Calculating the Average Load

In cases where the load applied to each LM block fluctuates under different conditions, such as an industrial robot advancing while holding a workpiece with its arm then retreating with its arm empty, or a machine tool handling various workpieces, it is necessary to calculate the service life of the LM block while taking into account such fluctuating loading conditions.
The average load (P_m) is the load under which the service life of the LM Guide is equivalent to that under varying loads applied to the LM blocks.

$$P_m = \sqrt[i]{\frac{1}{L} \cdot \sum_{n=1}^{n} (P_n{}^{i} \cdot L_n)}$$

P_m : Average Load[1] (N)
P_n : Varying load (N)
L : Total travel distance (mm)
L_n : Distance traveled under load P_n (mm)
i : Constant determined by rolling element

Note: This equation applies when the rolling elements are balls.

(1) With stepwise load fluctuation

LM Guide Using Balls (i=3)

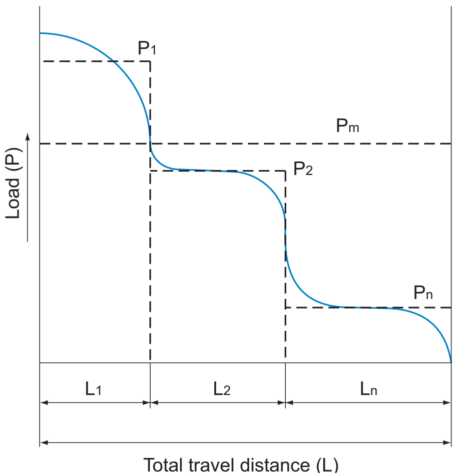
$$P_m = \sqrt[3]{\frac{1}{L} (P_1{}^{3} \cdot L_1 + P_2{}^{3} \cdot L_2 \cdots\cdots + P_n{}^{3} \cdot L_n)} \quad \cdots\cdots\cdots\cdots (1)$$

P_m : Average load (N)
P_n : Varying load (N)
L : Total travel distance (mm)
L_n : Distance traveled under P_n (mm)

LM Guide Using Rollers (i= $\frac{10}{3}$)

$$P_m = \sqrt[\frac{10}{3}]{\frac{1}{L} (P_1{}^{\frac{10}{3}} \cdot L_1 + P_2{}^{\frac{10}{3}} \cdot L_2 \cdots\cdots + P_n{}^{\frac{10}{3}} \cdot L_n)} \quad \cdots\cdots\cdots\cdots (2)$$

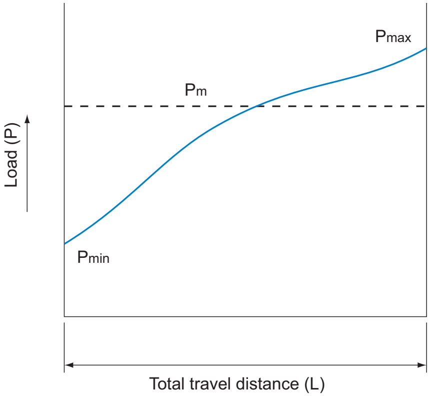
P_m : Average Load (N)
P_n : Varying load (N)
L : Total travel distance (mm)
L_n : Distance traveled under P_n (mm)



(2) With monotone load fluctuation

$$P_m \doteqdot \frac{1}{3}\left(P_{min} + 2 \cdot P_{max}\right) \quad \cdots\cdots\cdots\cdots(3)$$

P_{min}	: Minimum load	(N)
P_{max}	: Maximum load	(N)



(3) With sinusoidal load fluctuation

(a) $P_m \doteqdot 0.65P_{max}$ $\cdots\cdots\cdots\cdots$(4)

(b) $P_m \doteqdot 0.75P_{max}$ $\cdots\cdots\cdots\cdots$(5)