<TABLE 9.3> Gear factor, fg

Gear type	fg
Precision gear (both pitch and dimension error are less than 0.02mm)	1.05 ~ 1.1
Regular gear (both pitch and dimension error are from 0.02 to 0.1mm)	1.1 ~ 1.13

Actual bearing load P is calculated by multiplying the theoretically calculated load Po, with the applicable rotation factor (fb, fc, fg) and load factor fw.

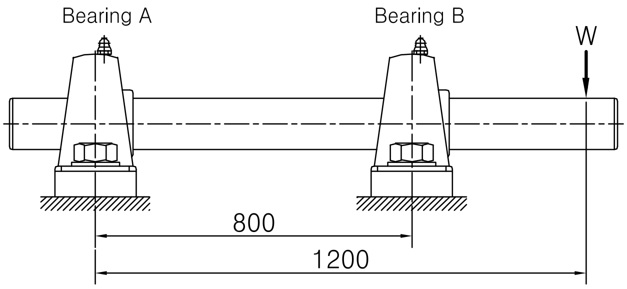
For example, for belt rotation $p = fb \cdot fw \cdot P0$ .....(9.8)

for chain rotation $p = fc \cdot fw \cdot P0$ .....(9.9)

for gear rotation $p = fg \cdot fw \cdot P0$ .....(9.10)

10. Ball bearing unit selection calculation examples

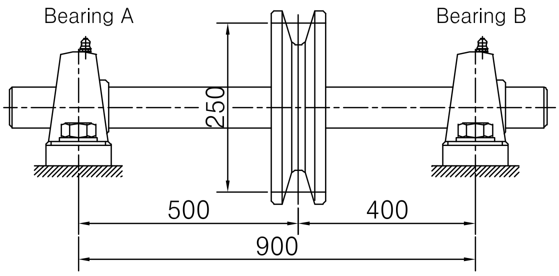
(Example 1) As shown in the drawing, radial load w = 500 Kg is applied to the shaft. What is the applied load on bearing A and B ?



Solution) $W_A = \frac{1200 - 800}{800} \times 500 = 250(Kg)$

$W_B = \frac{1200}{800} \times 500 = 750(Kg)$

(Example 2) As shown in the drawing, the shaft is rotated by a V-belt with transmission power H = 7.5 KW, shaft speed n = 500 rpm, and pulley pitch diameter d = 250mm. what is the applied load on bearing A and B ?



Solution) Rotating moment

$$M = 97400 \times \frac{H}{n}$$

$$= 97400 \times \frac{7.5}{500} = 1461(Kg-cm)$$

Effective transmission power P for the V-belt is,

$$P = \frac{M}{r} = \frac{1461}{25/2} = 116.8(Kg)$$

Now, the belt factor fb for the above belt is listed in Tabel 9.2 is 2.5 and the load factor fw listed in Table 9.1 is 1.2. Then, the real applied force, P, on the bearing is.

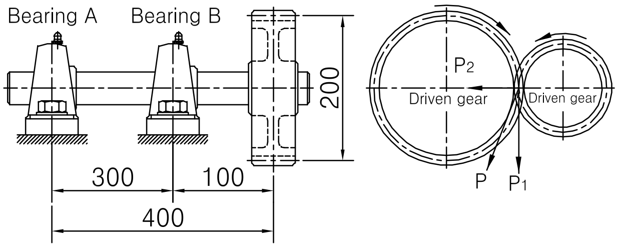
$$P = 2.5 \times 1.2 \times 116.8 = 350.4(Kg)$$

Therefore, applied force on bearing A and B are

$$WA = \frac{400}{900} \times 350.4 = 155.7 (Kg)$$

$$WB = \frac{500}{900} \times 350.4 = 194.7 (Kg)$$

(Example 3) As shown in the drawing, the shaft is rotated by a spur gear with trasmission power H = 5.5KW, shaft speed n = 500 rpm, pitch diameter d = 200 mm and teeth pressure angle $\alpha = 14°30'$. What is the applied load on bearing A and B ?



Solution) Rotating moment M on the gear is

$$M = 97400 \times \frac{H}{n}$$

$$= 97400 \times \frac{5.5}{500} = 1071.4(Kg-cm)$$

Tangential force P_1 is

$$P_1 = \frac{M}{r} = \frac{1071.4}{10} = 107.1(Kg)$$

Perpendicular force P_2 is

$$P_2 = P_1 \tan\alpha = 107.1 \times \tan 14°30' = 27.7(Kg)$$

Therefore, total applied force P on the gear is

$$P = \sqrt{P_1^2 + P_2^2} = \sqrt{107.1^2 + 27.7^2} = 110.6(Kg)$$

Assuming that the gear factor fg = 1.2 and the load factor fw = 1.2, the real applied force W on the shaft is

$$W = 1.2 \times 1.3 \times 110.6 = 172.5(Kg)$$

Therefore, the applied force on bearing A and B are

$$WA = \frac{100}{300} \times 172.5 = 57.5 (Kg)$$

$$WA = \frac{400}{300} \times 172.5 = 230 (Kg)$$

(Example 4) What is the bearing life when UC313 is operated with radial load Fr = 700Kg, thrust load Fa = 480Kg and shaft speed n = 1,200rpm? Assume ideal operating conditions.

Solution) The basic static load C for UC313 is listed in the catalog as C = 9270Kg. The applied equivalent radial load Pr on the bearing is Pr = X·V·Fr + Y·Fa. Here, the radial factors are X = 0.56 and V = 1.0

Thrust factor is

$$Fa/Co = \frac{480}{5980} = 0.0803,\ Y = 1.55$$

$$P_r = 0.56\times1.0\times700+1.55\times480=392+744=1136(Kg)$$

Therefore, lifetime Lh is

$$Lh = \frac{50000}{3n}\left(\frac{C}{P}\right)^3 = \frac{50000}{(3\times1200)}\times\left(\frac{9270}{1136}\right)^3$$

$$=7547(hour)$$

(Example 5) Which bearing should be selected when the operation life time should be greater than 6000 hours at shaft speed of n = 12000 rpm and radial load of fr = 500kgf ?

Solution) The life time factor of fh≒2.29 can be determined from the bearing calculated life time table for Lh = 6000. The speed factor fn≒0.3 is determined from shaft speed n = 1200 rpm. Since the ratio C/P can be used to calculate $c=fh\frac{P}{fn}=2.29\times\frac{500}{0.3}=3817(Kgf)$, unit diameter 211 or 308 can be selected with basic static load numbers of 4330 and 4070(kgf)

(Exampel 6) Which bearing should be selected when the ambient temperature is 150℃ and axis to axis distance is 1200mm ? The shaft material used is 45₵ mild steel (SM 20C material).

Solution) First, select the heat resistant bearing that could be used at 150℃. Next, calculate the thermal shaft expansion at the temperature

$$\Delta\ell = \ell_0\cdot\alpha\,(t_1 + t_0)$$

Here, ℓ_0 = axial distance at room temperature

α = Coefficient of linear expansion(SM20C = 11.7×10^{-6}/℃)

t_0 = normal temperature(assume 20℃)

t_1 = surrounding temperature during operation

$$\Delta\ell = 1200\times11.7\times10^{-6}\times(150-20)$$

$$= 1.825(mm)$$

The expansion is 1.825mm. Therefore, class 13 heat resistant bearing should be used following the special bearing mounting method. The life time should be calculated with basic static load determined from the temperature factor ft in Table 8.3.

(Example 7) Is it possible to guarantee a 2 year bearing life when UC207 bearing unit is used 8 hours a day with radial load of 200Kg and shaft speed of 3200 rpm?

Solution) In this example, the maximum speed for high speed and load operation is 3800 rpm. The required guaranteed life time is 8×365×2 = 5760 hours. The calculated life time can determined from the lifetime table with

$$fn = \left(\frac{33.3}{n}\right)^{\frac{1}{3}}$$

fn ≒ 0.218, basic static load for UC207

C = 2570(kgf)

$$fh = fn\frac{C}{P} = 0.218\times\frac{2570}{200}=2.8$$

Therefore, the calculated life time is determined from the table as 11000 hours. Two year operation is therefore guaranteed.

(Example 8) Which bearing should be selected when the radial load is 1000Kg, the speed is n = 12 rpm and the safety factor is fs = 2.0 ? Operating lifetime required is 8000 hours.

Solution) $Lh = 500\cdot fh^3,\ fh = \left(\frac{8000}{500}\right)^{\frac{1}{3}} = 2.52$

$$fn = \left(\frac{33.3}{n}\right)^{\frac{1}{3}} = \left(\frac{33.3}{12}\right)^{\frac{1}{3}} = 1.40$$

here, $fh = fn\cdot\frac{C}{P}$ therefore, $C = P\cdot\frac{fh}{fn}$

$$= 1000\times\frac{2.52}{14} = 1800(Kg)$$

Since UC200 series has C=3510Kg, select UC 210 series with C_0 = 2320Kg