3.7. Calculating the Rated Life

The service life of an LM Guide is subject to variations even under the same operational conditions. Therefore, it is necessary to use the rated life defined below as a reference value for obtaining the service life of the LM Guide. The rated life means the total travel distance that 90% of a group of units of the same LM Guide model can achieve without flaking (scale-like exfoliation on the metal surface) after individually running under the same conditions.

3.7.1. Rated Life Equation for an LM Guide® Using Balls

$$L = \left(\frac{f_H \cdot f_T \cdot f_C}{f_W} \cdot \frac{C}{P_C}\right)^3 \times 50$$

L	: Rated life	(km)
C	: Basic dynamic load rating	(N)
P_C	: Calculated load	(N)
f_H	: Hardness factor	(see Fig. 11 on page A-76)
f_T	: Temperature factor	(see Fig. 12 on page A-76)
f_C	: Contact factor	(see Table 10 on page A-76)
f_W	: Load factor	(see Table 11 on page A-77)

3.7.2. Rated Life Equation for an LM Guide® Using Rollers

$$L = \left(\frac{f_H \cdot f_T \cdot f_C}{f_W} \cdot \frac{C}{P_C}\right)^{\frac{10}{3}} \times 100$$

L	: Rated life	(km)
C	: Basic dynamic load rating	(N)
P_C	: Calculated load	(N)
f_H	: Hardness factor	(see Fig. 11 on page A-76)
f_T	: Temperature factor	(see Fig. 12 on page A-76)
f_C	: Contact factor	(see Table 10 on page A-76)
f_W	: Load factor	(see Table 11 on page A-77)

Once the rated life (L) has been obtained, the service life time can be obtained using the following equation if the stroke length and the number reciprocations are constant.

$$L_h = \frac{L \times 10^6}{2 \times \ell_s \times n_1 \times 60}$$

L_h	: Service life time	(h)
ℓ_s	: Stroke length	(mm)
n_1	: No. of reciprocations per min	(min^{-1})

f_H : Hardness factor

To ensure the achievement of the optimum load capacity of the LM Guide, the raceway hardness must be between 58 and 64 HRC.

At hardness below this range, the basic dynamic and static load ratings decrease. Therefore, the rating values must be multiplied by the respective hardness factors (f_H).

Since the LM Guide has sufficient hardness, the f_H value for the LM Guide is normally 1.0 unless otherwise specified.

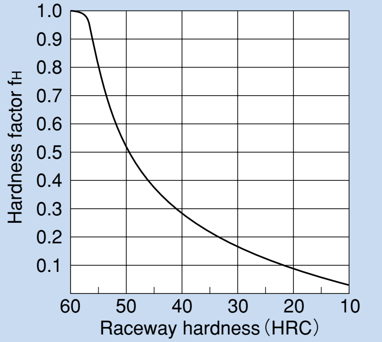

Fig. 11 Hardness Factor (f_H)

f_T : Temperature factor

For LM Guides used at ambient temperature over 100°C, a temperature factor corresponding to the ambient temperature, selected from Fig. 12, must be taken into account.

In addition, the selected LM Guide must also be of a high-temperature type.

Note: The LM Guide is designed to normally be used at ambient temperature of 80°C or less.

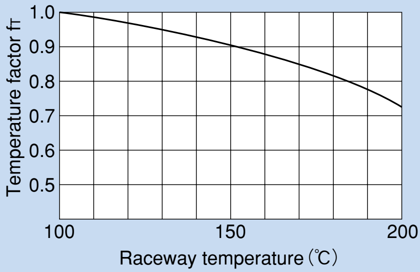

Fig. 12 Temperature factor (f_T)

f_C : Contact factor

When multiple LM blocks are used in close contact with each other, it is difficult to achieve uniform load distribution due to moment loads and mounting-surface accuracy. When using multiple blocks in close contact with each other, multiply the basic load rating (C or C_0) by the corresponding contact factor indicated in Table 10.

Note: When uneven load distribution is expected in a large machine, consider using a contact factor from Table 10.

Table 10 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 more	0.6
Normal use	1

f_W : Load factor

In general, reciprocating machines tend to produce vibrations or impact during operation. And, it is especially difficult to accurately determine all vibrations generated during high-speed operation and impacts produced each time the machine 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 11, which contains empirically obtained data.

Table 11 Load Factor (f_W)

Vibration/impact	Speed (V)	f_W
Faint	Hyper-slow $V \leqq 0.25$m/s	1 to 1.2
Weak	Slow $0.25 < V \leqq 1$m/s	1.2 to 1.5
Moderate	Medium $1 < V \leqq 2$m/s	1.5 to 2
Strong	Fast $V > 2$m/s	2 to 3.5

3.7.3. Example of Calculating the Rated Life (1) - with Horizontal Mount and High-speed Acceleration

[Service conditions]

Model No.: HSR35LA2SS+2500LP-Ⅱ

(basic dynamic load rating: C =50.2 kN)

(basic static load rating: C_0=81.4 kN)

Mass	m_1 =800 kg	Distance	ℓ_0=600 mm
	m_2 =500 kg		ℓ_1=400 mm
Speed	V =0.5 m/s		ℓ_2=120 mm
Time	t_1 =0.05 s		ℓ_3= 50 mm
	t_2 =2.8 s		ℓ_4=200 mm
	t_3 =0.15 s		ℓ_5=350 mm
Acceleration	α_1 =10 m/s²		
	α_3 =3.333 m/s²		
Stroke	ℓ_s =1450 mm		

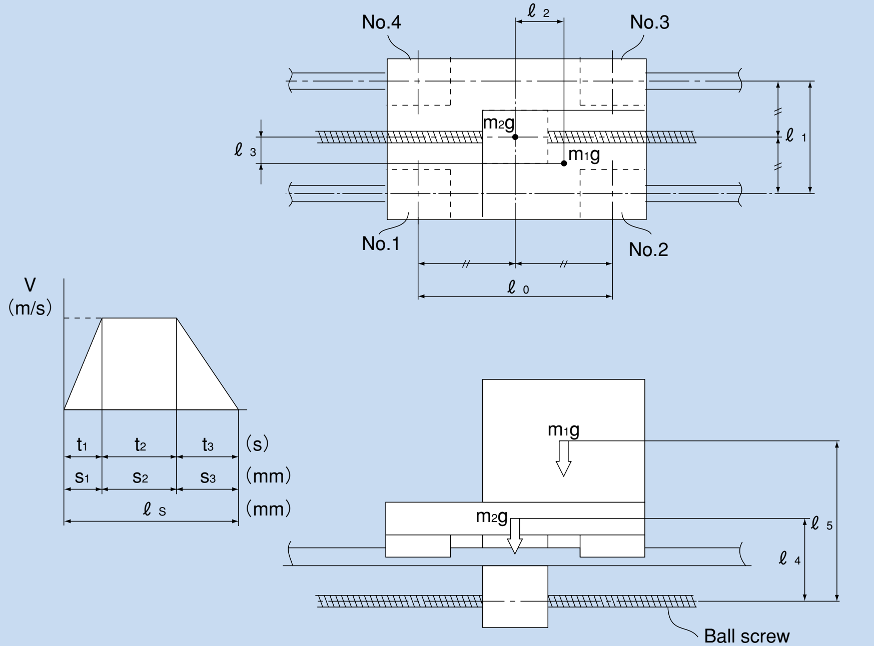

Fig. 13 Service Conditions

Load Applied to the LM Block

Calculate the load applied to each LM block.

●During uniform motion

■Applied load in the radial direction P_n

$$P_1 = +\frac{m_1 g}{4} - \frac{m_1 g \cdot \ell_2}{2 \cdot \ell_0} + \frac{m_1 g \cdot \ell_3}{2 \cdot \ell_1} + \frac{m_2 g}{4} = +2891\ \text{N}$$

$$P_2 = +\frac{m_1 g}{4} + \frac{m_1 g \cdot \ell_2}{2 \cdot \ell_0} + \frac{m_1 g \cdot \ell_3}{2 \cdot \ell_1} + \frac{m_2 g}{4} = +4459\ \text{N}$$

$$P_3 = +\frac{m_1 g}{4} + \frac{m_1 g \cdot \ell_2}{2 \cdot \ell_0} - \frac{m_1 g \cdot \ell_3}{2 \cdot \ell_1} + \frac{m_2 g}{4} = +3479\ \text{N}$$

$$P_4 = +\frac{m_1 g}{4} - \frac{m_1 g \cdot \ell_2}{2 \cdot \ell_0} - \frac{m_1 g \cdot \ell_3}{2 \cdot \ell_1} + \frac{m_2 g}{4} = +1911\ \text{N}$$

●During leftward acceleration

■Applied load in the radial direction $P\ell a_n$

$$P\ell a_1 = P_1 - \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = -\ 275.6\ \text{N}$$

$$P\ell a_2 = P_2 + \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = +\ 7625.6\ \text{N}$$

$$P\ell a_3 = P_3 + \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = +\ 6645.6\ \text{N}$$

$$P\ell a_4 = P_4 - \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = -\ 1255.6\ \text{N}$$

■Applied load in the lateral direction $Pt\ell a_n$

$$Pt\ell a_1 = -\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = -\ 333.3\ \text{N}$$

$$Pt\ell a_2 = +\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = +\ 333.3\ \text{N}$$

$$Pt\ell a_3 = +\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = +\ 333.3\ \text{N}$$

$$Pt\ell a_4 = -\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = -\ 333.3\ \text{N}$$

●During leftward deceleration

■Applied load in the radial direction $P\ell d_n$

$$P\ell d_1 = P_1 + \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +\ 3946.6\ \text{N}$$

$$P\ell d_2 = P_2 - \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +\ 3403.4\ \text{N}$$

$$P\ell d_3 = P_3 - \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +\ 2423.4\ \text{N}$$

$$P\ell d_4 = P_4 + \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +\ 2966.6\ \text{N}$$

Applied load in the lateral direction $Pt\ell d_n$

$$Pt\ell d_1 = +\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = +111.1\ N$$

$$Pt\ell d_2 = -\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = -111.1\ N$$

$$Pt\ell d_3 = -\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = -111.1\ N$$

$$Pt\ell d_4 = +\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = +111.1\ N$$

During rightward acceleration

Applied load in the radial direction Pra_n

$$Pra_1 = P_1 + \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = +6057.6\ N$$

$$Pra_2 = P_2 - \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = +1292.4\ N$$

$$Pra_3 = P_3 - \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = +312.4\ N$$

$$Pra_4 = P_4 + \frac{m_1 \cdot \alpha_1 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_1 \cdot \ell_4}{2 \cdot \ell_0} = +5077.6\ N$$

Applied load in the lateral direction $Ptra_n$

$$Ptra_1 = +\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = +333.3\ N$$

$$Ptra_2 = -\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = -333.3\ N$$

$$Ptra_3 = -\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = -333.3\ N$$

$$Ptra_4 = +\frac{m_1 \cdot \alpha_1 \cdot \ell_3}{2 \cdot \ell_0} = +333.3\ N$$

During rightward deceleration

Applied load in the radial direction Prd_n

$$Prd_1 = P_1 - \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +1835.4\ N$$

$$Prd_2 = P_2 + \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +5514.6\ N$$

$$Prd_3 = P_3 + \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} + \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +4534.6\ N$$

$$Prd_4 = P_4 - \frac{m_1 \cdot \alpha_3 \cdot \ell_5}{2 \cdot \ell_0} - \frac{m_2 \cdot \alpha_3 \cdot \ell_4}{2 \cdot \ell_0} = +855.4\ N$$

Applied load in the lateral direction $Ptrd_n$

$$Ptrd_1 = -\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = -111.1\ N$$

$$Ptrd_2 = +\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = +111.1\ N$$

$$Ptrd_3 = +\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = +111.1\ N$$

$$Ptrd_4 = +\frac{m_1 \cdot \alpha_3 \cdot \ell_3}{2 \cdot \ell_0} = -111.1\ N$$

Resultant Load

●During uniform motion

$P_{E1} = P_1 = 2891\ N$

$P_{E2} = P_2 = 4459\ N$

$P_{E3} = P_3 = 3479\ N$

$P_{E4} = P_4 = 1911\ N$

●During rightward acceleration

$P_{Era_1} = |Pra_1| + |Ptra_1| = 6390.9\ N$

$P_{Era_2} = |Pra_2| + |Ptra_2| = 1625.7\ N$

$P_{Era_3} = |Pra_3| + |Ptra_3| = 645.7\ N$

$P_{Era_4} = |Pra_4| + |Ptra_4| = 5410.9\ N$

●During leftward acceleration

$P_{E\ell a_1} = |P\ell a_1| + |Pt\ell a_1| = 608.9\ N$

$P_{E\ell a_2} = |P\ell a_2| + |Pt\ell a_2| = 7958.9\ N$

$P_{E\ell a_3} = |P\ell a_3| + |Pt\ell a_3| = 6978.9\ N$

$P_{E\ell a_4} = |P\ell a_4| + |Pt\ell a_4| = 1588.9\ N$

●During rightward deceleration

$P_{Erd_1} = |Prd_1| + |Ptrd_1| = 1946.5\ N$

$P_{Erd_2} = |Prd_2| + |Ptrd_2| = 5625.7\ N$

$P_{Erd_3} = |Prd_3| + |Ptrd_3| = 4645.7\ N$

$P_{Erd_4} = |Prd_4| + |Ptrd_4| = 966.5\ N$

●During leftward deceleration

$P_{E\ell d_1} = |P\ell d_1| + |Pt\ell d_1| = 4057.7\ N$

$P_{E\ell d_2} = |P\ell d_2| + |Pt\ell d_2| = 3514.5\ N$

$P_{E\ell d_3} = |P\ell d_3| + |Pt\ell d_3| = 2534.5\ N$

$P_{E\ell d_4} = |P\ell d_4| + |Pt\ell d_4| = 3077.7\ N$

Static Safety Factor

As indicated above, the maximum load is applied to the LM Guide during the leftward acceleration of the second LM block. Therefore, the static safety factor (f_s) is obtained in the following equation.

$$f_S = \frac{C_0}{P_{E\ell a_2}} = \frac{81.4 \times 10^3}{7958.9} = 10.2$$

Average Load P_{mn}

Obtain the average load applied to each LM block.

$$P_{m1} = \sqrt[3]{\frac{1}{2\cdot\ell_S}\left(P_{E\ell a1}^3\cdot S_1 + P_{E1}^3\cdot S_2 + P_{E\ell d1}^3\cdot S_3 + P_{Era1}^3\cdot S_1 + P_{E1}^3\cdot S_2 + P_{Erd1}^3\cdot S_3\right)}$$

$$= \sqrt[3]{\frac{1}{2\times1450}\left(608.9^3\times12.5 + 2891^3\times1400 + 4057.7^3\times37.5 + 6390.9^3\times12.5 + 2891^3\times1400 + 1946.5^3\times37.5\right)}$$

$$= 2940.1\ \text{N}$$

$$P_{m2} = \sqrt[3]{\frac{1}{2\cdot\ell_S}\left(P_{E\ell a2}^3\cdot S_1 + P_{E2}^3\cdot S_2 + P_{E\ell d2}^3\cdot S_3 + P_{Era2}^3\cdot S_1 + P_{E2}^3\cdot S_2 + P_{Erd2}^3\cdot S_3\right)}$$

$$= \sqrt[3]{\frac{1}{2\times1450}\left(7958.9^3\times12.5 + 4459^3\times1400 + 3514.5^3\times37.5 + 1625.7^3\times12.5 + 4459^3\times1400 + 5625.7^3\times37.5\right)}$$

$$= 4492.2\ \text{N}$$

$$P_{m3} = \sqrt[3]{\frac{1}{2\cdot\ell_S}\left(P_{E\ell a3}^3\cdot S_1 + P_{E3}^3\cdot S_2 + P_{E\ell d3}^3\cdot S_3 + P_{Era3}^3\cdot S_1 + P_{E3}^3\cdot S_2 + P_{Erd3}^3\cdot S_3\right)}$$

$$= \sqrt[3]{\frac{1}{2\times1450}\left(6978.9^3\times12.5 + 3479^3\times1400 + 2534.5^3\times37.5 + 645.7^3\times12.5 + 3479^3\times1400 + 4645.7^3\times37.5\right)}$$

$$= 3520.4\ \text{N}$$

$$P_{m4} = \sqrt[3]{\frac{1}{2\cdot\ell_S}\left(P_{E\ell a4}^3\cdot S_1 + P_{E4}^3\cdot S_2 + P_{E\ell d4}^3\cdot S_3 + P_{Era4}^3\cdot S_1 + P_{E4}^3\cdot S_2 + P_{Erd4}^3\cdot S_3\right)}$$

$$= \sqrt[3]{\frac{1}{2\times1450}\left(1588.9^3\times12.5 + 1911^3\times1400 + 3077.7^3\times37.5 + 5410.9^3\times12.5 + 1911^3\times1400 + 966.5^3\times37.5\right)}$$

$$= 1985.5\ \text{N}$$

Rated Life L_n

The rated lives of the four LM blocks are obtained from the corresponding rated life equations shown below.

$$L_1 = \left(\frac{C}{f_W\cdot P_{m1}}\right)^3\times50 = 73700\ \text{km}$$

$$L_2 = \left(\frac{C}{f_W\cdot P_{m2}}\right)^3\times50 = 20600\ \text{km}$$

$$L_3 = \left(\frac{C}{f_W\cdot P_{m3}}\right)^3\times50 = 43000\ \text{km}$$

$$L_4 = \left(\frac{C}{f_W\cdot P_{m4}}\right)^3\times50 = 239000\ \text{km}$$

(where $f_W = 1.5$)

Therefore, the service life of the LM Guide used in a machine or equipment under the service conditions stated above is equivalent to the rated life of the second LM block, which is 20,600 km.

3.7.4. Example of Calculating the Rated Life (2) - with Vertical Mount

[Service conditions]
Model No.: HSR25CA2SS+1500L-Ⅱ
(basic dynamic load rating: C =19.9 kN)
(basic static load rating: C_0=34.4 kN)

Mass	m_0=100 kg	Distance	ℓ_0= 300 mm
	m_1=200 kg		ℓ_1= 80 mm
	m_2=100 kg		ℓ_2= 50 mm
			ℓ_3= 280 mm
			ℓ_4= 150 mm
			ℓ_5= 250 mm
		Stroke	ℓ_s= 1000 mm

The mass (m_0) is loaded only during ascent; it is removed during descent.

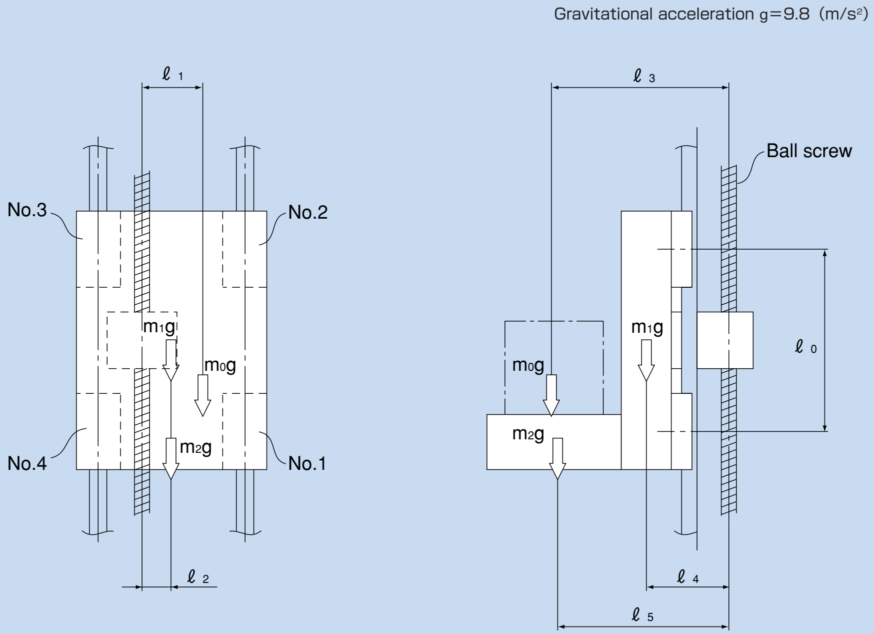

Fig. 14 Service Conditions

Load Applied to the LM Block

●During Ascent

■Load applied to each LM block in the radial direction Pu_n during ascent

$$Pu_1 = +\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} + \frac{m_0 g\cdot \ell_3}{2\cdot \ell_0} = +1355.6\ \text{N}$$

$$Pu_2 = -\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} - \frac{m_0 g\cdot \ell_3}{2\cdot \ell_0} = -1355.6\ \text{N}$$

$$Pu_3 = -\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} - \frac{m_0 g\cdot \ell_3}{2\cdot \ell_0} = -1355.6\ \text{N}$$

$$Pu_4 = +\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} + \frac{m_0 g\cdot \ell_3}{2\cdot \ell_0} = +1355.6\ \text{N}$$

■Load applied to each LM block in the lateral direction Ptu_n during ascent

$$Ptu_1 = +\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} + \frac{m_0 g\cdot \ell_1}{2\cdot \ell_0} = +375.7\ \text{N}$$

$$Ptu_2 = -\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} - \frac{m_0 g\cdot \ell_1}{2\cdot \ell_0} = -375.7\ \text{N}$$

$$Ptu_3 = -\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} - \frac{m_0 g\cdot \ell_1}{2\cdot \ell_0} = -375.7\ \text{N}$$

$$Ptu_4 = +\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} + \frac{m_0 g\cdot \ell_1}{2\cdot \ell_0} = +375.7\ \text{N}$$

●During Descent

■Load applied to each LM block in the radial direction Pd_n during descent

$$Pd_1 = +\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} = +898.3\ \text{N}$$

$$Pd_2 = -\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} = -898.3\ \text{N}$$

$$Pd_3 = -\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} = -898.3\ \text{N}$$

$$Pd_4 = +\frac{m_1 g\cdot \ell_4}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_5}{2\cdot \ell_0} = +898.3\ \text{N}$$

■Load applied to each LM block in the lateral direction Ptd_n during descent

$$Ptd_1 = +\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} = +245\ \text{N}$$

$$Ptd_2 = -\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} = -245\ \text{N}$$

$$Ptd_3 = -\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} - \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} = -245\ \text{N}$$

$$Ptd_4 = +\frac{m_1 g\cdot \ell_2}{2\cdot \ell_0} + \frac{m_2 g\cdot \ell_2}{2\cdot \ell_0} = +245\ \text{N}$$

Resultant Load

●During ascent

$P_{Eu1} = |P_{u1}| + |Pt_{u1}| = 1731.3\ N$

$P_{Eu2} = |P_{u2}| + |Pt_{u2}| = 1731.3\ N$

$P_{Eu3} = |P_{u3}| + |Pt_{u3}| = 1731.3\ N$

$P_{Eu4} = |P_{u4}| + |Pt_{u4}| = 1731.3\ N$

●During descent

$P_{Ed1} = |Pd_1| + |Ptd_1| = 1143.3\ N$

$P_{Ed2} = |Pd_2| + |Ptd_2| = 1143.3\ N$

$P_{Ed3} = |Pd_3| + |Ptd_3| = 1143.3\ N$

$P_{Ed4} = |Pd_4| + |Ptd_4| = 1143.3\ N$

Static Safety Factor

The static safety factor (f_s) of the KM Guide used in a machine or equipment under the service conditions stated above is obtained as follows.

$$f_S = \frac{C_0}{P_{EU2}} = \frac{34.4\times10^3}{1731.3} = 19.9$$

Average Load P_{mn}

Obtain the average load applied to each LM block.

$$P_{m1} = \sqrt[3]{\frac{1}{2\cdot\ell_S}(P_{EU1}{}^3\cdot\ell_S + P_{Ed1}{}^3\cdot\ell_S)} = 1495.1\ N$$

$$P_{m2} = \sqrt[3]{\frac{1}{2\cdot\ell_S}(P_{EU2}{}^3\cdot\ell_S + P_{Ed2}{}^3\cdot\ell_S)} = 1495.1\ N$$

$$P_{m3} = \sqrt[3]{\frac{1}{2\cdot\ell_S}(P_{EU3}{}^3\cdot\ell_S + P_{Ed3}{}^3\cdot\ell_S)} = 1495.1\ N$$

$$P_{m4} = \sqrt[3]{\frac{1}{2\cdot\ell_S}(P_{EU4}{}^3\cdot\ell_S + P_{Ed4}{}^3\cdot\ell_S)} = 1495.1\ N$$

Rated Life L_n

The rated lives of the four LM blocks are obtained from the corresponding rated life equations shown below.

$$L_1 = \left(\frac{C}{f_W \cdot P_{m1}}\right)^3 \times 50 = 68200 \text{ km}$$

$$L_2 = \left(\frac{C}{f_W \cdot P_{m2}}\right)^3 \times 50 = 68200 \text{ km}$$

$$L_3 = \left(\frac{C}{f_W \cdot P_{m3}}\right)^3 \times 50 = 68200 \text{ km}$$

$$L_4 = \left(\frac{C}{f_W \cdot P_{m4}}\right)^3 \times 50 = 68200 \text{ km}$$

(where $f_W = 1.2$)

Therefore, the service life of the LM Guide used in a machine or equipment under the service conditions stated above is 68,200 km.