MIET2510

Mechanical Design

Week 4 – Bearing Life Calculation – Part 3

School of Science and Technology, RMIT Vietnam



• Bearing life (L₁₀) may be calculated;

$$L_{10} = \frac{10^6}{60n} \left(\frac{C}{P}\right)^a$$

- where
 - n is the speed in rpm
 - C is the dynamic load rating
 - P is the equivalent radial load
 - a is the bearing factor (=3 for ball bearings)



 Equivalent radial load may be calculated

 $P = XVF_r + YF_a$

 The factors X and Y need to be obtained from tables and are based on

$$\frac{F_a}{C}$$
 and $\frac{F_a}{VF_r}$

TABLE 10.6

Factors for Deep-Groove Ball Bearings

F_a/C_s	е	F_a/V	$VF_r \leq e$	$F_a/VF_r > e$	
		X	Y	X	Y
0.014 ^a	0.19				2.30
0.21	0.21				2.15
0.028	0.22				1.99
0.042	0.24				1.85
0.056	0.26				1.71
0.070	0.27	1.0	0	0.56	1.63
0.084	0.28				1.55
0.110	0.30				1.45
0.17	0.34				1.31
0.28	0.38				1.15
0.42	0.42				1.04
0.56	0.44				1.00

Source: Based on Bamberger, E.N. et al., Life Adjustment Factors for Ball and Roller Bearings: An Engineering Design Guide, New York, ASME, 1971.

^a Use 0.014 if $F_a/C_s < 0.014$.



 Bearing tables are also required to obtain values to calculate the equivalent radial load and then L₁₀

 Table 11–2 Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and

 Angular-Contact Ball Bearings

		Fillet	Shoulder		Load Ratings, kN				
Bore, C mm r	OD.	Width, mm	Radius, mm	Diameter, mm		Deep Groove		Angular Contact	
	mm			d_{S}	d_H	<i>C</i> ₁₀	C_0	<i>C</i> ₁₀	C_0
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65



Question 1

A 25 mm (02-series) deep-groove ball bearing carries a combined load of 2 kN radially and 3 kN axially at 1500 rpm. The outer ring rotates, and the load is steady. Determine the rating life in hours.

- n = 1500 rpm
- $F_a = 3 \text{ kN}$
- $F_r = 2 \text{ kN}$
- a = 3
- V=1.2



Look up C and C₁₀ from table

Table 11–2 Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

		Fillet	Shoulder		Load Ratings, kN			
OD.	Width, mm	Radius, mm	Diameter, mm		Deep Groove		Angular Contact	
mm			d_{S}	d_H	<i>C</i> ₁₀	C_0	<i>C</i> ₁₀	C_0
30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
47	14	1.0	25	41	12.7	6.20	13.3	6.55
52	15	1.0	30	47	14.0	6.95	14.8	7.65
	OD, mm 30 32 35 40 47 52	OD, mmWidth, mm30932103511401247145215	OD, mmWidth, mmFillet Radius, mm3090.632100.635110.640120.647141.052151.0	OD, mm Width, mm Fillet Radius, mm Show 30 9 d_s 30 9 0.6 12.5 32 10 0.6 14.5 35 11 0.6 17.5 40 12 0.6 19.5 47 14 1.0 25 52 15 1.0 30	OD, mmWidth, mmFillet Radius, mm 12.5 $Choulder$ 3090.612.5 27 32100.614.52835110.617.53140120.619.53447141.0254152151.03047	DD, mm Width, mm Fillet Radius, mm Shoulder Deep G d_s d_H C_{10} d_s d_H C_{10} d_s d_H C_{10} d_s d_H d_s	DD, mmFillet Radius, mm C_{10} Load Rate M' <td>DD, mm Width, mm Fillet Radius, mm $Chouter$ Deep $rove$ Angular 30 9 0.6 d_S d_H C_{10} C_0 C_{10} 30 9 0.6 12.5 27 5.07 2.24 4.944 32 10 0.6 14.5 28 6.89 3.10 7.02 35 11 0.6 17.5 31 7.80 3.55 8.06 40 12 0.6 19.5 34 9.56 4.50 9.956 47 14 1.0 25 41 12.7 6.20 13.3 52 15 1.0 30 47 14.0 6.95 14.8</td>	DD, mm Width, mm Fillet Radius, mm $Chouter$ Deep $rove$ Angular 30 9 0.6 d_S d_H C_{10} C_0 C_{10} 30 9 0.6 12.5 27 5.07 2.24 4.944 32 10 0.6 14.5 28 6.89 3.10 7.02 35 11 0.6 17.5 31 7.80 3.55 8.06 40 12 0.6 19.5 34 9.56 4.50 9.956 47 14 1.0 25 41 12.7 6.20 13.3 52 15 1.0 30 47 14.0 6.95 14.8

 $C_{10} = 14$ C = 6.95



Calculate

$$\frac{F_a}{C} = \frac{3}{6.95} = 0.4317$$

$$\frac{F_a}{VF_r} = \frac{3}{1.2 \cdot 2} = 1.25$$

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Factors for Deep-Groove Ball Bearings

F_a/C_s	е	F_a/V	$TF_r \leq e$	$F_a/VF_r > e$	
		X	Ŷ	X	Y
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Need to interpolate

e = interp1([0.42, 0.56], [0.42, 0.44], F_a/C_s)



e = 0.4217

 From the table X=0.56, interpolating for Y, Y=1.0395

$P = XVF_r + YF_a$

$P = 0.56 \cdot 1.2 \cdot 2 + 1.0367 \cdot 3$

P = 4.4540



• Finally, calculating L₁₀

$$L_{10} = \frac{10^6}{60n} \left(\frac{C}{P}\right)^a$$
$$L_{10} = \frac{10^6}{60 \cdot 1500} \cdot \left(\frac{14}{4.4540}\right)^3$$

 $L_{10} = 344.93 hrs$



Thank you for your attendance :D



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Reference

- SKF Catalogue.
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- Mechanical Engineering Design (10th) by Richard G.Budynas and J.
 Keith Nisbett.
- Theory of Machines and Mechanisms (5th) by John J.Uicker, Gordon R.Pennock, Joseph E. Singley.

