ME 314 - Engineering Design : Mechanical Components
Lecture 20

Note Title

Chapter 11. Bearings and Lubrication

The word "bearing", applied in the context of machine elements, refers to contacting surfaces through which a load is transmitted.

The simplest possible bearings are unlubricated sliding bearings (also called plain bearings)- like the wooden cart wheels mounted directly on wooden axles in ancient times. Later, to get longer life and lower friction, lubricants were added.

In modern machinery using sliding bearings, oil or grease is used in common low-speed applications (lawn mower wheels, garden carts, children's tricycles) as well as in higher-speed applications (engine crankshafts).

In low-speed applications, the lubricant does not completely separate the surfaces, while the bearings in high-speed applications receive hydrodynamic lubrication during normal operation; that is, the oil film completely separates the surfaces (minimum oil film thickness is 0.0003 to 0.0008 in or 0.008 to 0.020 mm and the coefficient of friction is 0.002 to 0.010).

Sliding (or plain) bearings are of two types:

> **(1) Journal or sleeve bearings, which are cylindrical and support radial loads (i.e., loads that are perpendicular to the shaft axis); and**
>
> **(2) Thrust bearings which are generally flat and, in the case of a rotating shaft, support loads in the direction of the shaft axis.**

In this course, we will focus on another category of bearings for which rolling rather than sliding is the main mechanism. Their properties and selection are topics of Sections 11.8-11.11.

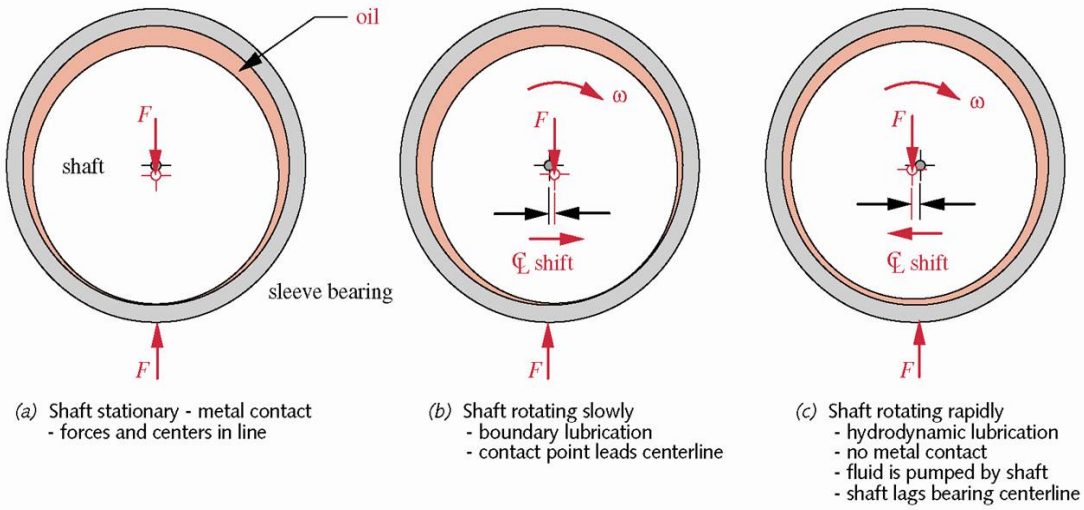


Figure 10-3

Boundary and Hydrodynamic Lubrication Conditions in a Sleeve Bearing—Clearance and Motions Exaggerated.

11.8 Rolling-Element Bearings (REB)

Alternatively, in roller-element bearings, the shaft and outer members are separated by balls or rollers, and thus rolling friction is substituted for sliding friction.

While sliding bearings are typically custom designed for the application, rolling-element bearings are typically selected from manufacturers' catalogs to suit the loads speeds, and desired life of the particular application.

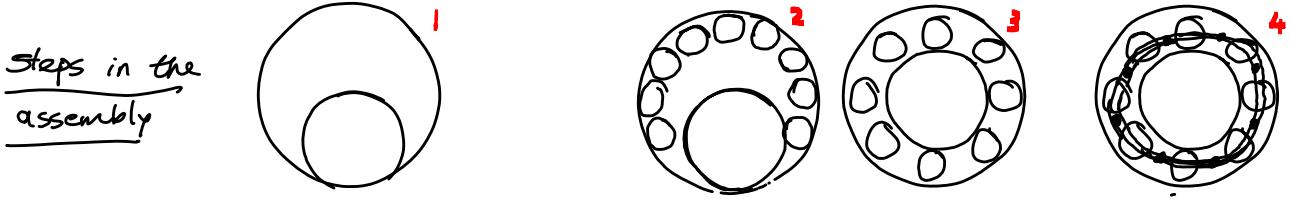
Rolling-element bearings can support radial, thrust, or combination of these loads depending on their design.

Materials: Ball bearings are commonly made of a hardened high carbon chromium steel, e.g., AISI 5210 steel. Roller bearings are often made from case-hardened AISI 3310, 4620, and 8620 steel alloys.

Manufacturing: All major bearing manufacturers worldwide make bearings according to standard dimensions specified by the Anti-Friction Bearing Manufacturers Association (AFBMA) and/or the International Standards Organization (ISO).

The AFBMA standards for bearing design discussed here and in text have been adopted by the American National Standards Institute (ANSI). Specifically, bearing life calculations are based on ANSI/AFBMA Standard 9-1990 for ball bearings and Standard 11-1990 for roller bearing. These standards also define tolerance classes for bearings.

Remark: Rolling-element bearings are also known as "antifriction" bearings. This is somewhat of a misnomer because these bearings do not, in all cases, provide lower friction than fluid-film bearings.



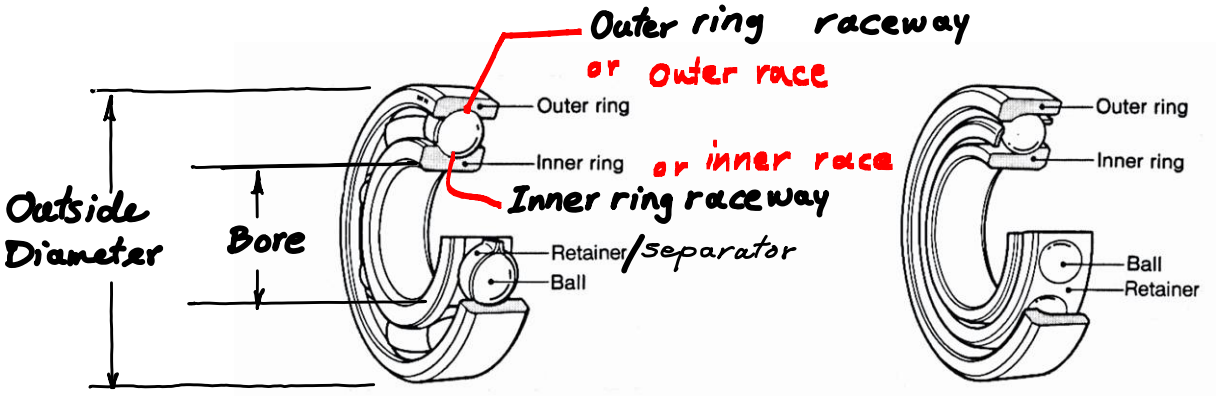
Types of Rolling-Element Bearings

REBs are divided into two broad categories:

1) Ball bearings which are suitable for small, high-speed applications. For applications with radial and heavy thrust loads at high speeds, deep-grooved ball bearings are best.

2) Roller bearings which are preferred for large, heavily-loaded systems. In particular, tapered roller bearings can handle heavy loads in both radial and thrust directions at moderate speeds.

Various types of roller bearings are shown in Figs 11-17 thru 11-20.



(*a*) Deep-groove (Conrad) ball bearing (*b*) Angular-contact ball bearing

Figure 10-17

Ball Bearings. *Courtesy of NTN Corporation.*

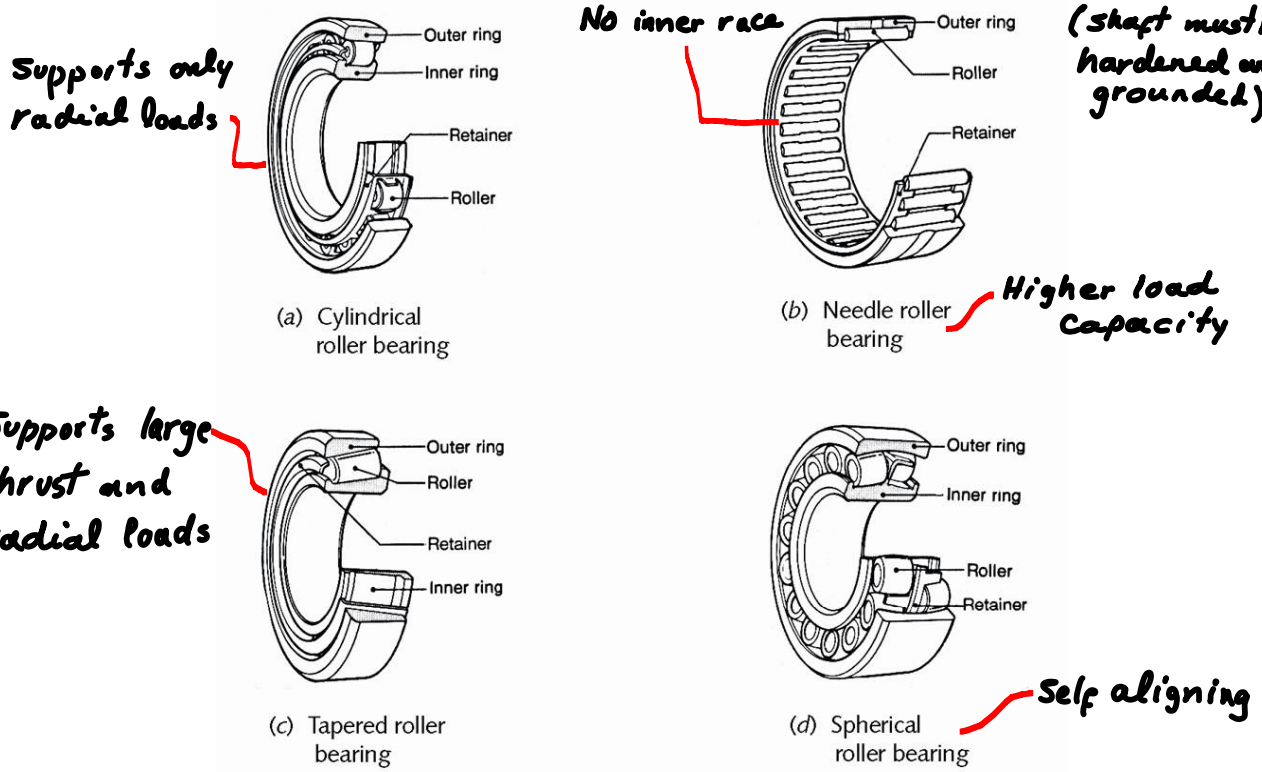


Figure 10-18

Roller-Type Bearings *Courtesy of NTN Corporation.*

Can support larger static and dynamic (shock) loads than ball bearings because of their line contact.

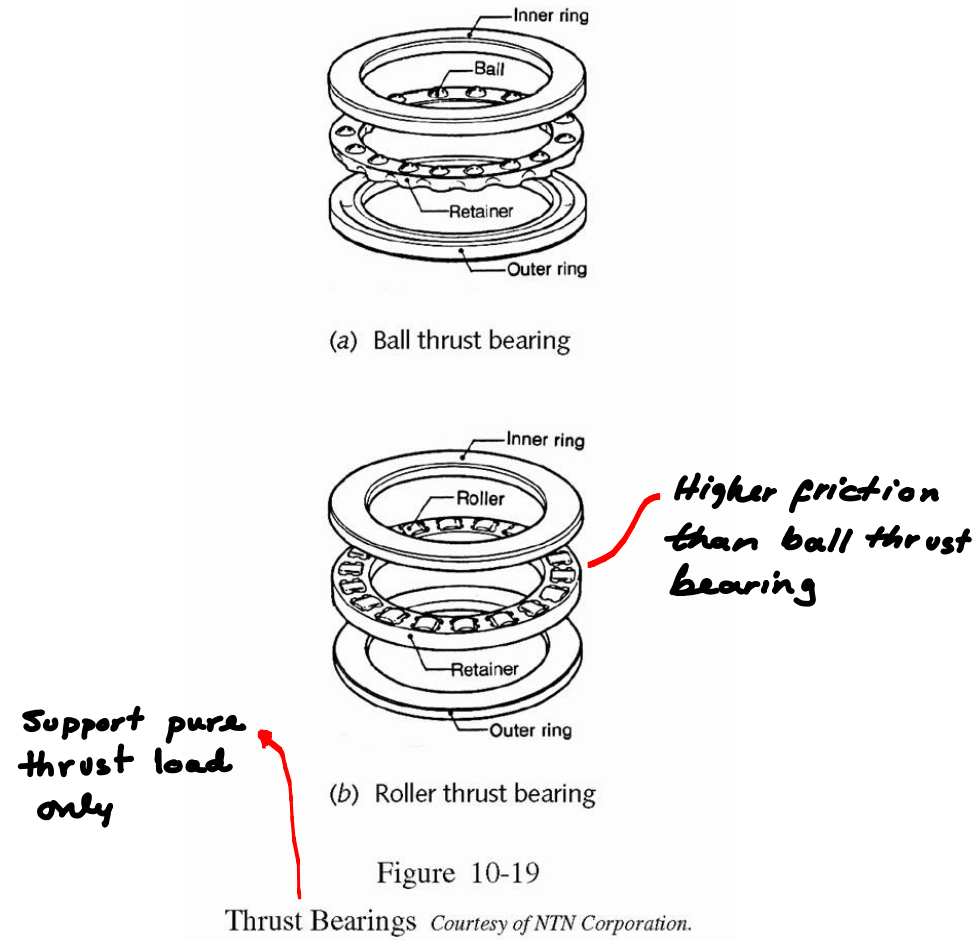


Figure 10-19

Thrust Bearings *Courtesy of NTN Corporation.*

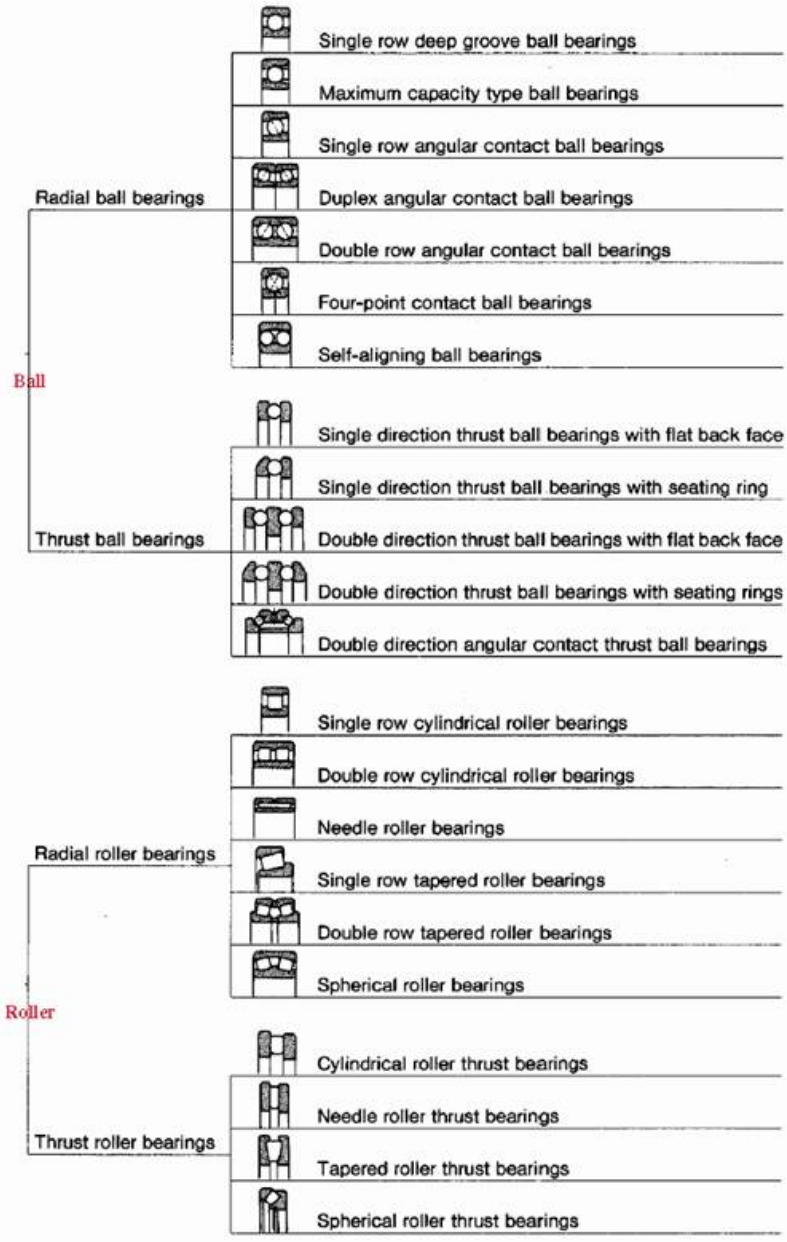


Figure 10-20

Classification of Rolling-Element Bearings *Courtesy of NTN Corporation.*