Tutorial Sheet 5: Rolling Bearings

1. Timken rates its bearings for 3000 hours at 500 rev/min. Determine the catalog rating for a ball bearing running for 10,000 hours at 1800 rev/min with a load of 2.75 kN with a reliability of 90 percent. [6.30 kN]

2. Consider Timken ball bearings again that are rated for 3000 hours at 500 rev/min. Determine the catalog rating for a ball bearing running for 10,000 hours at 1800 rev/min with a reliability of 96 percent and an application factor of 1.2. Take the Weibull parameters: $x_0 = 0$, $\theta = 4.48$, and $b = 1.5$. [$C_{10} = 9.37$ kN]

3. Two ball bearings from different manufacturers are being considered for a certain application. Bearing A has a catalog rating of 2.0 kN based on a catalog rating system of 3000 hours at 500 rev/min. Bearing B has a catalog rating of 7.0 kN based on a catalog that rates at 10^6 cycles. For a given application, determine which bearing can carry the larger load. [Bearing A]

4. Consider a shaft which is supported by two bearings. The first one is an angular-contact, inner ring rotating, 02-series ball bearing with the design radial load of 725 lbf. The other one is a cylindrical roller, inner ring rotating, 03-series bearing with design radial load of 2235 lbf. The life requirement is 40 kh at 520 rev/min and the application factor is 1.4. Select the bearings (i.e. select the bore size) to achieve an overall reliability of at least $R = 0.90$. [Try the 65 mm bore for both the bearings.]

5. A 02-series single-row deep-groove ball bearing with a 65-mm bore (see Tables 11-1 and 11-2 in Shigley for specifications) is loaded with a 3-kN axial load and a 7-kN radial load. The outer ring rotates at 500 rev/min.

   (a) Determine the equivalent radial load that will be experienced by this particular bearing. [9.29 kN]

   (b) Determine whether this bearing should be expected to carry this load with a 95 percent reliability for 10 kh. Use the Weibull parameters: $x_0 = 0.02$, $\theta = 4.459$, and $b = 1.483$. [No]

6. A 02-series single-row deep-groove ball bearing with a 30-mm bore (see Tables 11-1 and 11-2 in Shigley for specifications) is loaded with a 2-kN axial load and a 5-kN radial load. The inner ring rotates at 400 rev/min.

   (a) Determine the equivalent radial load that will be experienced by this particular bearing. [5.34 kN]

   (b) Determine the predicted life (in hours) that this bearing could be expected to give in this application with a 99 percent reliability. [445 h]

7. In bearings tested at 2000 rev/min with a steady radial load of 18 kN, a set of bearings showed an L_{10} life of 115 h and an L_{80} life of 600 h. The basic load rating of this bearing is 39.6 kN. Estimate the shape factor b and the characteristic life θ for a two-parameter Weibull model (considering $x_0 = 0$). The manufacturer rates ball bearings at 1 million revolutions. [$b = 1.65$, $\theta = 3.9$]

8. A shaft cycles such that each bearing undergoes the following radial loads: 30 percent of the time at 20 kN, 50 percent of the time at 25 kN, and 20 percent of the time at 30 kN. If the design life of a bearing is to be at least 5×10^6 revolutions, select the smallest 03-series cylindrical roller bearing that will accomplish this. Make use of Table 11-3 from Shigley and proceed iteratively. [35 mm]

9. Estimate the remaining life in revolutions of an 02-30 mm angular-contact ball bearing already subjected to 200,000 revolutions with a radial load of 18 kN, if it is now to be subjected to a change in load to 30 kN. Make use of Table 11-2 from Shigley. [0.267×10^6 revolutions]

10. Consider the same bearing of the previous problem that is running at 2000 rpm. It is subjected to a two-step loading cycle of 4 min with a loading of 18 kN, and of 6 min with a loading of 30 kN. This cycle is to be repeated until failure. Estimate the total life in revolutions, hours, and loading cycles. [451384 revolutions, 3.76 h, 22.57 cycles]