Power screws

The power screws are used to convert the rotary motion into a sliding one (rarely the other way around). They are commonly used as guide screws for machine tools, screws for presses and jacks.

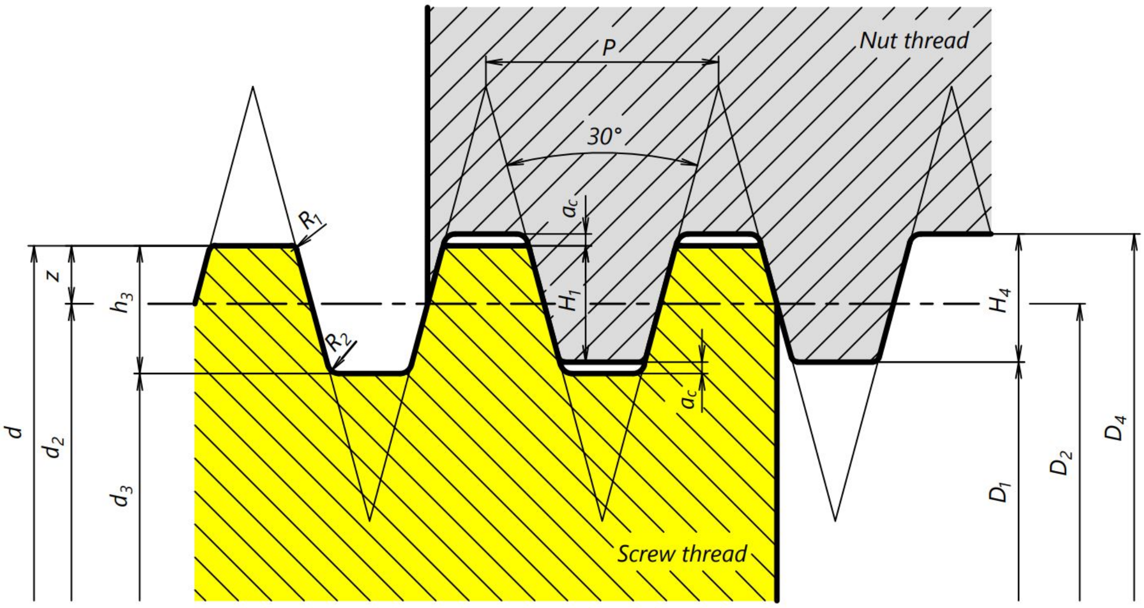

Fig.1 power screws

Lifting torque:

$$M_L = \frac{Fd_2}{2}\left[\frac{P+\pi\mu d_2 sec(30/2)}{\pi d_2-\mu P sec(30/2)}\right]$$

M_L	lifting torque	[Nm]
F	axial force	[N]
d_2	medium diameter	[mm]
P	thread pitch	[mm]
μ	friction	[]

Axial stress the screw:

$$\sigma = \frac{F}{\frac{\pi}{4}\left(\frac{d_2+d_3}{2}\right)^2}$$

σ	axial stress the screw	[MPa]
F	axial force	[N]
d_2	medium diameter	[mm]
d_3	smaller external thread diameter	[mm]

Shear stress the screw:

$$\tau = \frac{M}{\frac{\pi}{16}\left(\frac{d_2 + d_3}{2}\right)^3}$$

τ	shear stress the screw	[MPa]
M	torque	[Nm]
d_2	medium diameter	[mm]
d_3	smaller external thread diameter	[mm]

Maximal shear stress (Tresca) the screw:

$$\sigma_{tresca} = \sqrt{\sigma^2 + 4\tau^2} \leq \sigma_{Call}$$

σ_{tresca}	maximal shear stress (Tresca) the screw	[MPa]
σ	axial stress the screw	[MPa]
τ	shear stress the screw	[MPa]
σ_{Call}	allowed combined stress	[MPa]

Allowed combined stress:

$$\sigma_{Call} = \frac{R_{p0,2T}}{S_F} * C_c$$

σ_{Call}	allowed combined stress	[MPa]
$R_{p0,2T}$	the minimum yield strength or 0,2% proof strength at calculation temperature	[MPa]
S_F	safety factor	[]
C_c	coefficient according to load	[]

Coefficient according to load:

load	[]
Unidirectional load, non-impact load	0,8
Unidirectional load, with a small impact load	0,7
Unidirectional load, with a big impact load	0,6
Alternating load, with a small impact load	0,45
Alternating load, with a big impact load	0,25

Bearing stress the thread:

$$p_t = \frac{4F}{\frac{L_n}{P} * \pi * (d^2 - D_1^2)} \leq \sigma_{all(t)}$$

p_t	bearing stress the thread	[MPa]
F	axial force	[N]
L_n	nut length	[mm]
P	thread pitch	[mm]
d	thread	[mm]
D_1	minor diameter	[mm]
$\sigma_{all(t)}$	allowable bearing stress the thread	[MPa]

Allowable bearing stress the thread:

$$\sigma_{all(t)} = \frac{0{,}9R_{p0,2T}}{S_F} * C_c * C_t$$

$\sigma_{all(t)}$	allowable bearing stress the thread	[MPa]
$R_{p0,2T}$	the minimum yield strength or 0,2% proof strength at calculation temperature	[MPa]
S_F	safety factor	[]
C_c	coefficient according to load	[]
C_t	power screw coefficient	[]

Power screw coefficient:

$$C_t = 2{,}7083v^2 - 1{,}5937v + 0{,}25; \max v = 0{,}25$$

C_t	power screw coefficient	[]
v	screw speed	[m/s]

Screw speed:

$$v = \frac{n}{60} * \pi * d_2$$

v	screw speed	[m/s]
n	speed	[rpm]
d_2	medium diameter	[mm]

Buckling:

- Columns with eccentric loading:

The Secant equation for the stress calculation in the extreme fiber of a profile.

$$\frac{F_{max}}{S} = R_{p0,2T} / \left[1 + \frac{ec}{i^2} sec \left(\frac{L * \beta}{2i} \sqrt{\frac{F_{max}}{ES}} \right) \right]$$

applies under the following conditions:

$$\frac{L * \beta}{i} > 0{,}282 \sqrt{\frac{ES}{F}}$$

$$\frac{F_{max}}{S_F} * C_c \geq F$$

- Struts or short columns with eccentric loading:

$$\frac{F_{max}}{S} = R_{p0,2T} / \left[1 + \frac{ec}{i^2} \right]$$

applies under the following conditions:

$$\frac{L * \beta}{i} \leq 0{,}282 \sqrt{\frac{ES}{F}}$$

$$\frac{F_{max}}{S_F} * C_c \geq F$$

F_{max}	maximal (critical) force	[N]
S	profile area	[mm^2]
$R_{p0,2T}$	the minimum yield strength or 0,2% proof strength at calculation temperature	[MPa]
e	eccentricity	[mm]
c	extreme fiber distance	[mm]
i	gyration radius	[mm]
L	strut length	[mm]
β	type of strut mounting	[]
E	Young's modulus	[MPa]
F	axial force	[N]
S_F	safety factor	[]
C_C	coefficient according to load	[]

Type of strut mounting:

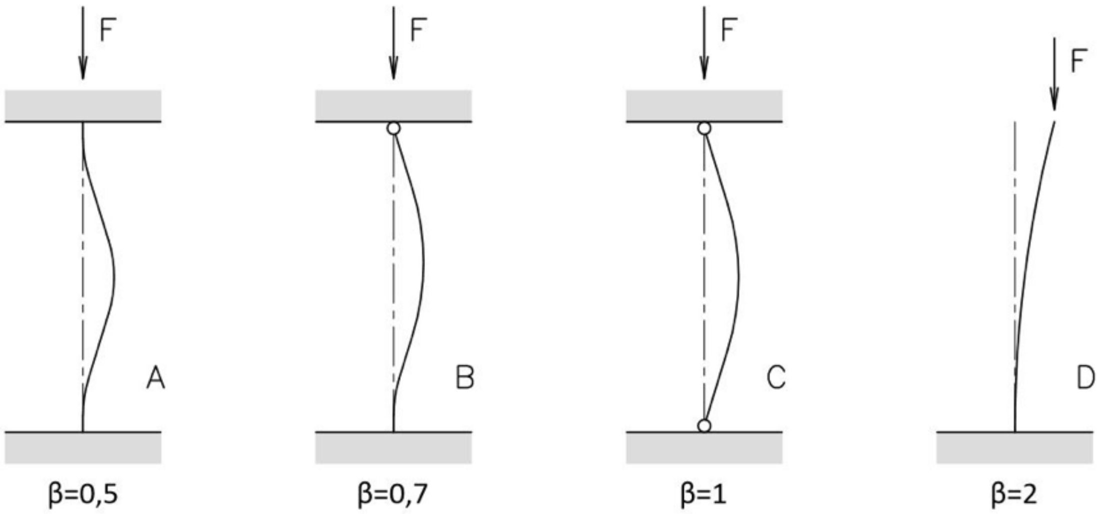

Fig.2 type of strut mounting

Literature:

MET-Calc: Allowable stress
https://met-calc.com/soubory/clanky/Allowable%20stress%20[EN].pdf
MET-Calc: Buckling
https://met-calc.com/soubory/clanky/Buckling%20[EN].pdf
Joseph E. Shigley, Charles R. Mischke, Richard G. Budynas: Konstruování strojních součástí 2010.