Permissible Rotational Speed

[Critical Speed of the Screw Shaft]

When the rotational speed reaches a high magnitude, 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.13 on A15-34 shows the relationship between the screw shaft diameter and the critical speed.

If determining the critical speed by calculation, it can be obtained from the equation (7) below. Note that in this equation, a safety factor of 0.8 is multiplied to the result.

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

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

ℓ_b : Distance between two mounting surfaces (mm)

E : Young's modulus (2.06×10^5 N/mm^2)

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

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

γ : Density (specific gravity) (7.85×10^{-6} kg/mm^3)

A : Screw shaft cross-sectional area (mm^2)

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

λ_1, λ_2 : Factor according to the mounting method

Fixed - free	λ_1=1.875	λ_2=3.4
Supported - supported	λ_1=3.142	λ_2=9.7
Fixed - supported	λ_1=3.927	λ_2=15.1
Fixed - fixed	λ_1=4.73	λ_2=21.9

[DN Value]

The permissible rotational speed of the Ball Screw must be obtained from the critical speed of the screw shaft and the DN value. The permissible rotational speed determined by the DN value is obtained using the equations (8) to (17) below.

Model No.				Permissible rotational speed determined by the DN value N_2
Precision	Caged Ball	Models SDAN-V and SDA-V	Standard lead/ Super lead	$N_2 = \frac{160000}{D}$ ·····(8)
		Model SBK (Medium) (SBK3636, SBK4040, and SBK5050)	Large lead	$N_2 = \frac{210000}{D}$ ·····(9-1)
		Model SBK (Medium) (Other than the above model numbers and the small size model SBK)		$N_2 = \frac{160000}{D}$ ·····(9-2)
		Model SBK (Small)		$N_2 = \frac{130000}{D}$ ·····(9-3)
		Models SBN-V (Medium), HBN-V	Standard lead	$N_2 = \frac{160000}{D}$ ·····(10-1)
		Models SBN-V (Small), HBN, and SBKH		$N_2 = \frac{130000}{D}$ ·····(10-2)
		Models HBN-K and HBN-KA		$N_2 = \frac{120000}{D}$ ·····(10-3)
	Full-Complement Ball	Models SDAN-VX and SDA-VZ (shaft diameters ϕ28 to 63)	Standard lead/ Super lead	$N_2 = \frac{130000}{D}$ ·····(11-1)
		Model SDA-VZ (shaft diameters ϕ10 to 25)		$N_2 = \frac{100000}{D}$ ·····(11-2)
		Model WHF	Super lead	$N_2 = \frac{120000}{D}$ ·····(12-1)
		Model WGF		$N_2 = \frac{70000}{D}$ ·····(12-2)
		Models BNS-V and NS-V	Large lead	$N_2 = \frac{100000}{D}$ ·····(13-1)
		Models BLW, BLK, BLR, BNS-A, BNS, NS-A, and NS		$N_2 = \frac{70000}{D}$ ·····(13-2)
		Models BIF-V (Medium), BNFN-V (Medium), and BNF-V (Medium)	Standard lead	$N_2 = \frac{130000}{D}$ ·····(14-1)
		Models BIF-V (Small), BNFN-V (Small), and BNF-V (Small)		$N_2 = \frac{100000}{D}$ ·····(14-2)
		Models BIF, DIK, BNFN, DKN, BNF, BNT, DK, MDK, MBF, BNK, and DIR		$N_2 = \frac{70000}{D}$ ·····(14-3)
	Full-Complement Ball (DIN Standard Compliant)	Models EPB-V, EBB-V (2806 to 8020)	Standard lead	$N_2 = \frac{130000}{D}$ ·····(14-4)
		Models EPB-V, EBB-V (1605 to 2512)		
Rolled	Full-Complement Ball	Models WTF and CNF	Super lead	$N_2 = \frac{70000}{D}$ ·····(15)
		Models BLK and BLR	Large lead	$N_2 = \frac{70000}{D}$ ·····(16)
		Model BTK-V	Standard lead	$N_2 = \frac{100000}{D}$ ·····(17-1)
		Models JPF, BNT, and MTF		$N_2 = \frac{50000}{D}$ ·····(17-2)

N_2 : Permissible rotational speed determined by the DN value (min^{-1})
D : Ball center-to-center diameter
(indicated in the dimensional tables of the respective model numbers)

When considering the rotational speed, the permissible rotational speed is regarded as the lower of the following rotational speed guidelines: the critical speed of the screw shaft (N_1) or the permissible rotational speed determined by the DN value (N_2). Refer to the dimensional tables of the respective model numbers for the permissible rotational speed.

If the service rotational speed exceeds the guidelines for maximum rotational speed, contact THK.

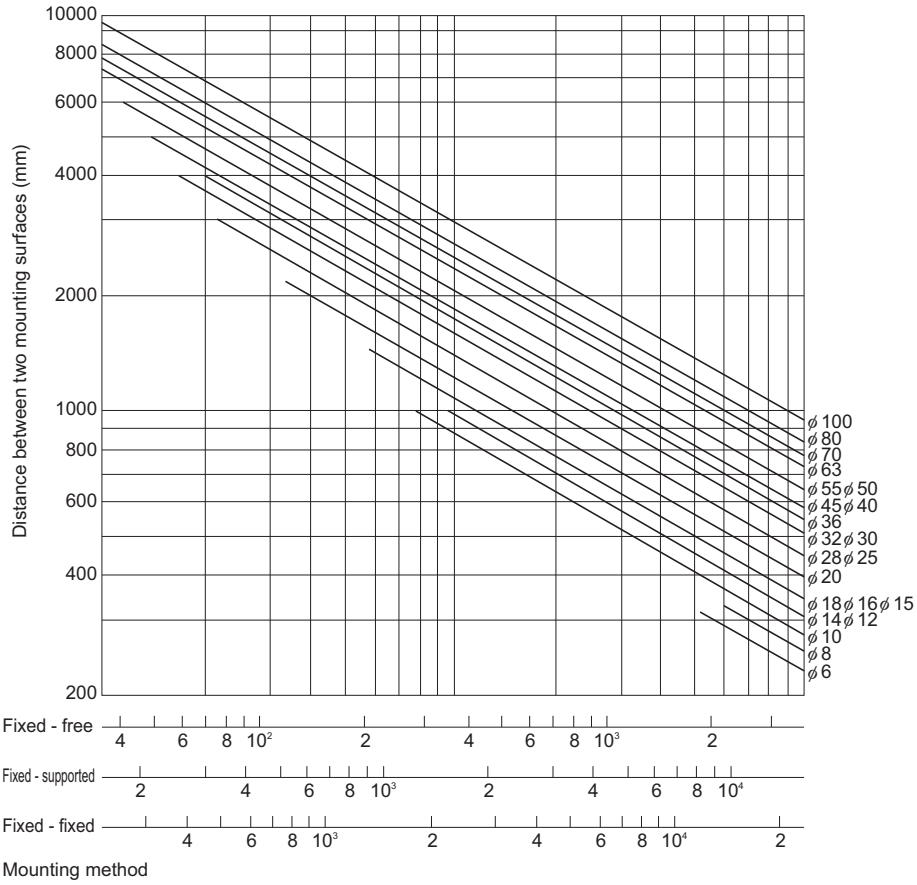

Fig.13 Permissible Rotational Speed Diagram