Review

Given: Radial load F_R

Life L

Reliability R

Find $C_{10,min}$ (minimum capacity)

$C_{10,Sel}$ (Selected bearing)

[FORWARD PROBLEM]

$$\underbrace{R \longrightarrow x}_{\text{excel Program}} \longrightarrow \underbrace{\frac{L}{x}}_{\text{Adjusted for reliability}} \longrightarrow C_{10,min}$$

$$C_{10,min} = K_a F_R \left(\frac{L/x}{L_{cat}} \right)^{0.333}$$

Ball bearing

Example

$F_R = 150$

$K_a = 1.4$

$L = 50$ million

$R = 95\%$

Find: Suitable bearing

$$C_{10,min} = (1.4)(150 * 4.45)\left(\frac{50}{0.62} \right)^{0.333}$$

Newtons $\quad L_{new}$

where from Excel Program for relvability

$x = 0.62$

$\frac{50}{0.62} = 80.6$ million

$C_{10,min} = 4031^{N} \cong 4$ KN

From Table for Series II deep grove ball bearing

$C_{10,sel} = 5.07$ KN

Bore Size $= 10^{mm}$

The designer approach to bearing Selection

Given : A bearing $(C_{10,sel})$

$R \geq R_{min}$

Find : Does it meet the rel. req. ?

$$C_{10,sel} = K_a F_R \left(\frac{L/x}{L_{cat}} \right)^{0.333}$$

$\Rightarrow$ Find $x \Rightarrow R$

Example

Given : 10-mm bore bearing

$C_{10,Sd} = 5.2$ KN

$L = 50$ million

$F_R = 150$ lbs

$K_a = 1.4$

Find: Does the bearing meet a 97% reliability

$$C_{10,Sd} = K_a F_R \left(L/x \right)^{0.333}$$

$$5200 = 1.4\,(150 * 4.45) \left(\frac{50}{x} \right)^{0.333}$$

$$\left(\frac{50}{x} \right)^{0.333} = 5.56$$

$$\Rightarrow x = 0.29 \xrightarrow{\text{EXCEL}} R = 98\% \text{ to } 99\%$$

Answer: Adequate bearing

Adding Thrust load to ball bearings

Example

Given:

$F_R = 150$ lbs

$F_a = 75$ lbs

$K_a = 1.4$

$L = 175$ million

$R = 96\%$

Find:

Suitable bearing ($C_{10,sel}$)

Deep groove Series II ball bearing

Step-1: Select a Trial bearing size

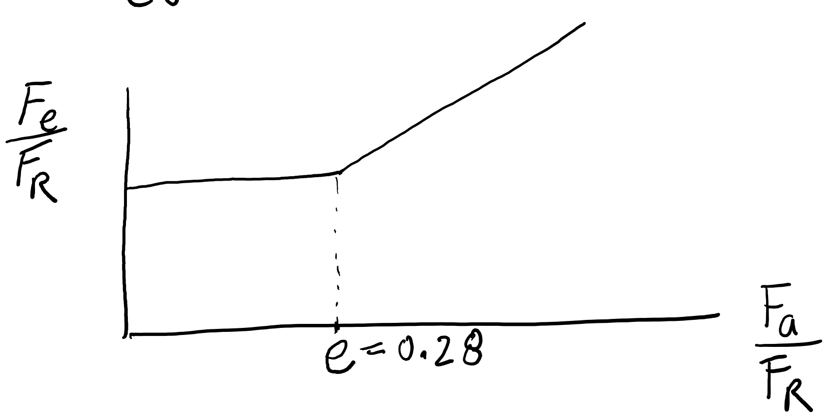
Trial: 15 mm bore size

$C_{10,sel} = 7.8$ KN $\quad \underbrace{C_o = 3.55 \text{ KN}}$

Check only if Bearing supports a load while stationary (static Capacity)

1) Find $\frac{F_a}{C_o}$

$$\frac{F_a}{C_o} = \frac{75\,(4.45)}{3550} = 0.094$$



From Table 11-1 we find

for $\frac{F_a}{C_o} = 0.094$ we find

e to be 0.28

Since $\frac{F_a}{F_R} = \frac{75}{150} = 0.5 > e = 0.28$

$\Rightarrow$ yes we must incorporate the influence of axial load

$$F_e = X_i F_R + Y_i F_a$$

$$F_e = 0.56\,(150) + 1.55\,(75)$$

$$F_e = 200.25 \text{ lbs}$$

check for adequate capacity

$$C_{10,min} = 1.4\,(200.25 * 4.45)\left(\frac{175}{0.533}\right)^{0.333}$$

where for 96% reliability $x = 0.533$

$\Rightarrow C_{10,min} = 8500^{N}$ or 8.5^{KN}

Since $C_{10,sel} = 7.8^{KN} < C_{10,min} = 8.5^{KN}$

we need to select a larger bearing

Next Trial $\equiv 17^{mm}$ bearing

$$C_{10,sel} = 9.56^{KN}$$

$$\frac{F_a}{\;} = 0.074$$

$e = 0.27$

$F_e = 206.25$ lbs

$C_{10,min} = 8.8$ KN $< C_{10,sel} = 9.56$ KN

Acceptable bearing

Reliability of System of bearings

Prob (A good AND B good) = Reliability of the Two Combined

= Prob (A good) AND Prob (B good)

Prob (A and B good) = Prob (A good) * Prob (B good)

$= R(A) \cdot R(B)$

example:

$R_{sys} = 90\%$

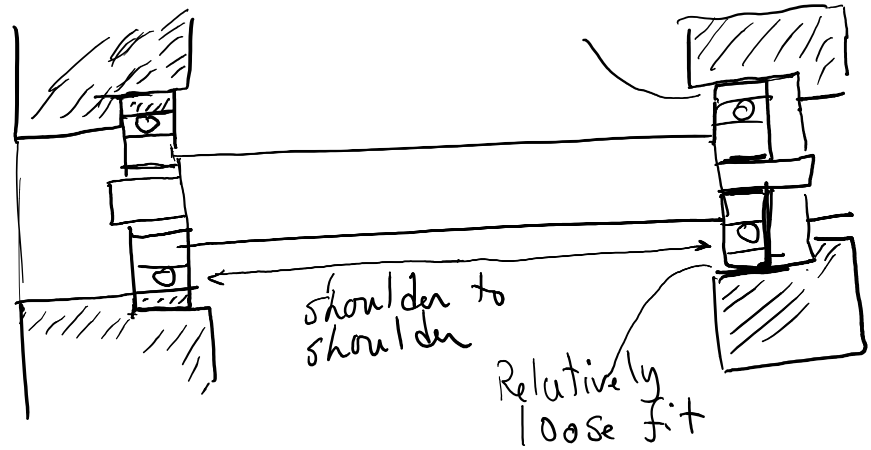
Assume $R(A) = R(B)$

$R_{sys} = R(A)^2$

$R(A) = \sqrt{R_{sys}} = \sqrt{0.9}$

$R(A) \approx .95$ or 95%

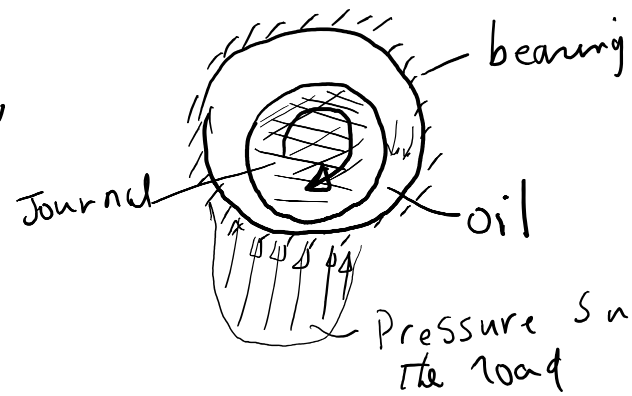
A Simple mounting



Advantages of ball/Roller bearings to Journal bearings

Journal bearings
- Full film hydrodynamic lub.

Friction is very low

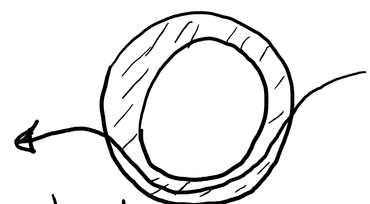


- No need for oil supply or Circulation
- Lower starting friction
- More Precision motion
- Cost
- No maintenance

- Smaller axial space

Advantages of Journal bearings to ball/roller bearings

- Ability to absorb shock loads
- Run quieter
- Work better in dusty environments



- Require Smaller radial space

Precisions

Precision index (ABEC) index

Annular Bearing Engineering Comittee (Sub. Committee of ABMA)

ABEC-1 lowest Precision } Roller skates
-3
-5
-7
-9 highest Precision (10 GB disk drive)

ABEC-1 7 for a 10^{mm} bore

ABEC-1] for a 10^{mm} bore
ABEC-3]

IT6 $\Rightarrow$ $\pm 0.0002''$ (bore tol.)

ABEC-5
ABEC-7

IT5 $\Rightarrow$ $\pm 0.00012''$

ABEC-9

IT4 $\Rightarrow$ $\pm 0.00004''$