* Assume the crank arm to be L=175mm with about a 250mm stroke.

Ignore non-axial force acted on the arm, only consider the compressive load.

* Calculation: Given the output of geartrain torque as T.

1. **The axial force** acted on the leadscrew

**The velocity of the nut:**

It’s a very slow, high thrust.

1. **Preliminary Screw Selection**
2. Find the core diameter:

Assuming the yield strength of the steel

(the core diameter)

1. Buckling check(Euler’s Formula):

For (next standard size up),

safe

Tr 40×7 (trapezoidal thread, 40 mm diameter, 7 mm pitch) was selected for safety and manufacturing standards.

Dimensions:

dr=33 #[mm] the minor diameter of the screw thread

dm=dr+p/2 #[mm] the pitch diameter of the lead screw

p=7 #[mm] the pitch of the lead screw

l=p #[mm] the lead of the screw thread

f=0.1 #the coefficient of friction on the thread

nt=4 #the number of threads involved in the lead screw

Sy=300 #[MPa] the yield strength of the lead screw

1. self-locking:

The condition for self-locking is

or

Where,

[mm]

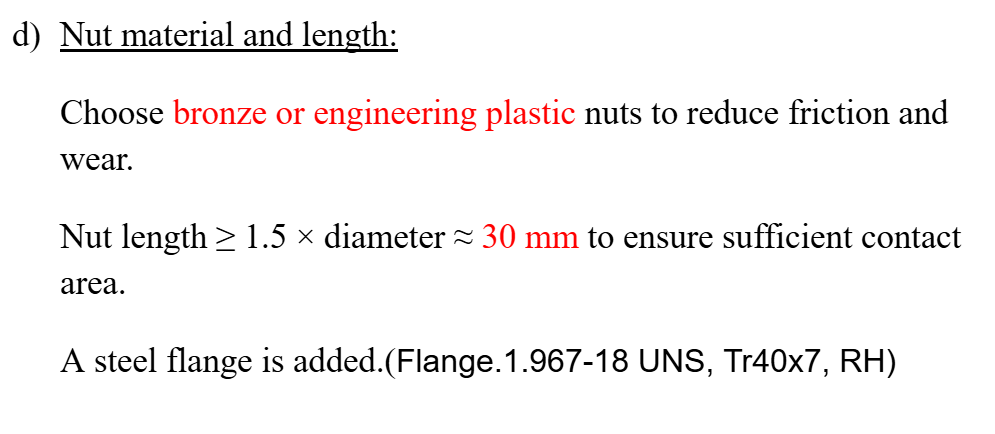
[deg]

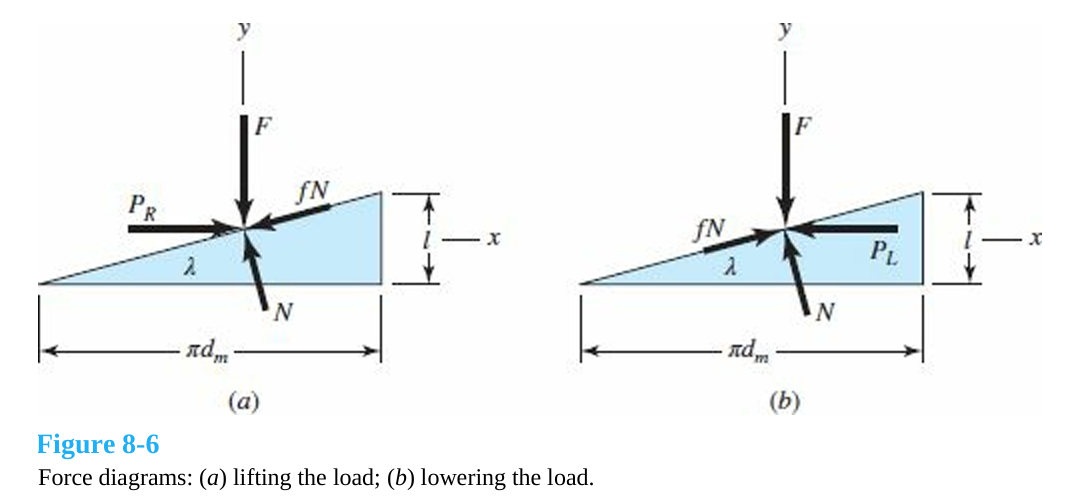
It can fulfill the self-locking condition and avoid an uncontrolled load in case of power failure.

1. Nut material and length:

Choose bronze or engineering plastic nuts to reduce friction and wear.

Nut length ≥ 1.5 × diameter ≈ 30 mm to ensure sufficient contact area.



1. We use equilibrium equations in x and y directions, **solving for *PR* and *PL***:

Where PR is the force to lift the load (defined as the force that makes the cradle to rotate clockwise to convey the paper roll), and PL is the force to lower the load.

Then, find the torque required by multiplying the load *P* with the mean radius *dm/2*,

1. **Thread failure:**

We use the von Mises theory to analyze thread failure:

1. Stress element:

1. Stress and Strain Components:

The nominal shear stress τ in torsion is

The axial nominal normal stress σ is

Where,

, *d* is the major diameter

The thread-root bending stress *σb* is

Where *nt* is the number of engaged threads.

The tangential shear stress *τzx* is

1. Three-dimensional von Mises stress:
2. Compare against the yield strength of the material

Where *n* is the factor of safety and

1. **Recommended Commercial Part**

Lead Screw

| Size(mm) | Tr40x7 |
| --- | --- |
| Length(m) | 1 |
| Material | AISI 1018 Carbon Steel |
| Yield Strength(MPa) | 300 |
| Vendor | Roton |
| Price(usd) | $174.30 |

Nut

| Size(mm) | Tr40x7 |
| --- | --- |
| Material | Bronze |
| Vendor | Roton |
| Price(usd) | $137.71 |

[**40 X 7 Right Hand Trapezoidal Lead Screws & Nuts for Power Transmission - Roton Products, Inc.**](https://www.roton.com/family/trapezoidal-right-screws-and-nuts-7060882/)

[**Power Screw Analysis.ipynb**](https://colab.research.google.com/drive/12VaEfzcBI957ljxYqvTidNJCQ27JQOy3?usp=sharing)