UNIT-V Design of Bearings & Miscellaneous Elements

Session -1

**Objective:** To introduce the Bearings and its elements

www.ahrinternational.com/**introduction\_to\_bearings**.htm‎

**Recap**: Recall the shafts and its purposes

**PPT and Board Explanation**

**BEARINGS:**

A bearing is a machine element which supports another moving machine element. It permits a relative motion between the contact surfaces of the members while carrying the load. Due to the relative motion between the surfaces a certain amount of power is wasted in overcoming frictional resistance and if the rubbing surfaces are indirect contact there will be rapid wear. In order to reduce frictional resistance and wear resistance in some cases to cases carry away the heat generated a layer of fluid may be provided.

**TYPES OF BEARINGS:**

Depend upon the nature of contact

**(i) Sliding contact bearing**

The sliding takes place along the surfaces of contact between the moving element and fixed element

**(ii) Rolling contact bearing**

The steel balls or rollers are interposed between the moving and fixed element. The balls offer rolling friction at the two points for each ball or roller.

**Material should have the following properties.**

* High compressive strength
* Low coefficient of friction
* High thermal conductivity
* High resistance to corrosion
* Sufficient fatigue strength
* It should be soft with a low modulus of elasticity
* Bearing materials should not get weld easily to the journal material.

**i) Lead base contains:**

* It contains Lead-74%, Antimony- 15%, Tin- 1%, Arsenic-O. 5% and Cu-O.25%.
* It has excellent resistance to seizure and has good corrosion resistance its Compressive strength and hardness decrease rapidly with an increase in temperature.
* Therefore it should not be used above 1150.
* It is used for split bushings made from strip or gravity cast bearings.

**ii) Tin base habit:**

* It contains Tin-89%, Antimony-7.5% and Copper-3.25%.
* It is slightly harder than lead habit at room temperature. It has excellent anti-series Deformability and acid-resisting properties.
* It is also used for split bushings.

**(iii) Leaded bronze:**

* The compositions and use of leaded bronze are as follows.
* Cu 80% Tin 10%, Lead-l0% it used for split bushings made 4
* From strip or gravity cast bears. 4
* These are having excellent Fatigue life and are capable of Carrying heavy loads at high Temperatures.
* Cu-72%, Tin-3%, Lead-23% Use for split bushings and hail’
* Beings made from strip or Gravity cast bearings.

**(iv) Copper lead alloy:**

* The compositions and uses of copper lead alloy are as follows. Cu-65%, Lead 35% -
* Use for split bushings and half Bearings made from strip or Gravity cast bearings
* Cu-71%, Lead-28%, Silver-l% Used for gravity cast bearings these are having excellent fatigue life and capable of carrying
* Heavy leads at high temperatures.
* But they are having poor erosion resistance compared to Habit

**(v) Gun metal:**

* Its composition is as follows.
* Copper-88%, Tin-l0%, Zinc-2%.
* It is used for high-grade bearings subjected to high pressure and high speeds.

(**vi) Phosphor bronze:**

* Superior fatigue resistance.

**(V) Plastics:**

* Composition is Copper-80%, Tin- 10%, Lcad-9%, Phosphores- 1%. It is used for bearings subjected to very high pressures and speeds.

**(vii) Cast Iron:**

* It is used with steel journals. It should be provided with adequate lubricant.
* It is used for low pressure and low speed bearings.

**(viii) Aluminum alloy:**

* Its composition is Al-92%, Cu-l%, Tin-6%, Ni-1%
* It is used for cast or forged solid construction.
* It has better fatigue resistance but poor surface behavior.

**(ix) Silver:**

* The usual form of construction is electro- plated bearing used with lead-tin or lead indium overlay.
* It has excellent corrosion resistance and
* The common commercial plastics used for bearings are Nylon and Teflon.
* These may be used as zero film bearings.
* These have high fatigue strength, hardness and more resistant to abrasive wear.

**Conclusion &Summary:** Recall the shaft mounting with bearing and its types

Session -2

**Objective:** To introduce sliding contact bearings

 To design sliding contact bearings

nptel.iitm.ac.in/courses/IIT-MADRAS/Machine\_**Design**\_II/.../5\_1.pdf‎

**Recap:** Recall the bearings and its types

**JOURNAL BEARING: Board Explanation**

A sliding contact bearing that supports a load in a radial direction is known as journal bearing. It consists of two main parts, a shaft and a hollow cylinder. The portion of the shaft inside the hollow cylinder also known as bearing is called as journal. In most applications the journal rotates while the bearing is stationary. However there are some applications where the journal is stationary and the bearing rotates and even somewhere both the journal and bearing rotates. This journal bearing may be classified as full journal bearing and partial journal bearing depending upon whether the journal is fully or partially covered by bearing.

**TERMS USED IN HYDRODYNAMIC JOURNAL BEARING**

1. **Diameter clearance:**

It the different between the diameter of journal and the bearing. c= D-d

1. **Radial clearance:**

It is the different between the radial of the bearing and the journal. c1=R-r=D-d/2

1. **Diameteral clearance ratio**:

 It is the ratio of the diameteral clearance to the diameter of the Journal.

=c/d= (D-d)/d

1. **Eccentricity:**

It is the radial distance between the center of the bearing and the displaced center of the bearing under load.

1. **Minimum oil film thickness:**

It is the minimum distance between the bearing and the journal under complete lubrication condition. It is denoted by ho and occurs at the line of centers. Bearing

A journal bearing is a sliding contact bearing which gives lateral support to the rotating shaft.

It consists of two main parts,

* A journal is that part of the shaft which runs in a sleeve or bushing.
* A hollow cylinder i.e. Sleeve is at rest.

In journal bearing, the diameter of the journal is kept less than the diameter of the bearing to allow the flow of lubricant between the surfaces

**Design steps:**

**Step 1:** Calculate the diameter of journal from given power. Use the following equations



Where,

T — Torque to be transmitted

P — Power to be transmitted

**Step 2:** Select a suitable value of — ratio. Determine the length of the D, L Bearing and the bearing pressure by using the table given in PSGDB 7.31.

**Step 3:** Calculate the bearing pressure by Using p = Check this Pressure with the allowable value given in the table of PSGDB page 7.31. If it is not within the limit, select suitable value of ratio. D

**Step 4:** Select the clearance and find out clearance ratio £by using the Table given in PSGDB

page 7.32 D

**Step 5:** Select suitable oil and its viscosity at operating temperature, Zn Which is preferably within 60° to 75°C.

**Step 6:** Calculate the bearing characteristic number. It should be P Greater than the minimum value given in PSGDB 7.31.

**Step 7:** Determine the Somerfield number and therefore the minimum Film thickness from fig. In PSGDB 7.40 otherwise use tables given in PSGDB 7.36 to 7.39

**Step 8:** Calculate the co-efficient of friction using Petroff’ s equation or Mckee’ s equation.

**Step 9:** Determine the heat generated (Hg) and heat dissipated (Hd).The generated heat is more than the dissipated heat, provide artificial Cooling arrangements.

**Conclusion &Summary:** Conclude the session by recalling the various steps on design process.

Session -3

**Objective:** To introduce rolling contact bearings

 To design rolling contact bearings

 nptel.iitm.ac.in/courses/Webcourse.../Machine%20**design**1/.../mod14les2...

**Recap:** Recall the bearings and its types

**ROLLING CONTACT BEARING Board Explanation**

The advent of automobiles and many high speed machineries make very much use another type of bearings known as rolling contact bearings. The friction produced in these bearing is very low. These bearings also called as antifriction bearings. They differ from sliding contact bearings in their structure and usage.

**COMPONENTS OF ROLLING CONTACT BEARINGS**

The rolling bearing consists of four main components (1) the inner ring, (2) outer ring, (3) the balls or rollers, (4) the retainers or separators. The inner ring is forced to fitted with machine shaft and outer ring is fitted with machine housing. The shaft rotates because of relative rotations of balls or rollers. The retainers is used to prevent the balls or rollers from ejecting out during operation.

**CLASSIFICATION OF ROLLING CONTACT BEARINGS**

The rolling contact bearings are classified into two major groups with respect to their structure

(1) Ball bearings

(2) Roller bearings

Basically the structure of ball bearings are similar expect that whether the rolling element between the inner ring and outer ring are balls or rollers. Also these ball bearings are many types such as deep grove ball bearings, angular contact bal bearings and so on. Both type of bearing can carry radial loads and axial loads acted individually or in combined form. Generally the ball bearings are used for light loads and the roller bearings are usually used for heavier loads. Also in the case of ball bearings the nature of contact is the point contact hence the friction produced is very less compared to roller bearings where the nature of contact is the line contact which produce more friction.



Figure 5.1 Types of radial ball bearing

**SELECTION OF BEARINGS FOR STEADY LOADING**

The size of bearing required is judged by the magnitude and nature of applied load, life and reliability. The bearing load is composed of weights involved forces derived from power transmitted and additional force based on method of operation

C- basic dynamic load rating

L- life of bearing in million revolutions

L10- life of bearing for 90% survival at 1 million revolutions

P- Equivalent load

k- Exponent (3 for ball bearing, 10/3 for roller bearings) P= (XFr+YFa) S

Fr- radial load

Fa- axial load

X- Radial load factor Y- axial load factor S- service factor

**Conclusion &Summary:** Conclude the session by recalling the various steps on design process.

Session -4

**Objective:** To design sliding contact bearing

Tutorial Problem: **Board Presentation**

 From university question bank solve simple problems on sliding contact bearing

**Conclusion &Summary**: Recall the session by summarizing the design procedure

Session -5

**Objective:** To design rolling contact bearing

Simple Problem: **Board Presentation**

 From university question bank solve simple problems on rolling contact bearing

**Conclusion &Summary**: Recall the session by summarizing the design procedure

Session -6

**Objective:** To design sliding contact bearing

Simple Problem: **Board Presentation**

Calculation of Heat generation and Heat dissipation

**Conclusion &Summary**: Recall the session by summarizing the calculation procedure

Session -7

**Objective:** To design sliding contact bearing

Simple Problem: **Board Presentation**

Calculation of Heat generation and Heat dissipation and select appropriate lubrication oil

**Conclusion &Summary**: Recall the session by summarizing the design procedure

Session -8

**Objective:** To improve problem solving skill

Tutorial Problem: **Board Presentation**

 From university question bank solve simple problems on sliding contact bearing and rolling contact bearing

**Conclusion &Summary**: Recall the session by summarizing the design procedure

Session -9

**Objective:** To solve simple problems with Mackees equation

 www.exlar.com/Engineering%20Stuff/59\_66.pdf

Simple Problem: **Board Presentation**

 From university question bank solve simple problems on sliding contact bearing

**Conclusion &Summary**: Recall the session by summarizing the design procedure

Session -10

**Objective:** To design connecting rod

**INTRODUCTION PPT & Board Presentation**

The connecting rod is an intermediate link between the piston and the crankshaft of an I.C. engine. It transmits force from the piston to the crankshaft. It also carries the lubricating oil from the crank pin end to the piston pin end and provides lubrication to the piston cylinder assembly. The connecting rod converts the reciprocating motion of the piston to rotary motion of the crankshaft. The main parts of the Connecting rod of an I.C. engine are shown in fig.



It has (i) An eye at the small end to acconunt date piston pin bearing

(ii) A long shank usually of I-section and

(iii)A big end opening, which is usually split to take the crank pin bearing shells. The length of the connecting rod is usually kept 3 to 4.5 times the crank radius.

The materials for connecting rod ranges from mild or medium carbon steels to alloy steels. In industrial engines, carbon steel with ultimate tensile strength 550 to 670N/mm2 is used. In transport engines, alloy steel having strength of about 780 to 940N/mm2 is used. Manganese steel. In aero engines, nickel chrome steel having ulti1i1al tensile strength of about 940 to 135 N/mm2 is used. Connecting rods are mostly manufactured by drop forging.

**Conclusion &Summary**: Recall the session by summarizing the connecting rod and its material

Session -11

**Objective:** To stresses induced on connecting rod

**STRESSES IN CONNECTING ROD**  **PPT & Board Presentation**

A connecting rod is subjected to alternating tension and compression, the compressive stress being much greater than tensile stress and is therefore mainly designed as a strut. The stresses in the connecting rod are set up by a combination of forces. The various for acting on the connecting rod are

* The combined effects of gas pressure on the piston and the Inertia of the reciprocating parts.
* Inertia of the connecting rod.
* Friction of the piston rings and of the piston.
* The friction of the two-end bearings.

Simple Problem:

Design simple problem on connecting rod.

Session -12

**Objective:** To improve problem solving skill

Tutorial Problem: **Board Presentation**

 From university question bank solve simple problems on sliding connecting rod

**Conclusion &Summary**: Recall the session by summarizing the design procedure