

# Q&A

**Question:** Do Ball Screws have critical speed?

Yes, they do have critical speed.

Rotating Shaft would vibrate remarkably, when revolution increases, because of the amplification of bending or deflection. In the worst case, Shaft would break or damage. The limit number of revolution that this abnormal vibration occurs is called critical speed. The critical speed varies depending on Shaft length, mounting method and so on, it is calculated by following formula.

$$N = \beta \times \frac{60 \cdot \lambda^2}{2\pi} \times \sqrt{\frac{E \cdot I \cdot g}{\gamma \cdot A \cdot L^4}} \text{ min}^{-1} \{\text{rpm}\}$$

$\beta$  : Safety Factor 0.8

$E$  : Young's modulus  $2.08 \times 10^5 \text{ N/mm}^2$  (MPa) {21,200kgf/mm<sup>2</sup>}

$I$  : Screw Shaft minimum moment of inertia of area

$$I = \frac{\pi}{64} d^4 \text{ mm}^4$$

$d$  : Screw Shaft Root diameter mm

$g$  : Gravity acceleration  $9.8 \times 10^3 \text{ mm/sec}^2$

$\gamma$  : Material specific gravity  $7.7 \times 10^{-5} \text{ N/mm}^3$  {7.85  $\times 10^{-6}$ kgf/mm<sup>3</sup>}

$L$  : Mounting span distance mm

$A$  : Screw Shaft minimum section area

$$A = \frac{\pi}{4} d^2 \text{ mm}^2$$

$\lambda$  : Factor for Ball Screw mounting method

Supported—Supported  $\lambda = \pi$

Fixed—Supported  $\lambda = 3.927$

Fixed—Fixed  $\lambda = 4.730$

Fixed—Free  $\lambda = 1.875$

Generally, calculation result for KSS Miniature Ball Screws seems to be no problem, because of small diameter and short length.

In the permissible speed of Ball screws obtained by critical speed only? The answer is "no". Permissible speed of Ball Screws is the lower one, either the calculated revolution by this formula or  $dn$  (Shaft dia.  $\times$  revolution), which is the limit number of not causing damage on re-circulation part. The calculation by  $dn$  would be remarkably large number, so it is unsuitable for actual usage. KSS sets a limit number of revolution, which should be 3,500 to 4,000 rpm.

**The limit revolution exists even though Miniature Ball screws!!**