## 5.3. Calculating the Average Load

When the load applied on the spline shaft fluctuates according to varying conditions, such as an industrial robot arm traveling forward while holding a workpiece and traveling backward with empty weight, and a machine tool handling various workpieces, this varying load condition must be taken into account in service life calculation.
The average load ($P_m$) is a constant load under which the service life of an operating Ball Spline with its spline nut receiving a fluctuation load in varying conditions is equivalent to the service life under this varying load condition.
The following is the basic equation.

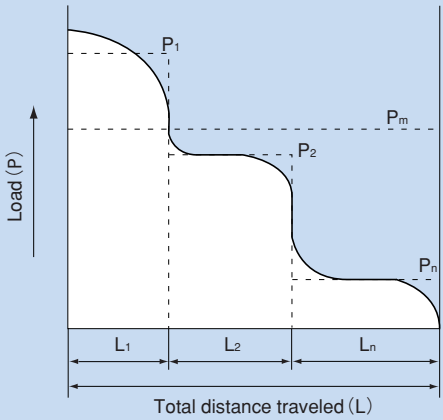
$$P_m = \sqrt[3]{\frac{1}{L} \cdot \sum_{n=1}^{n} (P_n^3 \cdot L_n)}$$

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

### ① When the load fluctuates stepwise

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

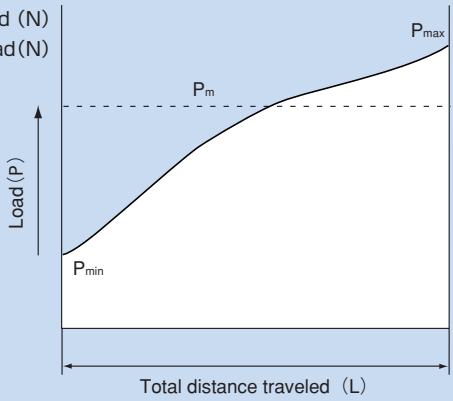
| | | |
|---|---|---|
| $P_m$ | : Average load | (N) |
| $P_n$ | : Varying load | (N) |
| L | : Total distance traveled | (m) |
| $L_n$ | : Distance traveled under $P_n$ | (m) |



### ② When the load fluctuates monotonically

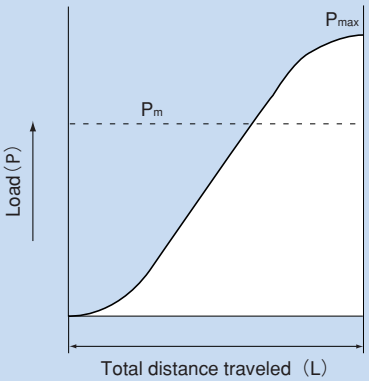
$$P_m \fallingdotseq \frac{1}{3}(P_{min} + 2 \cdot P_{max}) \quad \cdots\cdots\cdots(2)$$

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




### ③ When the load fluctuates sinusoidally

a) $P_m \fallingdotseq 0.65P_{max}$ ·····(3)




b) $P_m \fallingdotseq 0.75P_{max}$ ·····(4)