Bases of calculation for trapezoidal screw assemblies

Support capacity of trapezoidal screws

The load capacity for slide pairings depends on the following:

- Material pairing
- Surface properties
- Intake condition
- Surface pressure
- Lubrication conditions
- Sliding speed
- Temperature
- Duty period
- Possibility for heat dissipation

The maximum admissible surface pressure of 15 N/mm^2 (dynamic) and 25 N/mm^2 (static) should not be exceeded.

Required surface support proportion A_{erf}

$$A_{erf} = \frac{F}{P_{zul}}$$

A_{erf}	= Required surface support proportion	(mm^2)
F	= Axial load	(N)
P_{zul}	= Admissible surface pressure	(N/mm^2)

Feed rate s

$$s = \frac{n \cdot P}{1000}$$

s	= Feed rate	(m/min)
P	= Pitch	(mm)
n	= Speed	(rpm)

Bases of calculation for trapezoidal screw assemblies

Driving torque and driving power

Driving torque M_{ta}
for converting rotary into motion

$$M_{ta} = \frac{F \cdot P}{2000 \cdot \pi \cdot \eta}$$

M_{ta}	= Driving torque	(Nm)
F	= Operating load	(N)
P	= Pitch	(mm)
η	= Efficiency rating	

Coefficient of friction μ
related to the nut material

Nut material	Coefficient of friction μ dry	greased
Steel	0,15	0,10
G-CuSn7ZnPb/G-CuSn12Ni	0,10	0,05

Efficiency rating η

Friction angle ρ'

Lead angle α

$$\eta = \frac{\tan \alpha}{\tan (\alpha + \rho')}$$

$$\rho' = \mu \cdot 1{,}07$$

$$\tan \alpha = \frac{P}{d_2 \cdot \pi}$$

η	= Efficiency rating	
α	= Lead angle	
ρ'	= Friction angle	
P	= Pitch	(mm)
d_2	= Flank diametre	(mm)

Driving power P_a

$$P_a = \frac{M_{ta} \cdot n}{9550}$$

P_a	= Driving power	(kW)
M_{ta}	= Driving torque	(Nm)
n	= Speed	(rpm)

Bases of calculation for trapezoidal screw assemblies

Design of trapezoidal screws and the required driving power

Operating conditions:
Trapezoidal screw with red brass nut (G-CuSn 7 ZnPb)
Axial load: 15000 N
Surface pressure: 5 N/mm² (assumed)

Required surface support proportion A_{erf}

$$A_{erf} = \frac{15000}{5} \qquad A_{erf} = 3000\ mm^2$$

You can now select trapezoidal nuts from the dimension tables:
Red brass flange nut TGM-EFM-Tr50x8-RH-0, with a surface support proportion of 4900 mm² and a flank diametre of 46 mm.

Speed n

$$n = \frac{60 \cdot 1000}{46 \cdot \pi} \qquad n = 415\ rpm$$

Feed rate s

$$s = \frac{415 \cdot 8}{1000} \qquad s = 3{,}32\ m/min$$

Driving torque M_{ta}

$$M_{ta} = \frac{15000 \cdot 8}{2000 \cdot \pi \cdot 0{,}34} \qquad M_{ta} = 56{,}17\ Nm$$

Friction angle ρ'

Lead angle α

Efficiency rating η

$$\rho' = 0{,}1 \cdot 1{,}07 \qquad \rho' = 0{,}107$$

$$\tan\alpha = \frac{8}{46_2 \cdot \pi} \qquad \tan\alpha = 3{,}168°$$

$$\eta = \frac{\tan 3{,}168°}{\tan 3{,}168° + 0{,}107°} \qquad \eta = 0{,}34$$

Driving power P_a

$$P_a = \frac{56{,}17 \cdot 415}{9550} \qquad P_a = 2{,}44\ kW$$

Result

With a load of 15000 N, the selected trapezoidal screw can be operated at a feed rate of 3.32 m/min. The driving power is 2.44 kW. We recommend to use a motor with a rating of 4 – 5 kW since other factors, such as the breakaway torque and the efficiency rating for bearings and guides also have to be taken into account.

Bases of calculation for trapezoidal screw assemblies

Trapezoidal screws must not be operated near their critical speed. Slim, high speed screws have an inherent risk of developing resonant bending vibrations.
Speeds close to the critical speed considerably increase the risk of lateral buckling.
The critical speeds must therefore be included in the calculation of the critical buckling length.

$$n_k = \frac{d_3}{l_1^2} \cdot 10^8 \text{ (rpm)}$$

$$n_{kzul} = 0{,}8 \cdot n_k \text{ (rpm)}$$

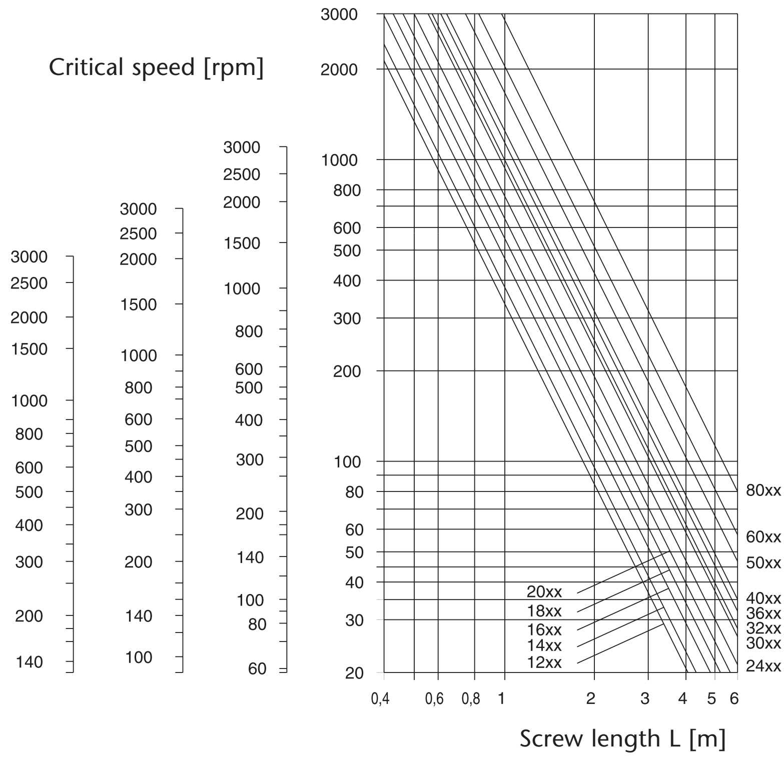
n_k = Critical speed (rpm)

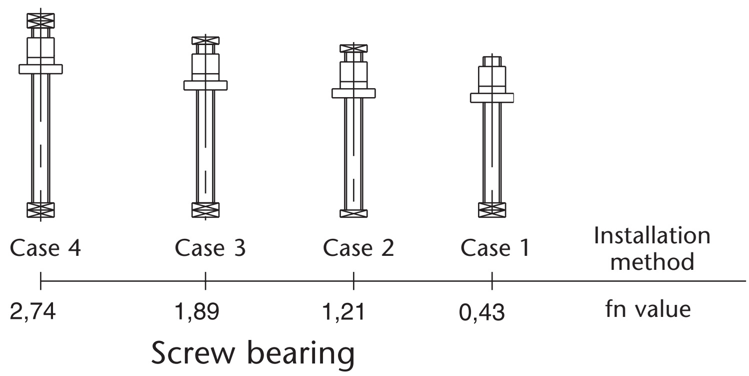
n_{kzul} = Maximum admissible operating speed (rpm)

f_n = Coefficient, determined by the bearing

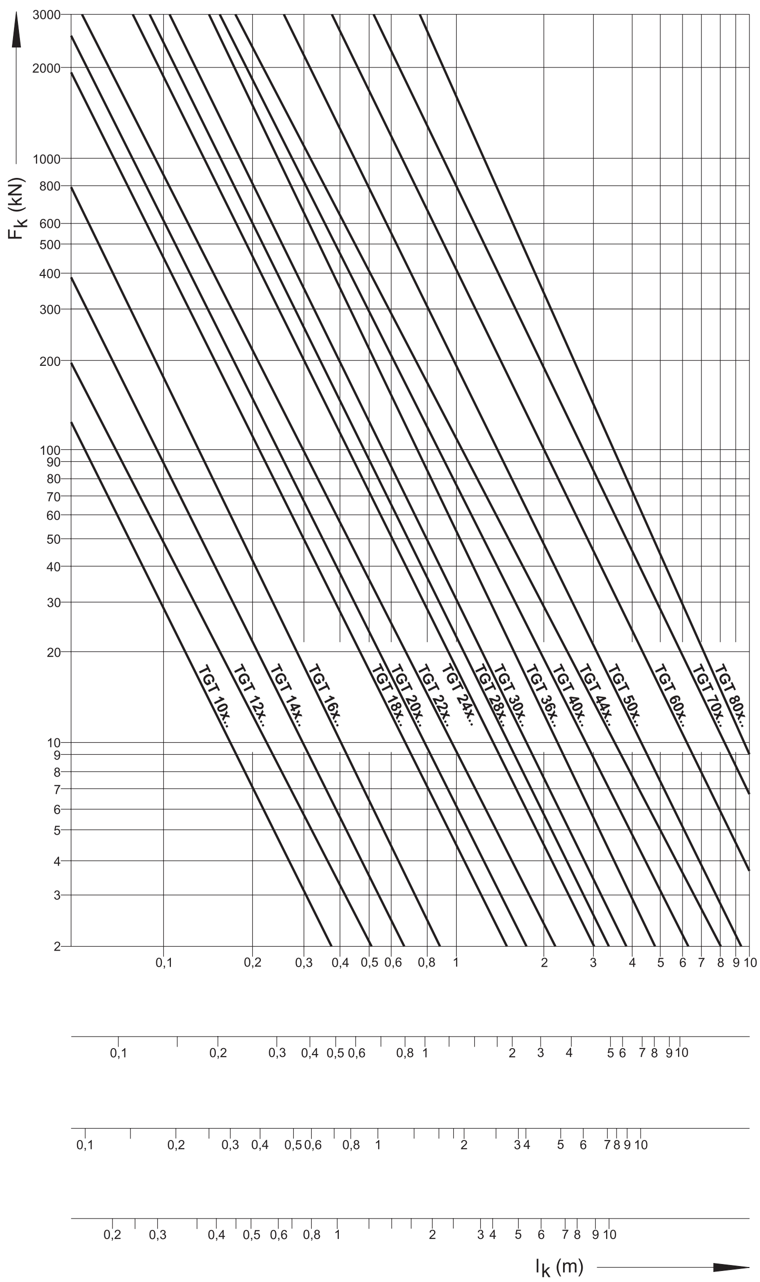
d_3 = Core diametre (mm) of the screw

l_1 = Thread length (mm)





Permitted buckling force of trapezoidal screws



Trapezoidal screws may only be used up to a maximum buckling force.

The screws may buckle if exposed to higher stresses.

The maximum axial load depends on the length, diametre and installation method of the trapezoidal screw.

The axial screw load should not exceed 50 % of the maximum permitted load theoretically. The diagram shows the maximum axial force depends on the screw length, screw diametre and installation method.

$$F_k = f_k \cdot \frac{d_2^4}{l_k^2} \cdot 10^5 \text{ (N)}$$

$$F_{kzul} = \frac{F_k}{4} \text{ (N)}$$

F_k = Maximum theoretical axial screw load

F_{kzul} = Maximum admissible axial force during operation

f_k = Coefficient, determined by the bearing

d_2 = Flank diametre (mm) of the screw

l_k = Unsupported thread length

f_k value	Installation method
0,26	Case 1
1,02	Case 2
2,04	Case 3
4,06	Case 4