Allowable Axial Load of Ball Screws (Details P.3942)

The Allowable Axial Load represents a maximum load, including a safety margin, that causes shaft buckling. The Maximum Axial Load to the Screw Shaft must be equal to or less than the Allowable Axial Load value.

(1) Calculation of the Allowable Axial Load*

Use the following three factors to find the value from the Allowable Axial Load Chart (Fig.2):
– Screw Shaft Diameter (Ø)
– Method of Mount Support (See Fig. 3)
– Distance between Load Acting Points (Refer to Fig. 3)
*Use a formula to find more accurate Allowable Axial Load. (Refer to **P.3942**)

(2) Calculation of Maximum Axial Loads

Use the following formulas for calculating each axial load at acceleration, constant speed and deceleration (at horizontal installation).

The largest load is regarded as the Maximum Axial Load:
– Constant speed ··· Axial Load (Pb)=μWg
– Acceleration ··· Axial Load (Pa)=Wα+μWg
– Deceleration ··· Axial Load (Pc)=Wα-μWg

*Note: When mounting vertically, omit "μ" from the calculation.

μ: Linear Guide Friction Constant (0.02 for the Linear Guides)
W: Mass of Works
g: Gravitational Acceleration 9.8m/s^2
α: Acceleration (*)

(*) Acceleration (α)=(Vmax/t) x 10^{-3}
Vmax: Fast-feed Velocity
t: Acceleration / Deceleration Time

(3) Safety Check

Check the Allowable Axial Load Chart (Fig. 2) to confirm that the Maximum Axial Load value is equal to, or less than, the Allowable Axial Load values.

Allowable Rotational Speed (Details P.3943)

The rotational speed of Ball Screws is determined by the necessary travel speed and the Ball Screw lead. The frequency must be equal to or less than the Allowable Rotational Speed. The Allowable Rotational Speed is examined by using the critical speed on the Rotary Shafts and the DmN value, which is the Rotary Speed limit of the ball circulating in the nuts.

(1) Allowable Rotational Speed

(1) Calculation of Allowable Rotational Speed
Use the following three factors to find the value from the Allowable Rotational Speed Chart (Fig.4)
– Screw Shaft Diameter (Ø)
– Mounting Method Type (See Fig. 3)
– Distance between Load Acting Points (Refer to Fig. 2)
*Note: To find a more accurate Allowable Rotational Speed, use one of the formulas found on **P.3943**.

(2) Safety Check

Use the Allowable Rotational Speed Chart (Fig. 4) to confirm that the Screw shaft rotational speed is equal to, or less than, the Allowable Rotational Speed values.

(2) DmN value

(1) Calculation of DmN
DmN = (Dm+A) x Nmax
Dm: Screw Shaft Diameter

A: Factor determined by the Ball Dia. (Refer to Fig. 5)
Nmax: Screw Shaft Max. revolutions

(2) Confirm the DmN value satisfies the following conditions:
– Precision Ball Screws ···DmN≤70000
– Rolled Ball Screws ··· DmN≤50000

Fig. 5 Value A

Ball Dia.	Value A
1.5875	0.3
2.3812	0.6
3.175	0.8
4.7625	1.0
6.35	1.8

Operating Life Calculation (Details P.3944)

Use the following formula for calculating the operating hours of the Ball Screws:

$$\text{Life Hours} = \frac{10^6}{60Nm}\left(\frac{C}{Pm \cdot fw}\right)^3$$

C : Basic Dynamic Load Rating (N)
Pm: Allowable Axial Average Load (N)
Nm: Average Revolutions (min^{-1})
fw: Operation Factor
Steady operation without impact fw=1.0–1.2
Normal operation fw=1.2–1.5
Operation with impact fw=1.5–2.0

C: Basic Dynamic Load Rating Definition

When a certain group of the same Ball Screws are operated with a certain Axial Load and 90% of the Screws achieve 1 million revolutions (10^6) without flaking in its operating life, the Axial Load is defined as the Basic Dynamic Load Rating.

Calculation of Allowable Axial Average Load & Revolutions

It is required to calculate according to the operation patterns. Refer to the table below Though it seems very difficult to calculate each condition such as the operation pattern and load, however, the Ball Screws' operating life is always inversely proportional by factor of three to the load. Therefore, more Ball Screw options will become available when the calculation is more exact.

Fig. 2 Allowable Axial Load Chart

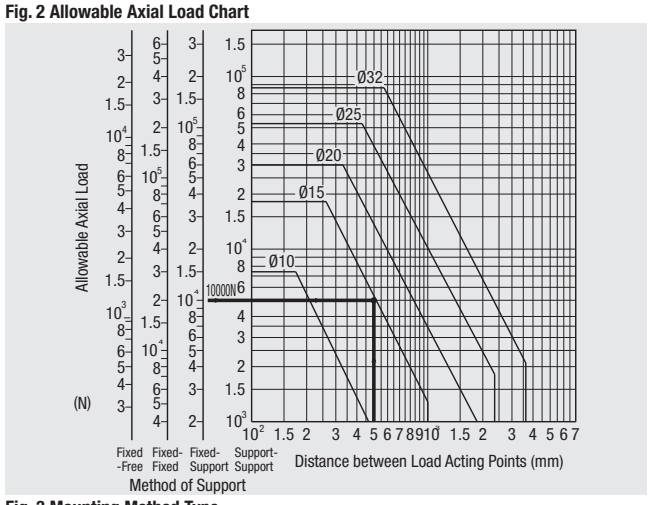


Fig. 3 Mounting Method Type

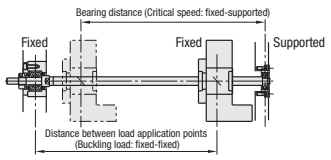
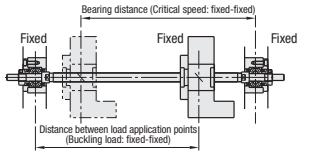
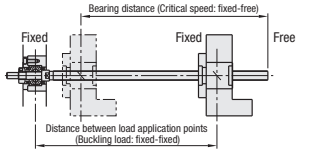
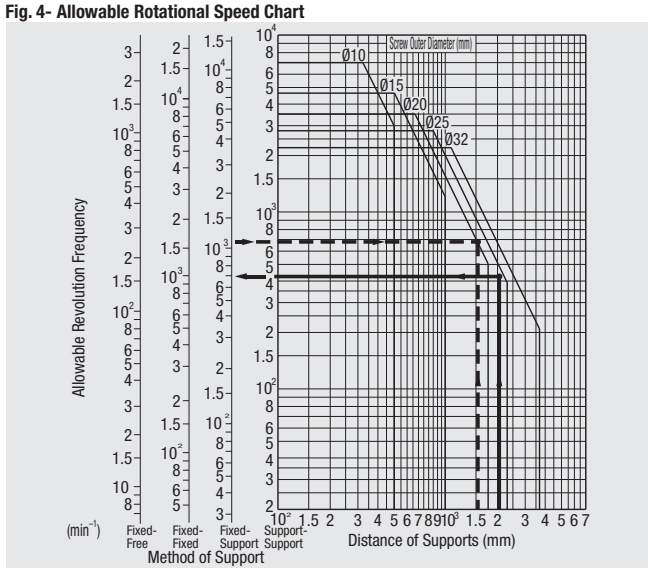
Installation Methods	Characteristics
	– Most commonly selected installation method – Intermediate – high speed applications – Medium – high accuracy – For the Support Unit, Standard Type BRW and BUR were selected
	– Intermediate speed applications – High accuracy – For the Support Unit, Standard Type BRW was selected
	– Low speed applications – For short shaft length – Medium accuracy – For the Support Unit, Economy Type BRWE was selected

Fig. 4- Allowable Rotational Speed Chart



Operating Pattern Examples (t1+t2+t3=100%)

Operating Pattern	Allowable Axial Load	Revolutions	Hrs. Rate
A	P_1N	N1min^{-1}	t_1%
B	P_2N	N2min^{-1}	t_2%
C	P_3N	N3min^{-1}	t_3%

Formula

$$Pm=\left(\frac{P1^3N1t1+P2^3N2t2+P3^3N3t3}{N1t1+N2t2+N3t3}\right)^{\frac{1}{3}} \text{ (N)}$$

$$Nm=\frac{N1t1+N2t2+N3t3}{t1+t2+t3} \text{ (min}^{-1}\text{)}$$