Team: P17046 - Concept Analysis
Engineer: Josh Closson
Rev: 1
Date: 15NOV16

Spring Selection

$$E_{Ball} + E_{Rotation} = E_{Spring}$$
$$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$
$$I = \frac{2}{3}mr^2$$
$$\omega = \frac{v}{r}$$

Substitution

$$\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{3}mr^2\right)\left(\frac{v}{r}\right)^2 = E_{Spring}$$

$$\frac{5}{6}mv^2 = E_{Spring}$$

Spring Energy

$$PE_{spring} = \frac{1}{2}k\left(x_f - x_i\right)^2$$

$$E_{spring} = 2PE_{spring}$$
$$E_{spring} = k\left(x_f - x_i\right)^2$$
$$\frac{E_{spring}}{\left(x_f - x_i\right)^2} = k$$
$$k_{min} = 18.86\ {}^{lb_f}/_{in}$$

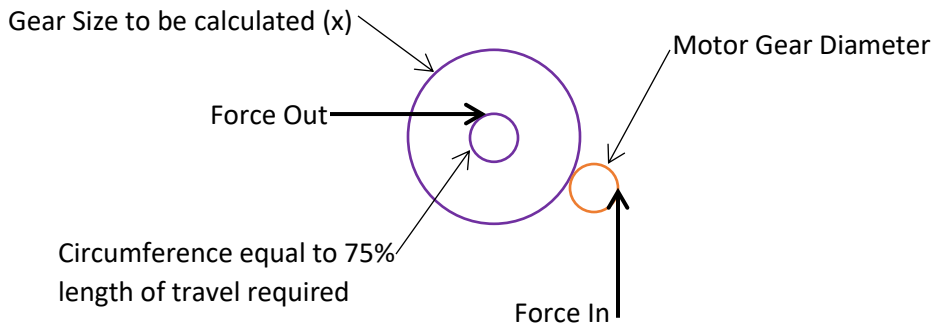
Selected Spring

https://www.thespringstore.com/pe162-1250-33-636-mw-7-000-mh-z-in.html
k = 22.00
Initial Length = 7.000”
Max Length = 12.000”
Maximum Load = 133 lbs
TSS Part # PE162-1250-33.636-MW-7.000-MH-Z-IN

Selected Servo

https://www.servocity.com/44-rpm-premium-planetary-gear-motor
Speed = 44rpm
Stall Torque = 347.2 oz-in
Torque for Calculations (1.15 SF) = 300 oz-in

Gear Train Design



Force Required

$$F_{spring} = k(x_f - x_i)$$
$$F_{out} = F_{spring}$$

Gear Ratio Required

$$MA = \frac{T_{out}}{T_{in}} = \frac{r_{out}F_{out}}{r_{in}F_{in}} = \frac{x}{r_{motor}}$$

$$x = \left(\frac{r_{out}F_{out}}{T_{in}}\right) r_{motor}$$

$$\pi d 0.75 = c = (x_f - x_i)$$

$$r_{rack\ gear} = \frac{1}{2}\left(\frac{(x_f - x_i)}{\pi\ 0.75}\right)$$

Speed Calculation

$$MA = \frac{w_a}{w_b} = \frac{w_{motor}}{w_{out}}$$

$$\frac{w_{motor}}{MA} = w_{out}$$