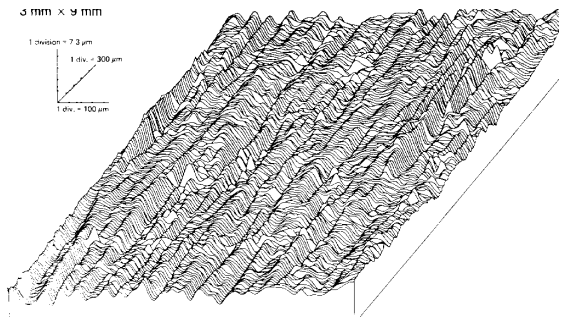
Example 9.1 Magnitude of Permanent Deformations in a Deep-Groove Ball Bearing



Problem Statement

For the 209 DGBB of Ex. 7.1 estimate the maximum permanent deformation at the inner raceway. Compare this value to the maximum elastic deformation.

Problem Solution

Ex. (2.1) $D = 12.7$ mm (0.5 in.)
$P_d = 0.0150$ mm (0.0006 in.)

Ex. (2.2) $f_i = 0.52$

Ex. (2.5) $\gamma = 0.1954$

Ex. (7.1) $Q_{max} = 4536$ N (1019 lb)
$\delta_{max} = 0.0604$ mm (0.00238 in.)

Ex. (9.2) $$\delta_s = 5.25 \cdot 10^{-7} \frac{Q^2}{D^3}\left(\frac{1}{1-\gamma}\right)\left(1-\frac{1}{2f}\right)$$

$$\delta_s = 5.25 \cdot 10^{-7} \frac{(4536)^2}{(12.7)^3}\left(\frac{1}{1-0.1954}\right)\left(1-\frac{1}{2 \cdot 0.52}\right) = 2.521 \cdot 10^{-4}\, mm (9.93 \cdot 10^{-6}\, in.)$$

Elastic deformation at $\psi = 0°$

$$\delta_{i0} = \delta_{max} - \frac{P_d}{2} = 0.06041 - \frac{0.0150}{2} = 5.291 \cdot 10^{-2}\, mm (0.00179 in.)$$

Therefore, elastic deformation >> permanent deformation

Example 9.2 Static Capacity and Factor of Safety in Static Loading for an Angular-Contact Ball Bearing

Problem Statement

The 218 ACBB of Ex. 2.6 is subjected to combined load: $F_r = F_a$ = 17800 N (4000 lb). Estimate the safety factor based on the bearing static capacity.

Problem Solution

Ex. (2.3) D = 22.23 mm (0.875 in.)
f = 0.52
$\alpha^0 = 40°$

Ex. (2.3) d_m = 125.3 mm (4.932 in.)

Eq. (2.27)
$$\gamma = \frac{D\cos\alpha}{d_m} = \frac{22.23\cos 40°}{125.3} = 0.1358$$

Eq. (9.8)
$$C_s = \varphi_s i Z D^2 \cos\alpha$$

Table 9.2 at γ= 0.1358, φ_S = 15.48

$$C_s = 15.48 \cdot 1 \cdot 16 \cdot (22.23)^2 \cos 40° = 93{,}760N\,(21{,}070lb)$$

Table 9.4 X_S = 0.5 and Y_S = 0.26

Eq. (9.15)

$$F_s = X_s F_r + Y_s F_a = 0.5 \cdot 17800 + 0.26 \cdot 17800 = 13530N\,(3040lb)$$

Therefore, use F_s = 17800 (4000 lb)

$$FS = \frac{C_s}{F_s} = \frac{93760}{17800} = 5.4$$