Rolling contact bearing selection

- **Rating life:**
  Rating life is defined as the life of a group of apparently identical ball or roller bearings, in number of revolutions or hours, rotating at a given speed, so that 90% of the bearings will complete or exceed before any indication of failure occur.

\[
L_{10} = \left( \frac{C}{K_s P} \right)^\varepsilon \text{ millions of revolution}
\]

- \( \varepsilon = 3 \) for ball \( Br \).
- \( \varepsilon = 10/3 \) for roller \( Br \).

\[
\frac{L_1}{L_2} = \left( \frac{P_2}{P_1} \right)^\varepsilon
\]

- \( L_1 \) and \( L_2 \) are the life of the bearings under two different loads.
- \( P_1 \) and \( P_2 \) are the equivalent applied loads.
- \( K_s \) is the service factor (table 2 page 52).
Rolling contact bearing selection

• **Rating life:**

\[ L_{10h} = \left( \frac{10^6}{60 \, n} \right) \left( \frac{C}{K_s \, P} \right)^e \text{ hours} \]

<table>
<thead>
<tr>
<th>Ks</th>
<th>Ball Br.</th>
<th>Roller Br.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform load</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Light shock</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Moderate shock</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>Heavy shock</td>
<td>2.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Extreme shock</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Fluctuating bearing loads

\[ C^e = \left( K_s \, P \right)^e \times \left( \frac{60 \, n}{10^6} \right) \]

if \( P_i \) is applied at \( n_i \) (r.p.m) during \( s_i \) of the cycle

\[ C^e = K_s^e \times \left( \frac{60 \, n}{10^6} \right) \sum_{i=1}^{m} s_i n_i P_i^e \]

Selection of deep groove ball bearings

Deep groove ball bearings are the most frequently used rolling bearings. They have proven their worth, for instance in electric motors, transmissions, household appliances, automobile engines, rolling stands, motor saws, boring and drilling machines, conveyor plants, ventilators, compressors, inline skates ...etc.

Equivalent load

Deep groove ball bearings also resist thrust, and a unit of thrust does different damage per revolution than a unit of radial load, so we must find the equivalent pure radial load that does the same damage as the existing radial and thrust loads.
Selection of deep groove, cylindrical, and thrust bearings

1. Basic static load rating \((C_o)\):
\[ C_o = f_s P_o \]  (table page 124)
\[ f_s = \text{static stress factor} \]
\[ P_o = \text{equivalent static load} \]
\[ = X_o F_r + Y_o F_a \]

(i) Single row deep groove ball bearings
\[ F_a / F_r \leq 0.8 \Rightarrow P_o = F_r \]
\[ F_a / F_r > 0.8 \Rightarrow P_o = 0.6F_r + 0.5F_a \]  (table page 53)

(ii) Cylindrical roller bearings
\[ F_a = 0 \Rightarrow P_o = F_r \]

(ii) Axial thrust bearings
\[ F_r = 0 \Rightarrow P_o = F_a \]

2. Dynamic capacity \((C)\):
\[ C = K_s P \left( L_{10} \right)^{1/\varepsilon} \]  (table page 124)
\[ P = \text{equivalent dynamic load} \]
\[ = X F_r + Y F_a \]

Example

Select a deep groove ball bearing having a rating life of 1200 hr to be fitted on a shaft which has a minimum diameter of 30 mm. The bearing will carry a radial load of 210 N along with an axial load of 214 N. The shaft is rotating at 5.83 RPS.

Sol:
\[ F_a / F_r = 1.02 > 0.8 \Rightarrow P_o = 0.6F_r + 0.5F_a \]  (table page 53)
\[ \therefore P_o = 0.6 \times 210 + 0.5 \times 214 = 233 N \]
\[ C_o = f_s P_o \]  (table page 124)
Assume normal conditions of operation smoothness, \( f_s = 1 \)

\[
Co = 1 \times 0.233 = 0.233 \text{ kN}
\]

*from table page 53, \( F_a / C_o = 0.214 / 0.233 = 0.92, \) assume normal bearing clearance, \( e = 0.44 \)

\[
\therefore (F_a / F_r = 1.02) > e \quad \Rightarrow \quad X = 0.56 \quad \text{and} \quad Y = 1
\]

\[
P = X F_r + Y F_a = 0.56 \times 210 + 1 \times 214 = 331.6 \text{ N}
\]

*from table page 124, \( C = K_s P (L_{10})^{1/\varepsilon} \)

\( e = 3, \quad \text{for ball bearings} \)

\( K_s = 1, \) assume uniform and steady load (table (2) page 52)

\[
L_{10} = \frac{(60 \times 60 \times 5.83 \times 1200)}{10^6} = 25.2 \text{ millions of rev.}
\]

\[
C = 0.3316 \times 1 \times (25.2)^{1/3} = 0.97 \text{ kN}
\]

from FAG catalog, dsh = 30 mm, \( C = 0.97 \text{ kN}, \) \( Co = 0.233 \text{ kN}, \) a preliminary selection is FAG 61806 with \( C = 3.45 \text{ kN}, \) \( Co = 2.55 \text{ kN}. \)

**Check:** *from table page 53, assume normal bearing clearance, \( F_a / C_o = 0.214 / 2.55 = 0.084, \) which gives \( e = 0.275 \)

\[
\text{for} \quad (F_a / F_r = 1.02) > e, \quad X = 0.56 \quad \text{and} \quad Y = 1.55
\]

\[
P = 0.56 \times 210 + 1.55 \times 214 = 449 \text{ N}
\]

\( C = 0.449 \times 1 \times (25.2)^{1/3} = 1.316 \text{ kN}, \) *this value is less than 3.45 kN*

\[
\therefore \quad \text{Bearing No FAG 61806 is a suitable selection.}
\]

**Note:**

If the calculated value of \( C (1.316 \text{ kN}) \) in the previous problem were greater than the value given in catalog (\( C = 3.45 \text{ kN} \)), another bearing should be selected.