Lifting Calculations

Monday, March 28, 2022 5:47 PM

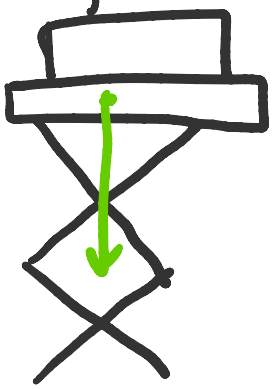
Assumptions: Lifting portion: ~10 lbs total (4.53 kg) round to 5 kg

max package weight: 20 lbs (9.07 kg) round to 9.5 kg

max total load: 30 lbs (13.6 kg) round to 14.5 kg from 9.5 kg + 5 kg

Lowering: load = 36 lbs max

Lifting: load = 10 lbs max.



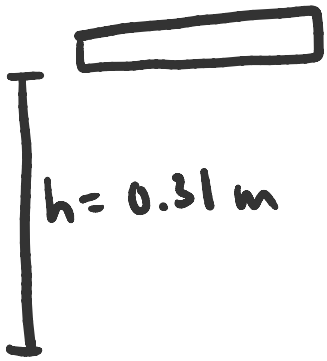
$\vec{F}_{down} = m \cdot g = (14.5\,kg)(9.8\,m/s^2)$

$= 142.1\,N$

Helps motor lower but motor needs to resist force to prevent sudden dropping.

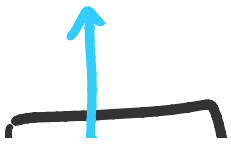
Assumptions: Distance to travel = 2ft = 0.31 m

$t = 30$ seconds

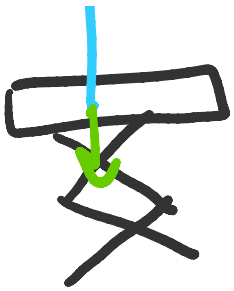


Find: Velocity package needs to be moving in this case.

$$v = \frac{d}{t} = \frac{0.31}{30} = 0.010\overline{3}\ m/s$$



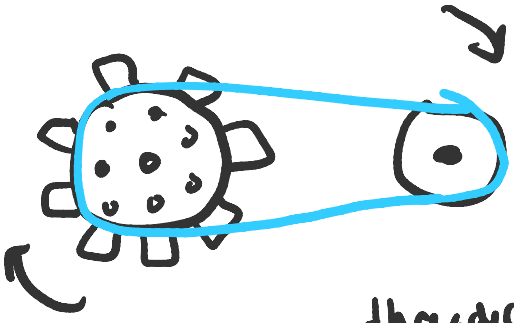
Lifting: $\vec{F}_{down} = m \cdot g = (5\,kg)(9.7) = \underline{49\,N}$



Lifting: $F_{down} = m \cdot g = (5\,kg)(9.81\,m/s^2) = 49\,N$

To raise: motor needs to overcome 49 N

Assuming Lifting setup looks like:



Motor gear/pulley

Threaded shaft

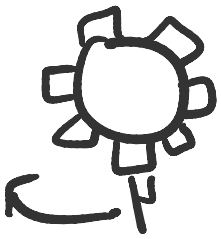
Gear flange: 32 mm D = 1.26 in

16 mm radius (0.63 in)

16×10^{-3} m

Assuming threaded shaft flange:

$r = \approx 0.25\,inch \approx 7\,mm$



90° torque angle to simplify calculations

$\tau = rF\sin\theta$, $\sin\theta = \sin 90 = 1$

$\tau = rF$

Assuming axis is main torque applier (worst case) other teeth will help in actuality.

Worst case, assuming motor gear/pulley takes ALL 49 N of force:

$\tau = (16 \times 10^{-3})(49\,N) = 0.784\,N/m$

actuality.

$\tau = (16 \times 10^{-3})(49\,N) = 0.784\,N/m$

But need additional to overcome, so assume 55 N force needed to move

$= \tau = (16 \times 10^{-3})(55\,N) = 0.88\,N/m$

0.784 N/m = 7.99 Kg/cm

0.88 N/m = 8.97 Kg/cm

For worst case: max load: 142.1 N

$\tau = (16 \times 10^{-3})(142.1) = 2.2736\,N/m = 23.1847\,Kg/cm$

Motor is well within specs! 70 Kg/cm = 6.865 N/m

Motor has extra torque for speed adjustments.