

Rolling Bearing Design

Example 1:

Solving an example for the deep groove ball bearings with the given data:

The radial force (F_r)	= 3000 N
The axial force (F_a)	= 300 N
The rotational speed (N)	= 1500 rpm
The shaft diameter (D)	= 40 mm
The rotation factor (V)	= 1 (for rotating inner ring)
The chosen life (L)	= 1250 Hours

Let

$$\begin{aligned}P &= 1.5 * F_r * K_{sf} \\P &= 1.5 * 3000 * 1.1 = 4950 \text{ N} \\C_r &= P (60 * 1250 * 1500 / 10^6)^{0.3} \\C_r &= 20\,415 \text{ N}\end{aligned}$$

Then we choose the bearing with (C) less than C_r which is SKF (6208), with

$$C = 30\,700 \text{ N}, C_0 = 16\,600 \text{ N}$$

$$\begin{aligned}I &= F_a / C_0 = 300 / 16600 = 0.01807 \\J &= F_a / F_r = 300 / 3000 = 0.1\end{aligned}$$

Comparing J with e from table to get X, Y

$$X = 1, Y = 0$$

$$P = 3000 \text{ N}$$

$$C_r = 12\,372.8 \text{ N} < C$$

The bearing is then safe for dynamic loading

$$P_0 = 0.6 * 3000 + 0.5 * 300 = 1950 \text{ N} < F_r$$

Using $P_0 = 3000 \text{ N}$

and take $S_0 = 1$

one gets $C_0 > S_0 * P_0$

The bearing is then safe for static loading

The actual life is found as

$$\begin{aligned}L &= (10^6 / 60 * N) * (C / P)^3 \\L &= 11\,907.2 \text{ Hours}\end{aligned}$$

Example 2:

Solving an example for taper roller bearing with the given data:

- The rotational speed = 500 r.p.m
- The axial force = 434 N
- The selected life is = 16000 hrs
- The left bearing is caring the axial force.
- The arrangement is back to back.
- The two diameters are equal.

Calculations for right bearing:

- The radial force = 3205 N
- The shaft diameter = 50 mm
- The life time selected is = 16000 hrs
- Nature of bearing loads, $K_{sf} = 1.1$

Let

$$P = 1.5 * F_r * K_{sf} \\ = 1.5 * 3205 * 1.1 = 5288.25 \text{ N}$$

$$C_r = P (60 * L * N / 10^6)^{0.3} = 33702 \text{ N}$$

From the bearing tables we choose bearing (SKF 32010X) with $C = 57200 \text{ N}$.

The given data for the bearing is:

$$e = 0.43$$

$$Y_A = 1.4$$

$$Y_{oA} = 0.8$$

Calculations for the left bearing:

- The radial force = 2840 N
- The axial force = 434 N
- The shaft diameter = 50 mm
- The life time selected is = 16000 hrs
- Nature of bearing loads, $K_{sf} = 1.1$

Let

$$P = 1.5 * F_r * K_{sf} \\ = 1.5 * 2840 * 1.1 = 4686 \text{ N}$$

$$C_r = P (60 * L * N / 10^6)^{0.3} = 29863.9 \text{ N}$$

From bearing tables we choose bearing (SKF 32010X) with $C = 57\,200\text{ N}$

$$F_{rA} / Y_A = 3205 / 1.4 = 2289.3$$

$$F_{rB} / Y_B = 2840 / 1.4 = 2028.6$$

Checking the loading conditions from taper tables : *p. 521 (SKF Cat.)*

$$0.5 (2289.3 - 2028.6) = 103.35 < K_a$$

$$F_{aA} = F_{aB} + K_a$$

where $F_{aB} = (0.5 * F_{rB}) / Y_B = 1014.28\text{ N}$

$$F_{aA} = 1014.28 + 434 = 1448.3\text{ N}$$

$$F_{aA} / F_{rA} = 0.45 > e$$

$$P_A = [(0.4 F_r) + (Y F_a)] * K_{SF}$$

$$P_A = 3640.6\text{ N}$$

$$F_{aB} / F_{rB} = 0.357 < e$$

$$P_B = F_{rB} * K_{SF}$$

$$P_B = 3124\text{ N}$$

The expected life for the chosen bearings:

$$L_A = 10^6 / 60 * N (C_A / P_A)^{3.33}$$

$$L_A = 320\,849.6\text{ hrs}$$

$$L_B = 10^6 / 60 * N (C_B / P_B)^{3.33}$$

$$L_D = 534\,096.6\text{ hrs}$$