Life Calculation Formula

Calculating the Nominal Life

The nominal life (L_{10}) of an LM System is obtained from the following formulas using the basic dynamic load rating (C), which is based on a reference distance of 50 km for an LM System with balls and 100 km for an LM System with rollers, and the calculated load acting on the LM System (P_C).

- An LM System with balls (using a basic dynamic load rating based on a nominal life of 50 km)

$$L_{10} = \left(\frac{C}{P}\right)^{3} \times 50 \quad \cdots\cdots (1)$$

L_{10}	: Nominal life	(km)
C	: Basic dynamic load rating	(N)
P	: Applied load	(N)

- An LM System with rollers (using a basic dynamic load rating based on a nominal life of 100 km)

$$L_{10} = \left(\frac{C}{P}\right)^{\frac{10}{3}} \times 100 \quad \cdots\cdots (2)$$

Note: These nominal life formulas may not apply if the length of the stroke is less than or equal to twice the length of the effective load range.

When comparing the nominal life (L_{10}), you must take into account whether the basic dynamic load rating was defined based on 50 km or 100 km. Convert the basic dynamic load rating based on ISO 14728-1 as necessary.

ISO-regulated basic dynamic load rating conversion formulas:

- LM System with balls

$$C_{100} = \frac{C_{50}}{1.26}$$

- LM System with rollers

$$C_{100} = \frac{C_{50}}{1.23}$$

C_{50} : Basic dynamic load rating based on a nominal life of 50 km

C_{100} : Basic dynamic load rating based on a nominal life of 100 km

Calculating the Modified Nominal Life

During use, an LM System may be subjected to vibrations and shocks as well as fluctuating loads, which are difficult to detect. In addition, the hardness of the raceways, the operating temperature, and having more than one LM System arranged in close contact will have a decisive impact on the service life. Taking these factors into account, the modified nominal life (L_{10m}) can be calculated according to the following formulas (3) and (4).

●Modified factor α

$$\alpha = \frac{f_H \cdot f_T \cdot f_C}{f_W}$$

α	: Modified factor	
f_H	: Hardness factor	(see Fig.1 on B0-11)
f_T	: Temperature factor	(see Fig. 2 on B0-11)
f_C	: Contact factor	(see Table 1 on B0-12)
f_W	: Load factor	(see Table 2 on B0-12)

●Modified nominal life L_{10m}

• LM System with balls

$$L_{10m} = \left(\alpha \times \frac{C}{P}\right)^{3} \times 50 \quad \cdots\cdots\cdots(3)$$

• LM System with rollers

$$L_{10m} = \left(\alpha \times \frac{C}{P}\right)^{\frac{10}{3}} \times 100 \quad \cdots\cdots\cdots(4)$$

L_{10m}	: Modified nominal life	(km)
C	: Basic dynamic load rating	(N)
P	: Applied load	(N)

● f_H: Hardness Factor

To maximize the load capacity of the LM System, the hardness of the raceways needs to be between 58 and 64 HRC.

If the hardness is lower than this range, the basic dynamic load rating and the basic static load rating decrease. Therefore, it is necessary to multiply each rating by the respective hardness factor (f_H).

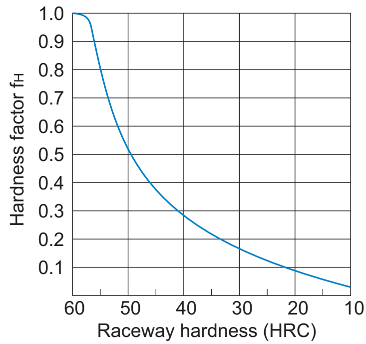

Fig.1: Hardness Factor (f_H)

● f_T:Temperature Factor

If the temperature of the environment surrounding the operating LM System exceeds 100℃, take into account the adverse effect of the high temperature and multiply the basic load ratings by the temperature factor indicated in Fig. 2.

In addition, the LM System must be of a high-temperature type.

Notes: If the temperature of the service environment exceeds 80℃, it is necessary to change the materials of the seal and end plate to high-temperature materials.
If the temperature of the environment exceeds 120℃, it is necessary to provide dimensional stabilization.
A Caged Ball LM Guide or Caged Roller LM Guide may not be used in such an environment because their operating temperature is 80°C or below.

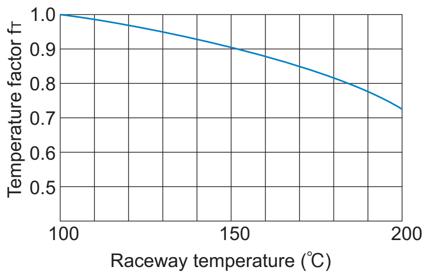

Fig. 2: Temperature Factor (f_T)

● f_C: Contact Factor

If multiple LM Guide blocks are closely arranged with each other, it is difficult to achieve uniform load distribution due to a moment load and the accuracy of the mounting surface. In such applications, multiply basic load ratings "C" and "C_0" by the corresponding contact factors in Table 1.

Note: If uneven load distribution is expected in a large machine, take into account the respective contact factor indicated in Table 1.

Table 1: Contact Factor (f_C)

Number of blocks used in close contact	Contact factor f_C
2	0.81
3	0.72
4	0.66
5	0.61
6 or greater	0.6
Normal use	1

● f_W: Load Factor

In general, reciprocating machines tend to involve vibrations or impacts during operation. It is extremely difficult to accurately determine vibrations generated during high-speed operation and impacts that occur during frequent starts and stops. Therefore, where the effects of speed and vibration are estimated to be significant, divide the basic dynamic load rating (C) by a load factor selected from Table 2, which contains empirically obtained data.

Table 2: Load Factor (f_W)

Vibrations/ impacts	Speed (V)	f_W
Faint	Very low $V \leqq 0.25$ m/s	1 to 1.2
Weak	Slow 0.25 m/s$<V\leqq$1 m/s	1.2 to 1.5
Medium	Medium 1 m/s$<V\leqq$2 m/s	1.5 to 2
Strong	High V>2 m/s	2 to 3.5