

5.6. Permissible Rotation Speed

5.6.1. Critical Speed of the Screw Shaft

When the rotation speed reaches a high level, the Ball Screw may resonate and eventually become unable to operate due to the screw shaft's natural frequency. Therefore, it is necessary to select a model so that it is used below the resonance point (critical speed).

Fig. 6 on page K-47 shows the relationship between the screw shaft diameter and a critical speed. If determining a critical speed by calculation, it can be obtained from the equation (8) below. Note that in this equation, a safety factor of 0.8 is multiplied to the result.

$$N_1 = \frac{60 \cdot \lambda_1^2}{2\pi \cdot \ell_b^2} \times \sqrt{\frac{E \times 10^3 \cdot I}{\gamma \cdot A}} \times 0.8 = \lambda_2 \cdot \frac{d_1}{\ell_b^2} \cdot 10^7 \quad \text{.....(8)}$$

where

N_1 : Permissible rotation speed determined by critical speed (min^{-1})

ℓ_b : Center distance (mm)

E : Young's modulus ($2.06 \times 10^5 \text{ N/mm}^2$)

I : Minimum geometrical moment of inertia of the screw shaft (mm^4)

$$I = \frac{\pi}{64} d_1^4 \quad d_1 : \text{Screw-shaft thread minor diameter (mm)}$$

γ : Density (specific gravity) ($7.85 \times 10^{-6} \text{ kg/mm}^3$)

A : Screw shaft sectional area (mm^2)

$$A = \frac{\pi}{4} d_1^2$$

λ_1, λ_2 : Factor for mounting method

Fixed - free $\lambda_1=1.875$ $\lambda_2=3.4$

Supported - supported $\lambda_1=3.142$ $\lambda_2=9.7$

Fixed - supported $\lambda_1=3.927$ $\lambda_2=15.1$

Fixed - fixed $\lambda_1=4.73$ $\lambda_2=21.9$

5.6.2. DN Value

The permissible rotation speed of the Ball Screw must be obtained from the critical speed of the screw shaft and the DN value.

The permissible rotation speed determined by the DN value is obtained using the equations (9) to (13) below.

Ball Screw with Ball Cage

●Models SBN and HBN

$$N_2 = \frac{130000}{D} \dots\dots\dots (9)$$

where

N_2 : Permissible rotation speed determined by DN value (min^{-1} (rpm))

D : Ball center diameter

(Described in the dimensional table for the respective model number in the "THK General Catalog - Product Specifications," provided separately.)

●Model SBK

$$N_2 = \frac{160000}{D} \dots\dots\dots (10)$$

Precision Ball Screw

$$N_2 = \frac{70000}{D} \dots\dots\dots (11)$$

Rolled Ball Screw

(excluding large-lead type)

$$N_2 = \frac{50000}{D} \dots\dots\dots (12)$$

Large-Lead Rolled Ball Screw

$$N_2 = \frac{70000}{D} \dots\dots\dots (13)$$

Of the permissible rotation speed determined by critical speed (N_1) and the permissible rotation speed determined by DN value (N_2), the lower rotation speed is regarded as the permissible rotation speed.

If the working rotation speed exceeds N_2 , a high-speed type Ball Screw is available. Contact THK for details.

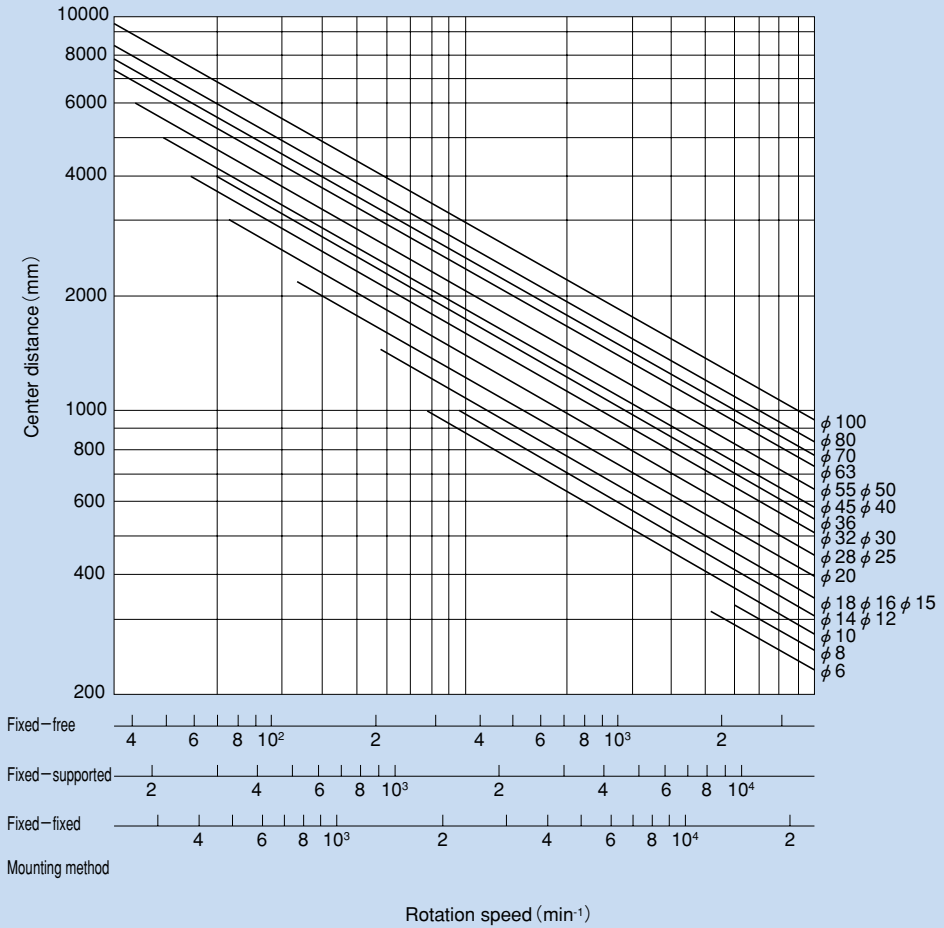


Fig. 6 Permissible Rotation Speed Diagram