Bearing Fundamentals
AGENDA

• Basic Bearing Design
• Ball Bearings
• Cylindrical Roller Bearings (CRB)
• Spherical Roller Bearings (SRB)
• Tapered Roller Bearings (TRB)
Basic Bearing Design

- Friction Bearings

- Anti-Friction Bearings
  - Ball
  - Cylindrical Roller
  - Tapered Roller
  - Spherical Roller
Through Hardened:
- Typically 52100 steel
- Same hardness throughout
- Standard CRB’s, SRB’s, and Ball Bearings are TH but can be made CC

Case Carburized:
- Typically low carbon, high alloy steel
- Better shock load resistance
BASIC BEARING DESIGN – HEAT TREAT

• Case Carburized Vs Through Hardened
**Basic Bearing Design – Cages**

**Functions:**
- Separates rollers to prevent inter-roller rubbing
- Retains and guides the rollers
- Noise damping
- Increases space for lubricant
**Basic Bearing Design – Cages**

- **Pressed Steel**
- **Machined Brass**
- **Pin Type**
BASIC BEARING DESIGN - ENHANCEMENTS

- Profiles
- Heat Treat Processes
- Materials
BASIC BEARING DESIGN - ENHANCEMENTS

• Surface Treatments

• Coatings

• Cage Modifications
Basic Bearing Design – Rolling Elements

- Ball
- Cylindrical roller
- Needle roller
- Tapered roller
- Symmetrical barrel roller
- Asymmetrical barrel roller
## Basic Bearing Design – Performance Summary

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Tapered Roller Bearing</th>
<th>Thrust Tapered Roller Bearing</th>
<th>Cylindrical Roller Bearing</th>
<th>Thrust Cylindrical Roller Bearing</th>
<th>Spherical Roller Bearing</th>
<th>Thrust Spherical Roller Bearing</th>
<th>Ball Bearing</th>
<th>Thrust Ball Bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Radial Load</td>
<td>Excellent</td>
<td>Unsuitable</td>
<td>Excellent</td>
<td>Unsuitable</td>
<td>Excellent</td>
<td>Unsuitable</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Pure Axial Load</td>
<td>Good</td>
<td>Excellent</td>
<td>Fair</td>
<td>Unsuitable</td>
<td>Good</td>
<td>Unsuitable</td>
<td>Fair</td>
<td>Excellent</td>
</tr>
<tr>
<td>Combined Load</td>
<td>Excellent</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Moment Load</td>
<td>Fair</td>
<td>Poor</td>
<td>Unsuitable</td>
<td>Unsuitable</td>
<td>Unsuitable</td>
<td>Unsuitable</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>High Stiffness</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Quiet Running</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Poor</td>
<td>Fair</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Low Friction</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Misalignment</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Unsuitable</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Locating Position</td>
<td>Excellent</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>(Fixed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Locating Position</td>
<td>Good</td>
<td>Unsuitable</td>
<td>Excellent</td>
<td>Unsuitable</td>
<td>Fair</td>
<td>Unsuitable</td>
<td>Good</td>
<td>Unsuitable</td>
</tr>
<tr>
<td>(Floating)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

*Note: The table compares different bearing types based on various characteristics and their performance ratings.*
BALL BEARINGS

Characteristics
- Dynamic misalignment
  - 0.006 radians
  - Moderate rigidity/Medium shaft deflection
- Highest-speed bearings
- Low torque
- Non-adjustable

Load Carrying Ability
- Point contact
- Poor static load ability
CYLINDRICAL ROLLER BEARINGS

Characteristics
- Dynamic misalignment
  - 0.0005 radians
  - Moderate rigidity/medium shaft deflection
- Moderately high-speed
- Low torque
- Non-adjustable
- Separable races provides easier installation, allows floating

Load Carrying Ability
- Good for heavy radial loads
- Poor choice for thrust load applications

Length: Diameter ratio of rollers < 4:1
Cylindrical EMA Bearing

- Expanded offering, enhanced performance
  - Offering beginning at 60 mm bore
  - Designed for general applications
  - Continue expanding offering and availability

- Single piece, land riding machined brass cage for harsh environments
- Special surface finishes for lower operating temperature and longer life
- Optimized internal geometries for higher load capacity and longer design life
SPHERICAL ROLLER BEARINGS

Characteristics

- Dynamic misalignment
  - 0.05 radians
  - Low rigidity/high shaft deflection
- Operate at moderate speeds
- Higher torque
- Non-adjustable
- Large cross section/Narrow profile

Load Carrying Ability

- Good for heavy radial loads
- Poor choice for thrust load applications
**NEW HIGH PERFORMANCE SRB < 200 mm BORE**

- Industry leading life and operating temperature performance on steel and brass cage designs

- Optimized geometry and finish - increased capacity and longer life

- Hardened above pitch cage for rigidity and longer design life

- Slotted cage - reduced weight and improved lube flow purge contaminants and reduce operating temperature
TAPERED ROLLER BEARINGS

Characteristics

• Dynamic misalignment
  • 0.0005 radians
  • High rigidity/low shaft deflection
• Wide range of speeds
• Low torque, True Rolling Motion
• Adjustable

Load Carrying Ability

• High load carrying capability
• Able to handle radial and axial loads
• Excellent in combination loading
TAPERED ROLLER BEARINGS

- The only “adjustable” bearing
  - Adjust clearance between races and rollers
  - Maximizes machine performance and extends bearing life

Radial

Axial

Clearance in adjustable bearings is measured axially
TAPERED ROLLER BEARINGS

• Axial and thrust loads combine to create seating force
• Keeps rollers perfectly aligned
• Line contact – high load carrying
• Efficient true rolling motion, low / no slip
TRB Ratings Increase

• TRB ratings increase from 2% to 28% depending on geometry and finish of the series.

• The increase is based on:
  
  • TRBs have consistently out-performed our fatigue life predictions in life testing during the past 10 years.
  
  • We have continuously improved our manufacturing processes and design standards over the past 25 years.
  
  • We have consistent products, processes, and quality globally.
  
  • Adjustment factors did not capture the increase in performance due to manufacturing process improvements.
SUMMARY

• Each bearing type has unique features offering advantages that must be matched to application needs
Questions?