1. Features of the Ball Screw

1.1. Driving Torque One Third of the Sliding Screw

With the Ball Screw, balls roll between the screw shaft and the nut to achieve high efficiency. Its required driving torque is only one third of the conventional sliding screw (Fig. 1 and 2). As a result, it is capable of not only converting rotational motion to linear motion, but also easily converting linear motion to rotational motion.

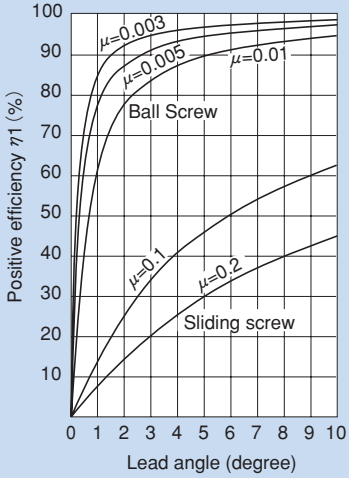


Fig. 1 Positive Efficiency (Rotational to Linear)

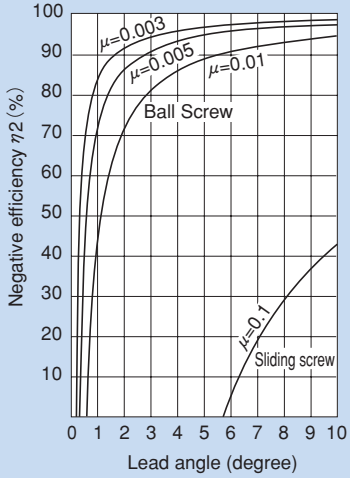


Fig. 2 Negative Efficiency (Linear to Rotational)

1.1.1. Calculating the Lead Angle

$$\tan\beta = \frac{\ell}{\pi \cdot d_P} \quad \cdots\cdots\cdots (1)$$

where

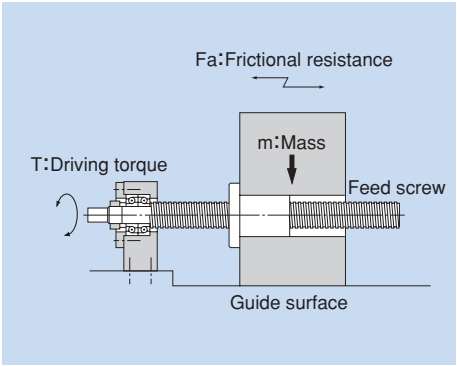
β	:Lead angle	(degree)
d_P	:Ball center diameter	(mm)
ℓ	:Feed screw lead	(mm)

1.1.2. Relationship between Thrust and Torque

The torque or thrust generated when thrust or torque is applied is obtained from equations (2) to (4).

Driving Torque Required to Gain Thrust

$$T = \frac{Fa \cdot \ell}{2\pi \cdot \eta 1} \quad \cdots\cdots\cdots (2)$$



where

T : Driving torque (N·mm)
Fa : Frictional resistance on the guide surface (N)
Fa = μ × mg
μ : Friction coefficient of the guide surface
g : Gravitational acceleration (9.8m/s^2)
m : Mass of the transferred object (kg)
ℓ : Lead of the feed screw (mm)
η1 : Positive efficiency of feed screw
(Fig. 1 on page K-5)

Thrust Generated When Torque is Applied

$$Fa = \frac{2\pi \cdot \eta 1 \cdot T}{\ell} \quad \cdots\cdots\cdots (3)$$

where

Fa : Thrust generated (N)
T : Driving torque (N·mm)
ℓ : Lead of the feed screw (mm)
η1 : Positive efficiency of feed screw
(Fig. 1 on page K-5)

Torque Generated When Thrust is Applied

$$T = \frac{\ell \cdot \eta 2 \cdot Fa}{2\pi} \quad \cdots\cdots\cdots (4)$$

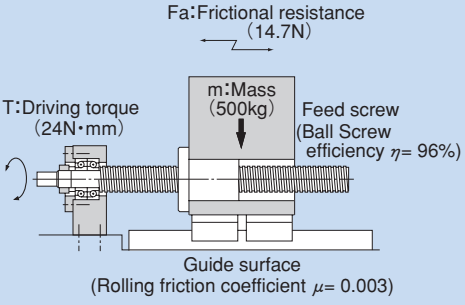
where

T : Torque generated (N·mm)
Fa : Thrust input (N)
ℓ : Lead of the feed screw (mm)
η2 : Negative efficiency of feed screw
(Fig. 2 on page K-5)

■Examples of Calculating Driving Torque

When moving an object with a mass of 500 kg using a screw with an effective diameter of 33 mm and a lead length of 10 mm (lead angle: 5°30'), the required torque is obtained as follows.

Rolling guide (μ= 0.003)
Ball Screw (from μ= 0.003, η= 0.96)



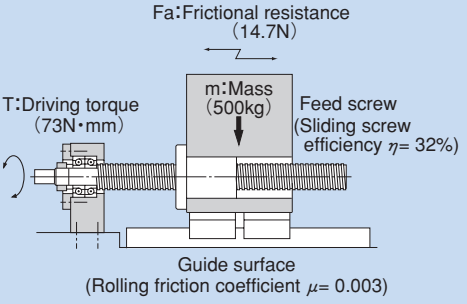
Frictional resistance of the guide surface

$$Fa = 0.003 \times 500 \times 9.8 = 14.7\ N$$

Driving torque

$$T = \frac{14.7 \times 10}{2\pi \times 0.96} = 24\ N \cdot mm$$

Rolling guide (μ= 0.003)
Ball Screw (from μ= 0.2, η= 0.32)



Frictional resistance of the guide surface

$$Fa = 0.003 \times 500 \times 9.8 = 14.7\ N$$

Driving torque

$$T = \frac{14.7 \times 10}{2\pi \times 0.32} = 73\ N \cdot mm$$