Design fundamentals

The following are the relevant calculations which underlie screw design and safe operation of a Speedy, Easy or Rondo leadscrew.

Calculations at dynamic load:

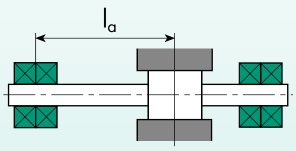
Critical rotational speed n_{per}

Permissible rotational speeds must differ substantially from the screw's own frequency.

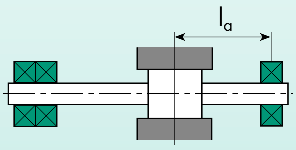
$$n_{per} = K_D \cdot 10^6 \cdot \frac{d_2}{l_a^2} \cdot S_n \quad [min^{-1}]$$

n_{per} = permissible rotational speed [min^{-1}]
K_D = characteristic constant [–]
as a function of bearing configuration › see aside
d_2 = core screw diameter [mm]
l_a = bearing distances [mm] › see aside
(always include maximum allowable l_a in calculation!)
S_n = safety factor [–], usually S_n = 0.5 … 0.8

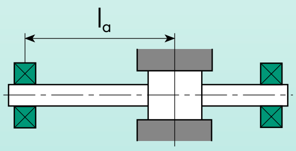
Config. 1: fixed – fixed
→ K_D = 276



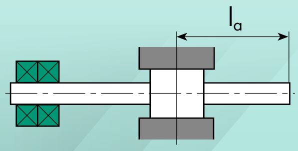
Config. 2: fixed – single
→ K_D = 190



Config. 3: single – single
→ K_D = 122

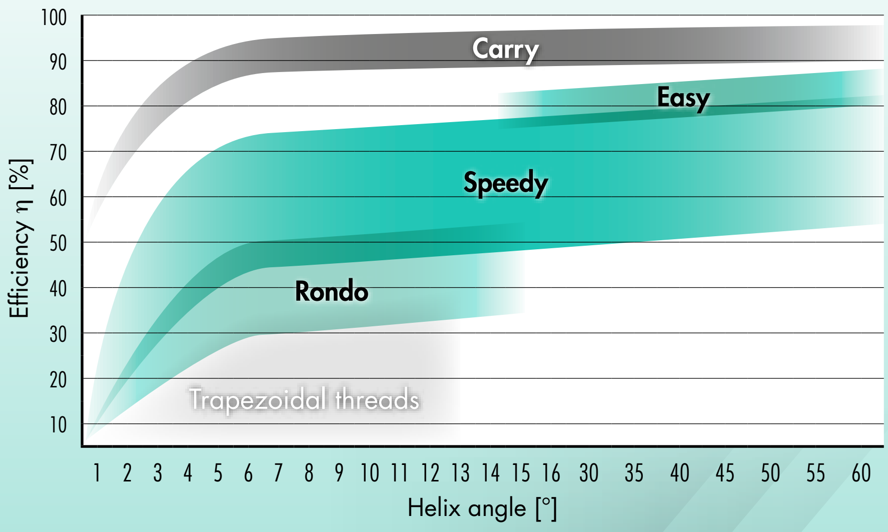


Config. 4: fixed – free
→ K_D = 43



Efficiency η_p (practical)
The efficiency η depends on the helix angle and reaches the following values:

- **Speedy** ~0.5 … 0.75
- **Easy** >0.8
- **Rondo** ~0.3 … 0.5



Basic calculations

Driving torque M

depends upon the type of power transmission

- Case 1: torque → linear movement

$$M_a = \frac{F_a \cdot p}{2000 \cdot \pi \cdot \eta} \ [\text{Nm}]$$

- Case 2: axial force → torque

$$M_e = \frac{F_a \cdot p \cdot \eta'}{2000 \cdot \pi} \ [\text{Nm}]$$

M_a = input torque [Nm], case 1
M_e = output torque [Nm], case 2
F_a = axial force [N]
p = pitch [mm]
η = efficiency [%]
η' = corrected efficiency [%]

Input performance P

$$P = \frac{M_a \cdot n}{9550} \ [\text{kW}]$$

P = input performance [kW]
n = rotational speed [min^{-1}]

A safety margin of 20% is recommended when selecting drives.

Maximum authorized load depending on speed

$$F_{per.} = C_0 \cdot f_L \ [\text{N}]$$

C_0 = static load rate [N]
f_L = load factor [–] for POM-C nuts

Circumferential speed v_C [m/min]	**Load factor f_L** [–]
5	0.95
10	0.75
20	0.45
30	0.37
40	0.12
50	0.08

Example

- Parameters:
  Speedy 10/50 with non-preloaded POM-C nut, d_0 = 10 mm, p = 50 mm and C_0 = 1250 N;
  required moving speed v_S = 200 mm/sec.

- We need to find: $F_{per.}$

Therefore we calculate n [min^{-1}],

$$n = \frac{v_S\ [\text{mm/sec.}] \cdot 60}{p\ [\text{mm}]} = \frac{200 \cdot 60}{50} = 240\ \text{min}^{-1}$$

the circumferential speed v_C [m/min]

$$v_C = \frac{d_0\ [\text{mm}] \cdot \pi \cdot n\ [\text{min}^{-1}]}{1000} = \frac{10 \cdot \pi \cdot 240}{1000} = 7.53\ \text{m/min}$$

and find the load factor f_L in above table:

f_L at v_C of 7.53 m/min ≈ 0.85 [–]

- It follows:

$$F_{per.} = C_{stat} \cdot f_L = 1250 \cdot 0.85 = 1062.5\ \text{N}$$

So the maximum load for a Speedy 10/50 at v_S = 200 mm/sec. (→ n = 240 min^{-1}) is 1060 N.