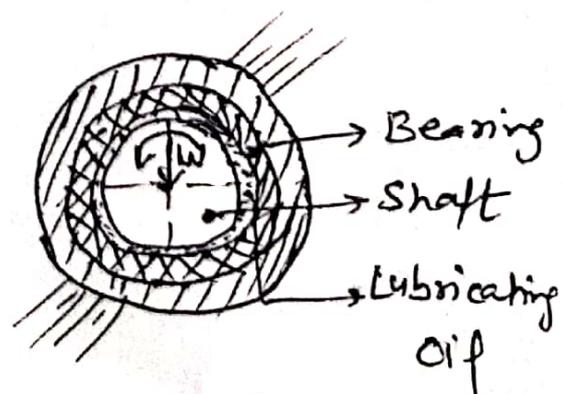
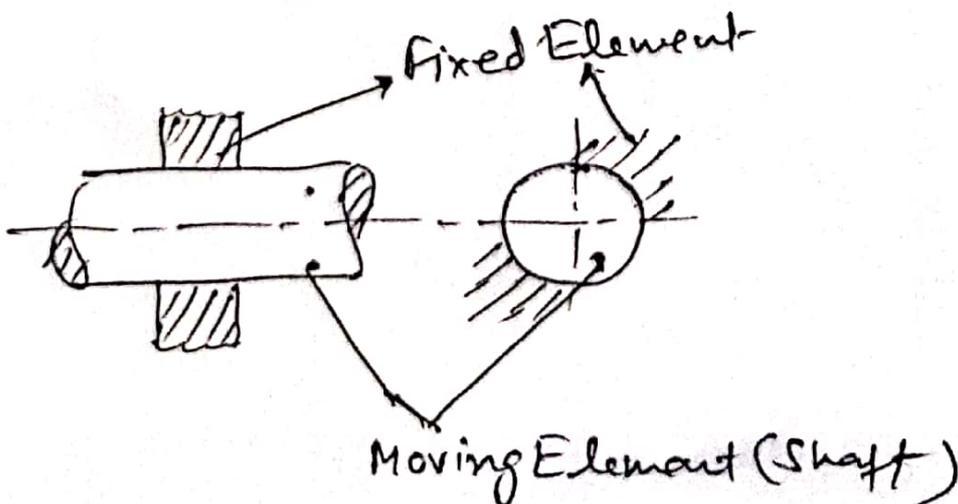


2. Depending upon nature of contact

The bearing under this group are classified as:

- i) sliding contact bearing
- ii) rolling contact bearing.

Sliding Contact Bearing:-



In sliding contact bearing, sliding action takes place along the surface of contact between moving element and fixed element. (3)

* Sliding contact bearings are also known as plain bearing or journal bearing.

⇒ In this case surface of moving element or shaft slides over the surface of bush resulting in friction and wear.

* To reduce friction two surfaces are separated by film of lubricating oil.

Applications.

Sliding contact bearings are used in the following applications.

i) Crank shaft bearing in petrol and diesel engine.

ii) Centrifugal pumps

iii) Large size electric motors

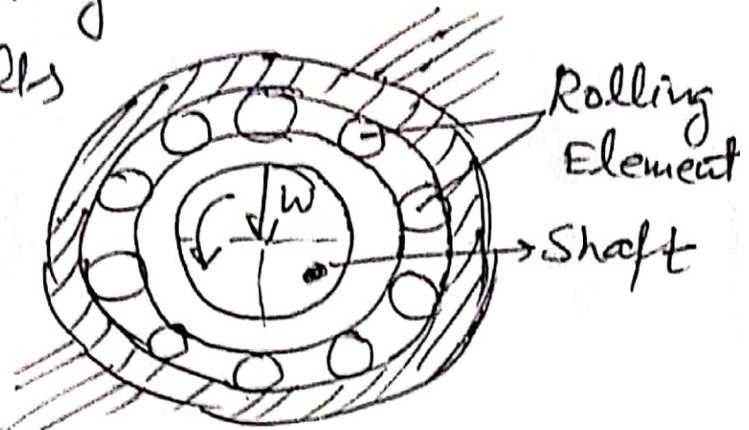
iv) Steam and gas turbines

v) Concrete mixers.

Rolling contact Bearing :-

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In this bearing, rolling elements such as balls or rollers are introduced between surfaces that are in contact or relative motion.



* In this type sliding friction is replaced by rolling friction.

⇒ Rolling contact bearings are also known as anti friction bearings or simply ball bearing.

Applications :- Rolling contact bearings are used in following applications

- i) Machine tool spindle.
- ii) Automobile front and rear axles
- iii) Gear boxes
- iv) Small size electric motors.
eg. fan, coolers etc.

3. On the basis of Lubrication (5)

Sliding contact bearings are classified in following groups

- i) Thick film Bearings
- ii) Thin film Bearings
- iii) Zero film Bearings

Basic Mode of Lubrication

Lubrication :- Lubrication is the science of reducing friction by application of suitable substance known as lubricant between the rubbing surfaces of bodies having relative motion.

* Lubricants are used to reduce friction between rubbing surfaces and to carry away heat generated by friction.

⇒ Lubricants also protect the bearing against corrosion.

* Lubricants are classified into following groups :-

- i) Liquid Lubricant e.g. mineral or vegetable oils
- ii) Semi-Liquid Lubricants e.g. grease
- iii) Solid Lubricant e.g. graphite.

Objective of Lubrication,

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- i) to reduce friction.
- ii) to reduce or prevent wear
- iii) to carry away heat generated due to friction
- iv) to protect the journal and bearing from corrosion.

Basic Modes of Lubrication

There are three basic modes of lubrication

- i) Thick film lubrication
- ii) Thin film lubrication
- iii) Zero film lubrication.

Thick Film Lubrication :-

It describes a condition of lubrication, where two surfaces of the bearing in relative motion are completely separated by a film of fluid.

Thin Film Lubrication :- It describes a condition of lubrication where two working surfaces are partially in contact with each other although a film of lubricant is present between 'two surfaces'.

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Zero film Lubrication: - In this category no lubricant is used or a bearing operates without any film of lubricant.

⇒ Thick film lubrication is further divided into two categories.

- i) Hydrodynamic Lubrication
ii) Hydrostatic Lubrication
- } will be discussed later.

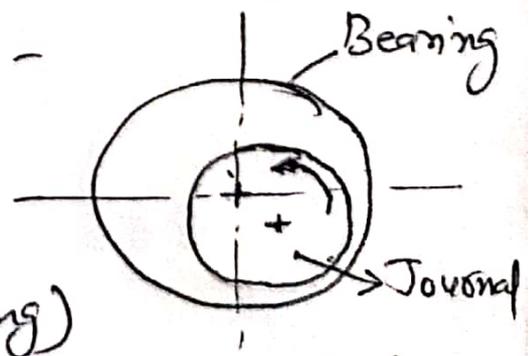
Types of sliding contact bearing

Sliding contact bearing or journal bearing works on the principle of hydrodynamic lubrication and supports radial load.

* On the basis of rotation of journal with respect to bearing, there are two types of journal bearing.

1. Full Journal Bearing: -

In this type, the angle of rotation or angle of contact of bearing (bushing)



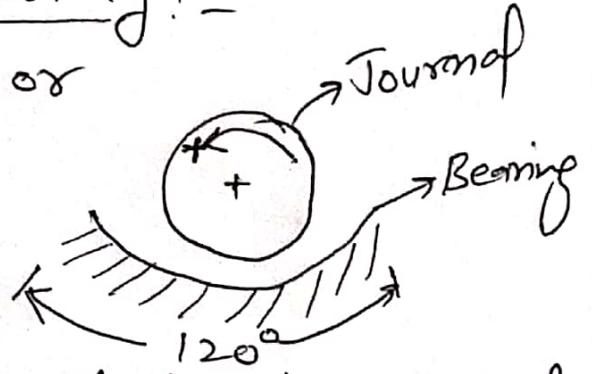
with the journal is 360° as shown in figure.

- * This bearing takes load in any radial direction.
- * Most bearings used in industrial applications are full journal bearing.

2. Partial Journal Bearing: -

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When angle of rotation or angle of contact of bearing with the journal is less than 180° , then bearing is said to be partial journal bearing.



- * Most of partial journal bearings have 120° angle of contact.
- * This type of bearing has less friction than full journal bearing.
- * Partial journal bearing can take loads in one radial direction only.
- * Most common application of this bearing is found in railroad car axle.

ii) On the basis of size of journal and bearing, there are two types of journal bearing.

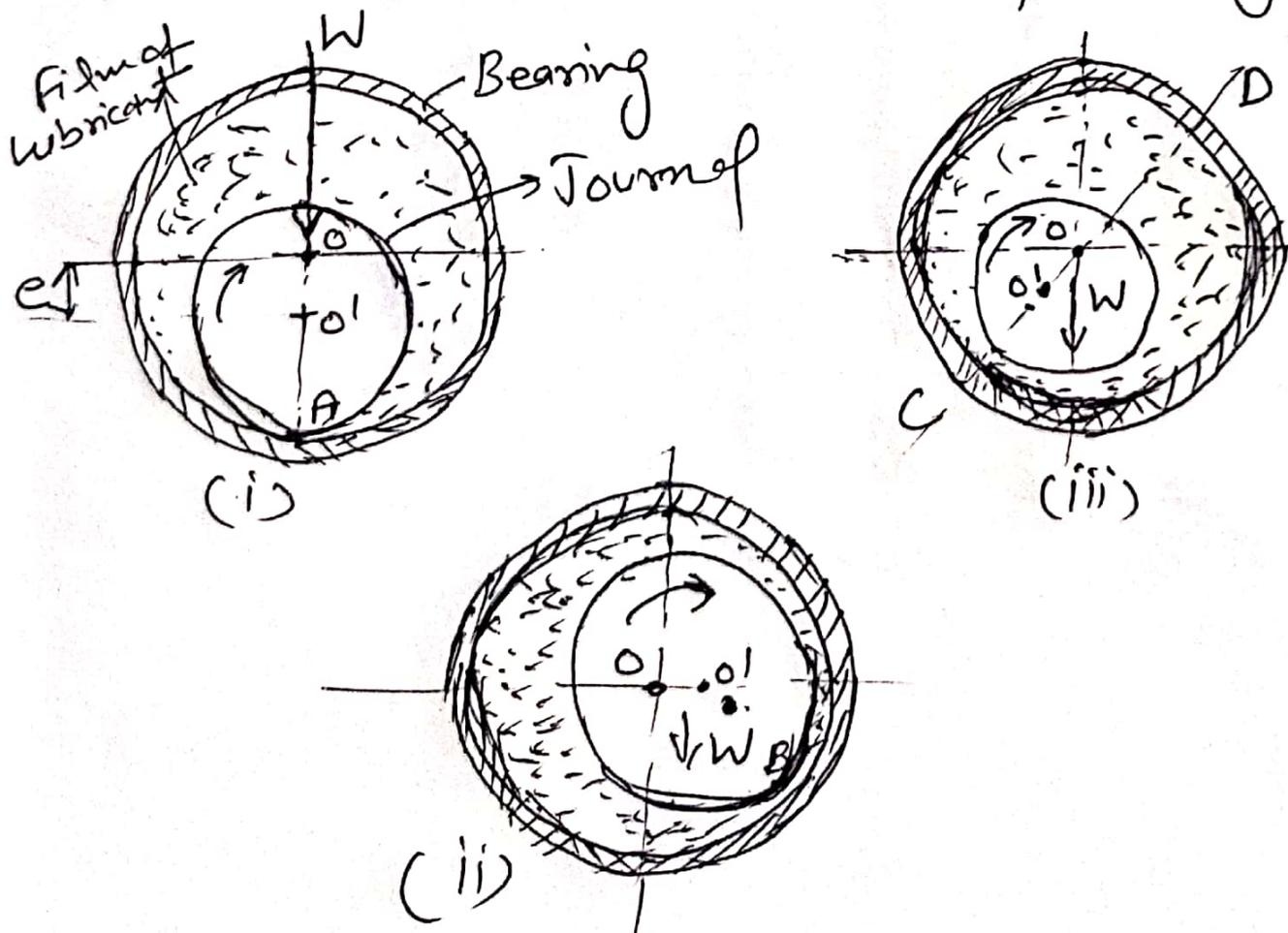
a) Clearance Bearing: - A clearance bearing is a bearing in which diameter of journal is less than diameter of bearing, i.e. there is a clearance space between journal and bearing, e.g. full and partial journal bearing,

b.) Fitted Bearing: - It is a bearing in which diameter of journal is equal to diameter of bearing i.e. there is no space between journal and bearing.

Hydrodynamic Lubrication: - It is defined as a system of lubrication in which the load supporting fluid film is created by the shape and relative motion of the sliding surfaces.

Principle of Hydrodynamic Lubrication: -

The principle of hydrodynamic lubrication is shown in following figures



i) Initially the journal or shaft is ⁽¹⁰⁾ at rest at A. Under the action of load W, it sinks to the bottom of clearance space i.e. there is metal to metal contact at this stage between journal and bearing (Fig-i)

ii) As the journal starts to rotate, it moves to bearing surface B and separated by a thin film of lubricant (figure-ii)

iii) As the speed of journal is further increased, a continuous fluid film is established. The centre of journal has moved so that, minimum film thickness is at C (fig-iii)

* From D to C in the direction of motion, it is noted that, the film is continuously narrowing. This curved shaped film is considered as Wedge-shaped film.

⇒ Due to motion of journal more & more fluid is forced into the wedge-shaped clearance space. Due to this, pressure is generated within the system.

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* As the pressure is created within the system, due to rotation of the shaft, this type of bearing is also known as self-acting bearing.

⇒ The pressure generated in the clearance space supports the external load (W)

* In this case it is not necessary to supply the lubricant under pressure and only requirement is sufficient and continuous supply of the lubricant.

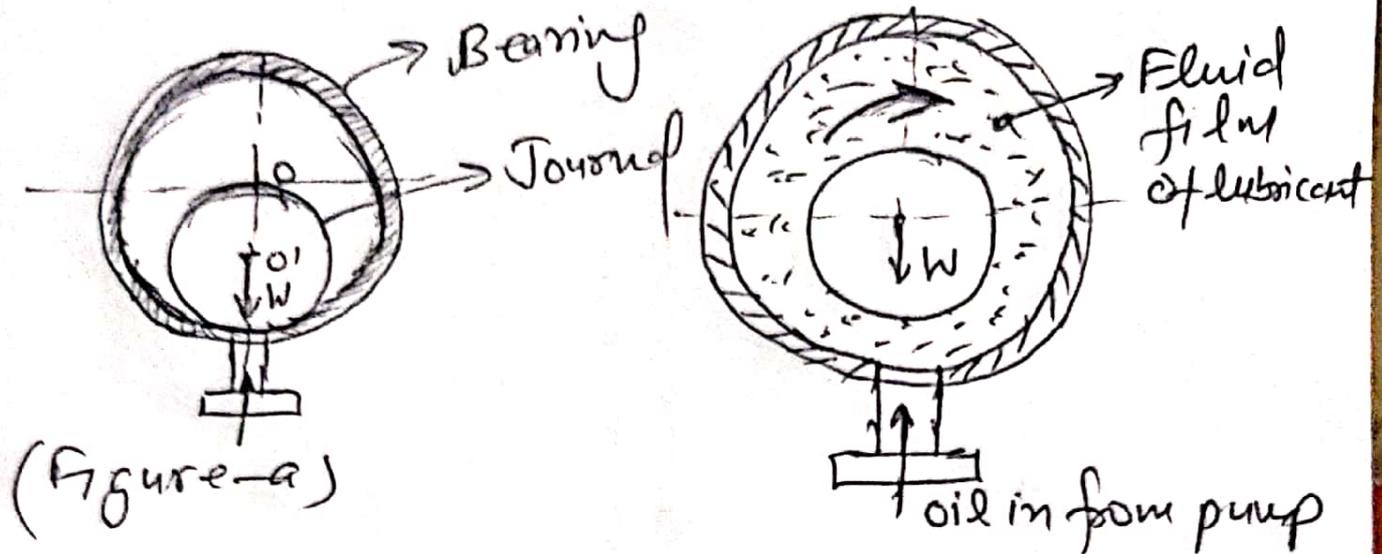
Hydrostatic Lubrication

It is defined as a system of lubrication in which load supporting fluid film, separating the two contact surfaces is created by an external source e.g. a pump, supplying sufficient lubricant under pressure.

* Since the lubricant is supplied under pressure, this type of bearing is called externally pressurised bearing.

Principle of Hydrostatic Bearing

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Initially, the shaft or journal is at rest on bearing surface due to action of load (W).

* As the pump starts, high pressure fluid of lubricant is admitted in the clearance space, forcing the two surfaces of bearing and journal to separate out.

* Thus pressure required to support load (W) is created with the help of an external source like pump.

⇒ These bearings are used in vertical turbo-generators, ball mills etc.