Machine Design Test 3

July 25, 2022

Gabe Morris

[1]:

```
# Notebook Preamble
import sympy as sp
import matplotlib.pyplot as plt

plt.style.use('maroon_ipynb.mplstyle')
```

Contents

1 Problem 11-2

1.1 Given

A certain application requires a ball bearing with the inner ring rotating, with a design life of 25 kh at a speed of 350 rpm. The radial load is 2.5 kN and an application factor of 1.2 is appropriate. The reliability goal is 0.9.

1.2 Find

Find the multiple of rating life required, x_D, and the catalog rating C_{10} with which to enter a bearing table. Choose a 02-series deep-groove ball bearing from Table 11–2, and estimate the reliability in use.

1.3 Solution

The relationship for x_D is,

$$x_D = \frac{L_D}{L_R}$$

[2]:
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LD = 60*25_000*sp.S(350)
LR = 10**6
xD = LD/LR
xD
```

[2]: 525

The catalog rating comes from Eq. 11-9,

$$C_{10} = a_f F_D \left(\frac{x_D}{x_0 + (\theta - x_0)[\ln(1/R_D)]^{1/b}} \right)^{1/a}$$

[3]:
```
# Weibull parameters
x0, theta = sp.S('0.02'), sp.S('4.459')
b = sp.S('1.483')

a = sp.S(3)
af = sp.S('1.2')
FD = sp.S('2.5')
RD = sp.S('0.9')
C10 = af*FD*(xD/(x0 + (theta - x0)*(sp.log(1/RD))**(1/b)))**(1/a)
C10  # kN
```

[3]: 24.2553302533208

Choose the 02-35 mm with a $C_{10} = 25.5$ (from Table 11-2). The reliability may be estimated using Eq. 11-21.

$$R = \exp\left(-\left\{\frac{x_D\left(\frac{a_f F_D}{C_{10}}\right)^a - x_0}{\theta - x_0}\right\}^b\right)$$

[4]:
```
C10 = sp.S('25.5')
R = sp.exp(-((xD*(af*FD/C10)**a - x0)/(theta - x0))**b)
R
```

[4]:

0.919509230992636

2 Problem 11-8

2.1 Given

A straight (cylindrical) roller bearing is subjected to a radial load of 20 kN. The life is to be 8000 h at a speed of 950 rpm and exhibit a reliability of 0.95.

2.2 Find

What basic load rating should be used in selecting the bearing from a catalog of manufacturer 2 in Table 11–6?

2.3 Solution

The catalog rating may be found using the same procedure from the previous problem.

[5]:
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LD = 60*8_000*sp.S(950)
LR = 10**6
xD = LD/LR
xD
```

[5]:

456

[6]:
```
x0, theta = sp.S('0.02'), sp.S('4.459')
b = sp.S('1.483')

a = sp.Rational(10, 3)
af = 1
FD = sp.S(20)
RD = sp.S('0.95')
C10 = af*FD*(xD/(x0 + (theta - x0)*(sp.log(1/RD))**(1/b)))**(1/a)
C10  # kN
```

[6]:

144.944057059528