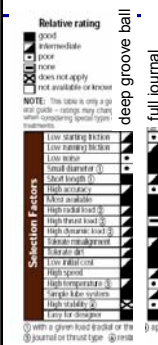


Rolling-Element Bearings

- ❖ Types
 - » Ball Bearings
 - » Roller Bearings
- ❖ Selection of rolling-element bearings

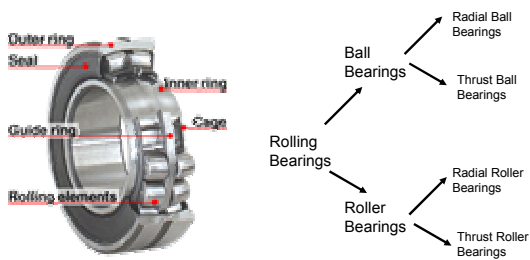
Comparing Rolling to Journal



- ❖ Rolling Bearing are better because:
 - » low starting and good operating friction
 - » radial and thrust loads
 - » no self-excited instabilities
 - » less space axially
 - » can seal lubricant in bearing
- ❖ Journal Bearings are better because:
 - » fatigue failure not a problem
 - » less space radially
 - » less noise
 - » more tolerant to misalignment
 - » less expensive, except for oiling system
 - » less operating friction

pg. 654 in Norton

Rolling-Element Bearings



Which one to choose? → Next page

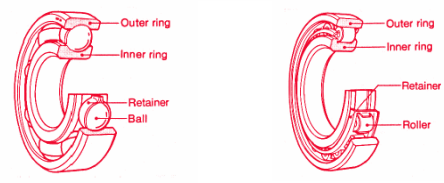
| Selection Factors | Bearing Types | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------|---------------|----|----|----|--------|----|----|----|---------|----|----|----|--------|----|------|----|----|----|-----|-----|-----|----------|--------|---|
| | Ball | | | | Roller | | | | Journal | | | | Thrust | | Ext. | | | | | | | | | |
| | 2a | 2b | 2c | 2d | 2f | 3a | 3b | 3c | 3d | 3e | 3f | 8a | 8b | 8c | 8d | 8e | 8f | 2a | 12a | 12c | 12d | press. e | G as e | |
| Low starting friction | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Low running friction | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Low noise | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Small diameter a | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Short length a | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High accuracy | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Most available | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High radial load b | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High thrust load b | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High dynamic load b | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Tolerance to misalignment | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Tolerate dirt | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Low initial cost | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High speed | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High temperature c | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Simple lube system | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| High reliability d | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Easy for designer | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |

Reprinted From: "Design Data" Teague & Dunn, Machine Elements
See http://www.engineersedge.com/bearing_application.htm

Ball Bearings vs Roller Bearings

Ball Bearings versus Roller Bearings

| Ball | Roller |
|--------------|----------------------------|
| High speed | Higher radial load support |
| Axial thrust | Usually seperable |



A) Ball Bearings

- ❖ good for smaller sizes, lighter loads

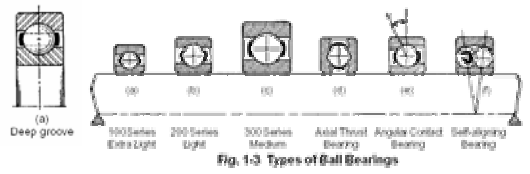
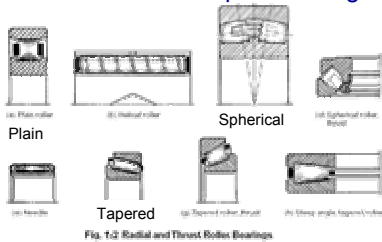


Fig. 1-3 Types of Ball Bearings

B) Roller Bearings

- good for larger sizes, heavier loads
- handle shock and impact loading well



Rolling Element Comparisons

Figure 10-21, Pg. 658 in Norton

| TYPE | SIZE RANGE IN INCHES | AVERAGE RELATIVE RATINGS | | | | Remarks: Lubrication, Maintenance |
|-------------------------|----------------------|--------------------------|--------|-------------------|-------------|-----------------------------------|
| | | Capacity | Radial | Thrust | Speed | |
| CORROD TYPE | 1/16 to 1/2 | Good | Fair | Good to Excellent | to 1000 rpm | to 1000 rpm |
| | 1/2 to 1 1/2 | Good | Fair | Good to Excellent | to 1000 rpm | |
| MAXIMUM TYPE | 1/16 to 1/2 | Excellent | Poor | Good | to 1000 rpm | to 1000 rpm |
| | 1/2 to 1 1/2 | Excellent | Poor | Good | to 1000 rpm | |
| ANGULAR CONTACT 15°-40° | 1/16 to 1/2 | Good | Good | Good | to 1000 rpm | to 1000 rpm |
| | 1/2 to 1 1/2 | Good | Good | Good | to 1000 rpm | |
| ANGULAR CONTACT 30° | 1/16 to 1/2 | Excellent | Good | Good | to 1000 rpm | to 1000 rpm |
| | 1/2 to 1 1/2 | Excellent | Good | Good | to 1000 rpm | |
| DELT. ALIGNING | 1/16 to 1/2 | Good | Fair | Good | to 1000 rpm | to 1000 rpm |
| 1/2 to 1 1/2 | Good | Fair | Good | to 1000 rpm | | |

Selection of Rolling Element Bearings

Once a bearing type suited to the application is chosen, selection of appropriate-size bearing depends on the magnitude of loads and the desired fatigue life.

Basic Dynamic Load Rating (C):

Ball Bearings $\implies L = \left(\frac{C}{P}\right)^3$

Roller Bearings $\implies L = \left(\frac{C}{P}\right)^{10/3}$

L = Expected bearing life (expressed in millions of revolutions)

C = Dynamic load rating (Capacity)

P = Constant applied load

see Figure 10-23 for Ball Bearings, pp. 662

Basic Static Load Rating (C₀):

see Figure 10-23, pp. 662 for Ball Bearings

Selection of Rolling Element Bearings

Combined Radial and Thrust Loads:

$$P = XVF_r + YF_a$$

$$\text{If } \frac{F_a}{VF_r} \leq e \implies X = 1 \text{ and } Y = 0$$

X=Radial factor (see Figure 10-24)

Y=Thrust factor (see Figure 10-24)

V=Rotation factor (see Figure 10-24)

F_r=Radial load

F_a=Axial Load

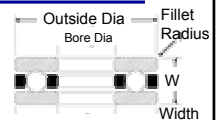
e = minimum ratio between axial and radial loads (see Figure 10-24)

Rolling Element Analysis

- Calculate P
- Specify the number of cycles
- Calculate C
- Choose a bearing from the manufacturer's catalog based on C, C₀

Bearing Selection

Ex: Figure 10-23
Dimensions and Load Ratings for 6300 Series Ball Bearings (FAG Bearings Corp.)



| BEARING NUMBER | BOUNDARY DIMENSIONS | | | | SNAP RING DIMENSIONS | | | MAX. FILLET RADIUS R _{max} | APPROX. WEIGHT W | % C | DYNAMIC LOAD RATING C | STATIC LOAD RATING C ₀ | | |
|----------------|---------------------|----------|-------|--------|----------------------|-------|------|-------------------------------------|------------------|------|-----------------------|-----------------------------------|------|------|
| | BORE | O. DIAM. | WIDTH | | H | S | E | | | | | | | |
| 6300 | 10 | 32.07 | 35 | 1.3780 | 11 | 4.331 | 1.25 | 1.562 | 0.44 | .025 | .13 | 22000 | 1400 | 850 |
| | 12 | 47.24 | 37 | 1.4567 | 12 | 4.728 | 1.25 | 1.625 | 0.44 | .040 | .15 | 20000 | 1700 | 1040 |
| | 15 | 59.06 | 42 | 1.6535 | 13 | 5.118 | 1.25 | 1.821 | 0.44 | .040 | .20 | 18000 | 1930 | 1200 |
| 6303 | 17 | 66.93 | 47 | 1.8504 | 14 | 5.512 | 1.41 | 2.074 | 0.44 | .040 | .25 | 16000 | 2320 | 1460 |
| | 20 | 78.74 | 52 | 2.0472 | 15 | 5.906 | 1.41 | 2.276 | 0.44 | .040 | .34 | 14000 | 3000 | 1930 |
| | 25 | 98.43 | 62 | 2.4409 | 17 | 6.693 | 1.95 | 2.665 | 0.67 | .040 | .58 | 11000 | 3800 | 2500 |