MIET2510

Mechanical Design

Week 4 – Bearing Life Calculation– Part 3

School of Science and Technology, RMIT Vietnam

Bearing Life Calculation

- Bearing life (L_{10}) 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)

Bearing Life Calculation

- 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

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

TABLE 10.6

Factors for Deep-Groove Ball Bearings

		$F_a/VF_r \le e$		$F_a/VF_r > e$	
F_a/C_s	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 $F_a/C_s < 0.014$.

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Bearing Life Calculation

- Bearing tables are also required to obtain values to calculate the equivalent radial load and then L_{10}

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

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm		Load Ratings, kN			
						Deep Groove		Angular Contact	
				d_S	d_H	C_{10}	C_0	C_{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

Bearing Life Calculation

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
- $F_a = 3$ kN
- $F_r = 2$ kN
- $a = 3$
- $V=1.2$

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Bearing Life Calculation

- Look up C and C_{10} from table

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

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm		Load Ratings, kN: Deep Groove		Load Ratings, kN: Angular Contact	
				d_S	d_H	C_{10}	C_0	C_{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

$C_{10} = 14$
C = 6.95

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Bearing Life Calculation

- Calculate

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

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

TABLE 10.6

Factors for Deep-Groove Ball Bearings

		$F_a/VF_r \le e$		$F_a/VF_r > e$	
F_a/C_s	e	X	Y	X	Y
0.014[a]	0.19				2.30
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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.

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- Need to interpolate

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e = interp1([0.42, 0.56], [0.42, 0.44], F_a/C_s)
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e = 0.4217
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Bearing Life Calculation

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

$$P = XVF_r + YF_a$$

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

$$P = 4.4540$$

Bearing Life Calculation

- Finally, calculating L_{10}

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

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

$$L_{10} = 344.93\ hrs$$

Thank you for your attendance :D

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Reference

- *SKF Catalogue.*
- *Mechanical Design of Machine Components (2nd) by Ansel C.Ugural.*
- *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.*

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