Static Safety Factor

The basic static load rating C_0 refers to the static load with constant direction and magnitude, under which the calculated contact stress in the center of the contact area between the roller and the raceway under the maximum load is 4000 MPa. (If the contact stress exceeds this level, it will affect the rotation.) This value is indicated as "C_0" in the specification tables. When a load is statically or dynamically applied, it is necessary to consider the static safety factor as shown below.

$$\frac{C_0}{P_0} = f_S$$

f_S : Static safety factor (see Table3)
C_0 : Basic static load rating (N)
P_0 : Static equivalent radial load (N)

Table3 Static Safety Factor (f_S)

Load conditions	Lower limit of f_S
Normal load	1 to 2
Impact load	2 to 3

∗ Target minimum values for the static safety factor are shown in the table above. For better service life and other aspects of dynamic performance, THK recommends maintaining a figure of 7 or above.

[Static Equivalent Radial Load P_0]

The static equivalent radial load of the Cross-Roller Ring is obtained from the following equation.

$$P_0 = X_0 \cdot \left(Fr + \frac{2M}{dp}\right) + Y_0 \cdot Fa$$

P_0 : Static equivalent radial load (N)
Fr : Radial load (N)
Fa : Axial load (N)
M : Moment (N·mm)
X_0 : Static radial factor (X_0=1)
Y_0 : Static axial factor (Y_0=0.44)
dp : Roller pitch circle diameter (mm)

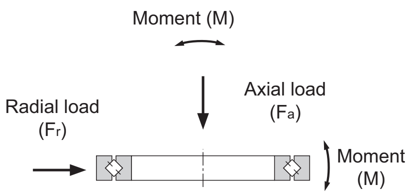

Fig.3

Example of calculation (1): Horizontal Installation

Calculate the nominal life (L) and the static safety factor (f_s) for model RB25025 under the following conditions.

m_1 =100 kg
m_2 =200 kg
m_3 =300 kg
D_1 =300 mm
D_2 =150 mm
H =200 mm
C =69.3 kN
C_0 =150 kN
dp =277.5 mm
ω =2 rad/s (ω: angular velocity)

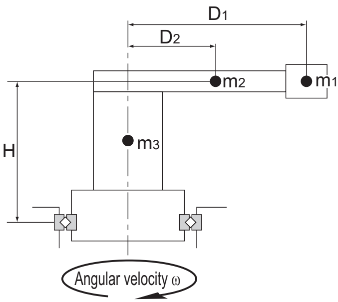

Fig.4

●Applied load

Radial load : Fr
$$=m_1 \cdot D_1 \times 10^{-3} \cdot \omega^2 + m_2 \cdot D_2 \times 10^{-3} \cdot \omega^2$$
$$=100 \cdot 300 \times 10^{-3} \cdot 2^2 + 200 \cdot 150 \times 10^{-3} \cdot 2^2$$
$$=240\ \text{N}$$

Axial load : Fa
$$=(m_1+m_2+m_3) \times g$$
$$=(100+200+300) \times 9.807$$
$$=5884.2\ \text{N}$$

Moment : M
$$=m_1 \cdot g \times D_1 + m_2 \cdot g \times D_2 + (m_1 \cdot D_1 \times 10^{-3} \cdot \omega^2 + m_2 \cdot D_2 \times 10^{-3} \cdot \omega^2) \times H$$
$$=100 \cdot 9.807 \times 300 + 200 \cdot 9.807 \times 150 + (100 \cdot 300 \times 10^{-3} \cdot 2^2 + 200 \cdot 150 \times 10^{-3} \cdot 2^2) \times 200$$
$$=636420\ \text{N·mm}$$

●Nominal life

$$\frac{Fa}{(Fr + 2M/dp)} = \frac{5884.2}{(240 + 2 \times 636420/277.5)} = 1.22 \leqq 1.5$$

∴X =1 , Y =0.45

Therefore, the dynamic equivalent radial load (P_c) is obtained as follows.

$$P_C = X \cdot \left(Fr + \frac{2M}{dp}\right) + Y \cdot Fa = 1 \cdot \left(240 + \frac{2 \times 636420}{277.5}\right) + 0.45 \cdot 5884.2 = 7474.7\ \text{N}$$

If f_W is 1.2 and f_T is 1.0, the nominal life is calculated as follows. Thus, the nominal life (L_{10}) is 9.1×10^8 rev.

$$L_{10m} = \left(\alpha \times \frac{C}{P_C}\right)^{\frac{10}{3}} \times 10^6 = \left\{\frac{1 \cdot 69.3 \times 10^3}{(1.2 \cdot 7474.7)}\right\}^{\frac{10}{3}} \times 10^6 = 9.1 \times 10^8\ \text{rev}$$

$$\alpha = \frac{f_T}{f_W}$$

●Static safety factor

The static equivalent radial load (P_0) is obtained as follows.

$$P_0 = X_0 \cdot \left(Fr + \frac{2M}{dp}\right) + Y_0 \cdot Fa = 1 \cdot \left(240 + \frac{2 \times 636420}{277.5}\right) + 0.44 \cdot 5884.2 = 7415.8\ \text{N}$$

Using the value of P_0 above, the static safety factor (f_s) is calculated to be 20.2.

$$f_S = \frac{C_0}{P_0} = \frac{150 \times 10^3}{7415.8} = 20.2$$

Example of calculation (2): Vertical Installation

Calculate the nominal life (L) and the static safety factor (f_s) for model RB25025 used in the following conditions.

m =300 kg
F =1500 N
L_1 =300 mm
L_2 =150 mm
C =69.3 kN
C_0 =150 kN
dp =277.5 mm
N =140 min^{-1}

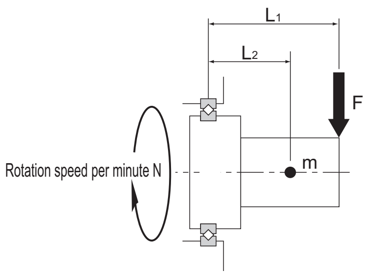

Fig.5

●Applied load

Radial load : Fr =F+m • g
=1500+300•9.807
=4442.1 N

Axial load : Fa =0 N

Moment : M =F×L_1+m • g×L_2
=1500×300+300•9.807×150
=891315 N·mm

●Nominal life

$$\frac{Fa}{(Fr + 2M/dp)} = \frac{0}{(4442.1 + 2 \times 891315/277.5)} = 0 \leqq 1.5$$

∴X =1 , Y =0.45

Therefore, the dynamic equivalent radial load (P_c) is obtained as follows.

$$P_C = X \cdot \left(Fr + \frac{2M}{dp}\right) + Y \cdot Fa = 1 \cdot \left(4442.1 + \frac{2 \times 891315}{277.5}\right) + 0.45 \cdot 0 = 10866\ N$$

If f_W is 1.2 and f_T is 1.0, the nominal life is calculated as follows. Thus, the nominal life (L_{10}) is 2.6×10^8 rev.

$$L_{10m} = \left(\alpha \times \frac{C}{P_C}\right)^{\frac{10}{3}} \times 10^6 = \left\{\frac{1 \cdot 69.3 \times 10^3}{(1.2 \cdot 10866)}\right\}^{\frac{10}{3}} \times 10^6 = 2.6 \times 10^8\ rev$$

$$\alpha = \frac{f_T}{f_W}$$

●Static safety factor

the static equivalent radial load (P_0) is obtained as follows.

$$P_0 = X_0 \cdot \left(Fr + \frac{2M}{dp}\right) + Y_0 \cdot Fa = 1 \cdot \left(4442.1 + \frac{2 \times 891315}{277.5}\right) + 0.44 \cdot 0 = 10866\ N$$

Using the value of P_0 above, the static safety factor (f_s) is calculated to be 13.8.

$$f_S = \frac{C_0}{P_0} = \frac{150 \times 10^3}{10866} = 13.8$$