Power Screws

Looking at a square thread screw, we unwind one turn:

$$\alpha = \tan^{-1} \frac{\text{Lead}}{2\pi r_m}$$

This shows an inclined ramp with angle

$$\mu$$ Thread friction

$$\mu_c$$ Collar friction

Load on nut

Mean thread radius

Mean collar radius
Power Screw Torque

The torque required to raise the load $W$ is

$$T_{raise} = W \left[ r_m \frac{\mu + \tan \alpha}{1 - \mu \tan \alpha} + \mu_c r_c \right]$$

and to lower the load, we flip two signs:

$$T_{lower} = W \left[ r_m \frac{\mu - \tan \alpha}{1 + \mu \tan \alpha} + \mu_c r_c \right]$$
Power Screw Thread Angle

If the thread form is not square but has an angle $2\phi$, replace the thread friction $\mu$ with the effective friction

$$\mu_e = \frac{\mu}{\cos \phi}$$

The effect:

- Square: $2\phi = 0$, $\phi = 0$, $1/\cos \phi = 1.0$
- Acme: $2\phi = 29^\circ$, $\phi = 14.5^\circ$, $1/\cos \phi = 1.033$
- Unified: $2\phi = 60^\circ$, $\phi = 30^\circ$, $1/\cos \phi = 1.15$

The thread angle effectively increases surface friction between 3 and 15%
Power Screws - Overhauling

If the collar friction is small (e.g., it may have a ball thrust bearing), too small a thread friction may let the weight screw down on its own.

This can happen when \( \mu < \tan \alpha = \frac{\text{Lead}}{2\pi r_m} \)

(the numerator goes negative).

\[
T_{\text{lower}} = W \left[ r_m \frac{\mu - \tan \alpha}{1 + \mu \tan \alpha} + \mu_c r_c \right]
\]

This is the same case for a weight sliding down a ramp when the incline angle \( \alpha \) exceeds \( \tan^{-1} \mu \).