



Anti-Friction Bearing Fundamentals

An Online Continuing Education Course for Engineers

Course Number: M-1062

Credit: 1 Hours / 1 PDH / 1 CPD

Anti-Friction Bearings Course

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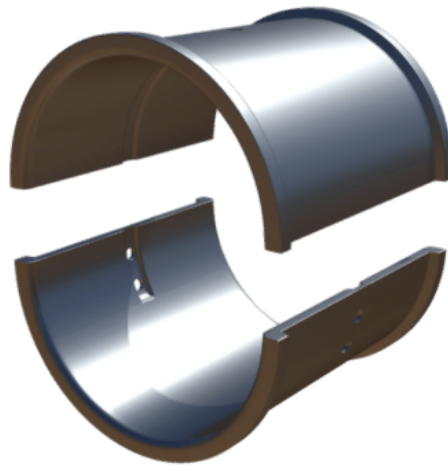
Introduction

Bearings allow humans to move an object on or within another object. Their main purpose is to extract the desired motion from a whole motion. For example, a pump shaft that passes through a pump housing should rotate, but the housing should not. Almost all machines operate with some form of rotating, sliding, or oscillating motion; where this occurs, bearings are used.

There are **two** main categories of bearing: **plain** and **anti-friction (rolling)**. Both bearing designs have found widespread application throughout the engineering world, but no single bearing design can cater to all applications. As can be seen in the below images, the two types of bearing are not even slightly similar. **This course focuses on anti-friction bearings only.**



Anti-Friction Bearing



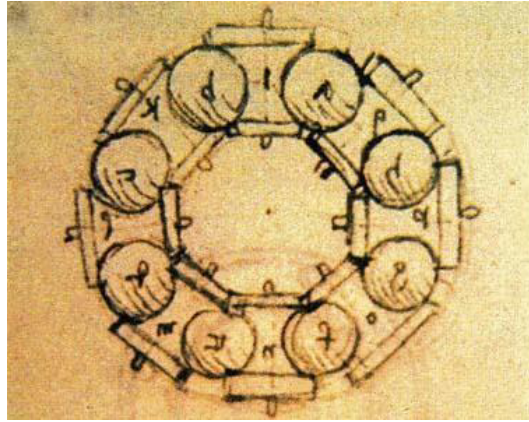
Plain Bearing

History

Bearings date back to the age of antiquity and have existed in various forms over the past several thousand years. The earliest recorded plain bearing design (very basic) originates from Egyptian times, while the oldest recovered rolling element bearing design dates to 40 BC.

Leonardo da Vinci drew concepts of the modern-day ball bearing in circa. 1500 and Galileo developed this design still further in the 1700s. It was not until 1740 that John Harrison invented a practical caged roller bearing, and it would be a further 54 years until Philip Vaughan patented the first modern ball bearing design (1794).

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Leonardo da Vinci's Ball Bearing

The Industrial Revolution in the 1800s saw a massive increase in the design and application of bearings. As the applications of bearings grew, so did the range of materials they were constructed from. Bearings were constructed from sapphire, wood, ceramic, metal, and glass (to name a few materials). Some of the largest bearing companies in existence were founded during this period; these include **FAG** (1883), **Timken** (1898) and **SKF** (1907).

Many additional advances in bearing technology have continued over the past 100 years, although most developments have refined existing bearing designs rather than created entirely new ones.

Bearing Functions

All bearings have **three** main functions:

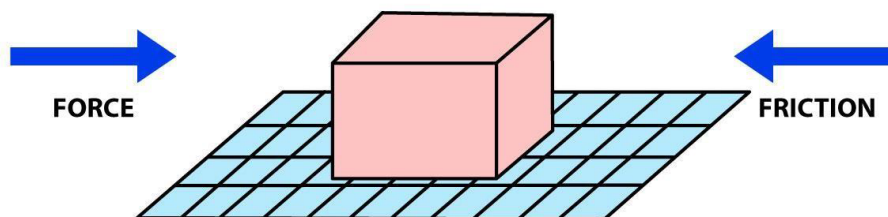
- **Reduce Friction**
- **Carry Load**
- **Guide Parts**

This section of the course discusses each of these topics in greater detail.

Friction

Friction is the resistance to movement between two or more bodies. Friction has several forms, but the most relevant concerning bearings are **static**, **sliding** and **rolling** friction. Note that sliding and rolling friction are also sometimes referred to as **dynamic** forms of friction.

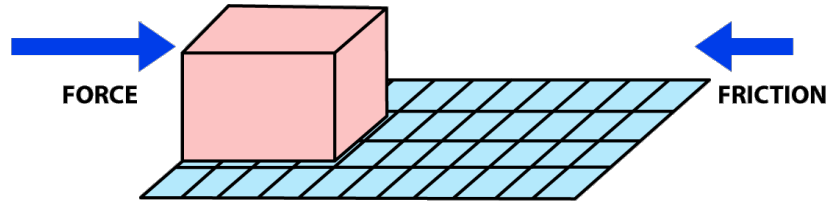
Static friction – friction between two (or more) solid bodies that are **not** moving relative to each other. Any force applied to a body must overcome static friction before it begins to move. For example, a box placed stationary on a table will not move unless the force applied exceeds static friction.



Static Friction Holding a Box Stationary

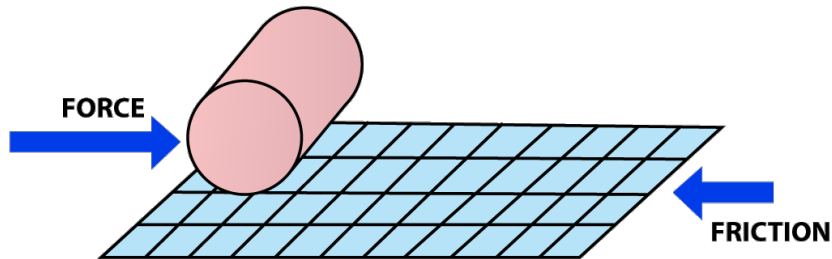
Sliding friction – friction between two bodies that are moving relative to each other and in contact with each other. For example, a box being sild across a table. Sliding friction is also known as **dynamic** or **kinetic** friction.

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Sliding Friction (box slides left to right)

Rolling friction – friction between two bodies when one rolls across another. For example, when a car wheel rolls across a road. Rolling friction is usually less than sliding friction.

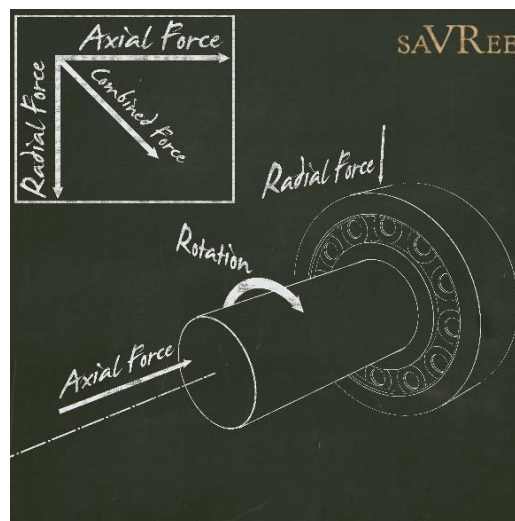


Rolling Friction (roller slides left to right)

Plain bearings operate on the principle of sliding friction while rolling (anti-friction) bearings operate on the principle of rolling friction. The coefficient of friction associated with rolling bearings is usually lower than that of plain bearings.

Loads

Bearings are expected to carry loads during their working life. Loads may be **axial**, **radial**, or **combined**. Bearings must be selected based on the loads and service conditions they are likely to encounter. Incorrect sizing and selection of a bearing may lead to bearing failure.



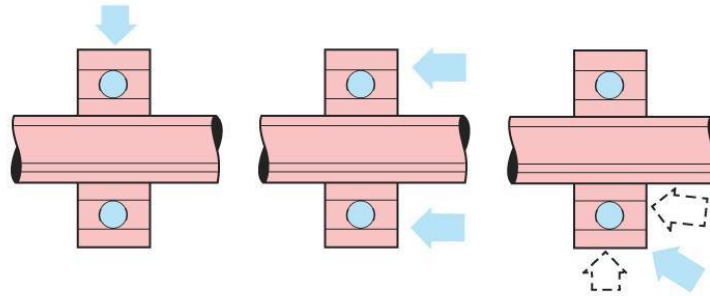
Bearing Loads

Axial loads – loads that are applied **parallel** to the shaft; sometimes called **thrust** loads.

Radial loads – loads that are applied **perpendicular** (90 degrees) to the shaft.

Combination loads – loads that are a **combination of both axial and radial loads**, sometimes referred to as **angular loads**.

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Radial, Axial, and Combination Loads

Bearings are designed to cater to specific load conditions. For example, **deep groove ball bearings** can carry moderate to heavy radial loads and some axial loads, which makes them suitable for many applications. The deep groove ball bearing is the most common anti-friction bearing in use today.



Deep Groove Ball Bearing (exploded view)

Guide Parts

Guiding of parts usually refers to machinery components having a sliding or reciprocating motion. A bearing by nature guides parts because it **confines unwanted motion and allows desirable motion**. For example, it is desirable that motion is transmitted to the wheels of a car so that they rotate, but it is not desirable that this motion be transferred to the engine casing.

Bearing Lubrication

All anti-friction bearings require some form of **lubrication**. The most common forms of lubrication are **liquid lubricants** (mineral oil, etc.) and **grease** (lubricant mixed with a thickening agent). Appropriate lubricants will:

- **Reduce friction**, which **reduces heat and wear**.
- **Protect** bearing surfaces from **corrosion** and **foreign particle contamination**.
- **Dissipate heat**.

Typical **anti-friction-bearing lubricants** include mineral oil, various greases, animal fats, and vegetable-based oils (to name a few).

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Lubricant Types (mineral oil, synthetic, animal, plant)

Mineral oil-based lubricants are by far the most popular lubricants because they are cheap and versatile.



Mineral Oil Lubrication

Synthetic lubricants generally cost much more than mineral oil-based lubricants and are not as common.

Animal fat-based lubricants are not viable for many applications due to their low availability compared to other lubricant types. An additional problem with animal fats is that some religions do not allow for the use of certain animal fats e.g. swine/pig fat.

Plant/vegetable oils are used in some applications, but they are more expensive, increasing production costs. The largest advantage of plant/vegetable oils is that they are biodegradable.

Components

The subject of anti-friction bearings is the subject of this course. The table below lists the components of an anti-friction bearing. The table below lists the components of an anti-friction bearing. The table below lists the components of an anti-friction bearing.

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

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