Bearings

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MET 210W

Bearing

- A machine element that transmits, with minimum friction, a load between two surfaces moving in opposite directions.

Single-Row Ball Bearing

- Good radial load capacity
- Fair thrust capacity
- Fair misalignment (.15°)
- “point bearing” – high bearing stress
- Increase number of balls or ball size to increase capacity
Double-Row Ball Bearings

- Two rows of balls
- Increased radial load over single-row bearings
- Slightly smaller misalignment possible

Angle Contact Ball Bearing

- One side of race is higher to accommodate larger thrust loads
- Angle of resultant force between 15 and 40 degrees

Cylindrical Roller Bearings

- Much greater radial load capacity
- Line bearing element yields large bearing stress
- No thrust loads permitted
- Poor misalignment
**Single & Double Row Needle Bearings**

Essentially roller bearings with rollers having much smaller diameter than roller bearings.

**Spherical Roller Bearings**

- Self-aligning bearing
- Excellent misalignment (~ 4 degrees)
- Pretty much the same radial load as roller bearings

**Tapered Roller Bearings**

- Designed for substantial thrust loads with high radial loads
- Vehicle wheels and heavy-duty machinery often use these bearings

**Thrust Bearings**

- High level of thrust loads
- Almost no radial loads
Mounted Bearings

Bearings can be ball, roller, tapered roller, etc. as discussed earlier

Materials

- High carbon steel (.95 to 1.10% carbon) – usually AISI 52100 Steel
- Through hardened to RC 58-65 – very hard
- Some are case hardened

- Despite high strength, the bearing stresses are quite high which leads to bearing failure in fatigue.

Bearing Designations

- Bearing Number

Bore size – if greater than 04, the bore size is 5 mm times the number. In this case, the bore size is:

$10 \times 5 \, \text{mm} = 50 \, \text{mm}$

6 is manufacturer’s design code for the particular bearing

Bearing Selection Table

<table>
<thead>
<tr>
<th>Bearing number</th>
<th>Class</th>
<th>Bore size</th>
<th>Outside Diameter</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>0200</td>
<td>5 mm</td>
<td>90 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>5001</td>
<td>0300</td>
<td>6 mm</td>
<td>100 mm</td>
<td>25 mm</td>
</tr>
</tbody>
</table>

$C_r = 4650\#$

$C = 6050\#$
Basic Static Load Rating, $C_0$

- The load that the bearing can withstand without permanent deformation of any component of the bearing.
- Deformations known as brinelling.
- Deformed bearings loud and will fail quickly due to excess impact of the balls.

Rated Life

- Typically the life that 90% of the bearings would survive.
- 10% of bearings fail at this life… represented by the symbol $L_{10}$
- Typically a rated life, $L_{10}$, is for 1 million revolutions. Some companies use 90 million cycles. Some report the average life for which 50% of the bearings will not survive.

Design Life

$$L_d = \left( \frac{C}{P_d} \right)^k (10^6)$$

$L_d$ = Design life (revolutions)

$C$ = basic dynamic load rating

$P_d$ = design load

$k$ = exponent

= 3 for ball bearings

= 3.33 for roller bearings

$L_d = \text{(hrs)(rpm)(60 min/hr)}$

Basic Dynamic Load Rating

$$C = P_d \left( \frac{L_d}{10^6} \right)^{1/k}$$

The required Basic Dynamic Load Rating can be calculated form the design life and the design load.
Required Basic Dynamic Load Rating

\[ C = P_d \left( \frac{f_L}{f_N} \right) \]

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Selection Flowchart

\[ P = VXR + YT \]

abt. \( Y = 1.5 \)

- Assign \( Y \)
- \( C = P/L_h \)
- Select Bearing
- Compute \( T/c_b \)
- \( P = VXR \)
- Select Bearing

- \( C = P/L_h \)
- \( Y \)

- \( C = P/L_h \)

- \( Y \)

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