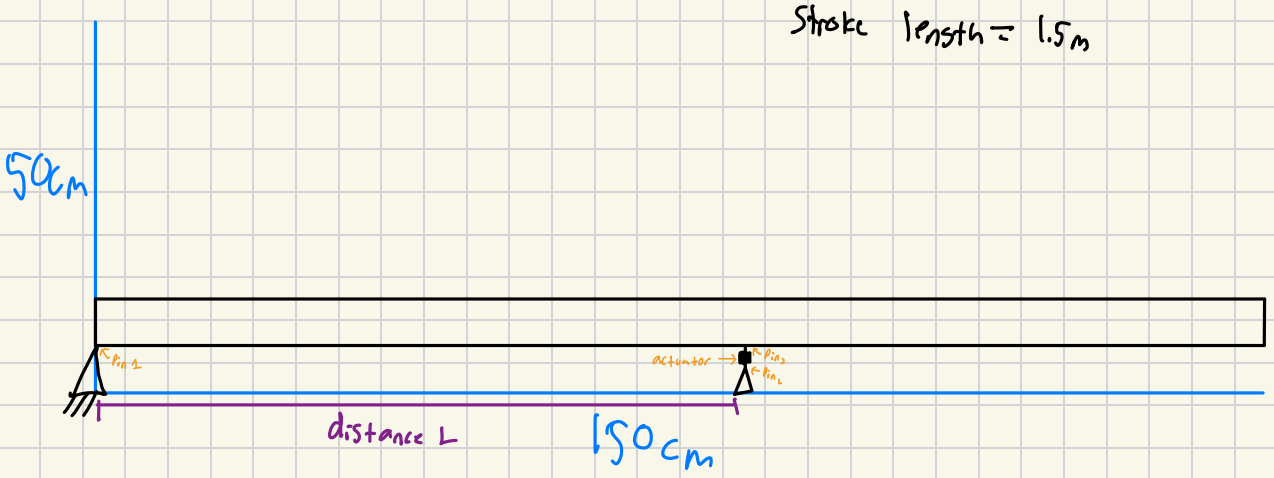
Portfolio

Part 1

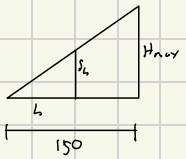
Use Actuator RSX Max force = 294 kN

Stroke length = 1.5 m



decrease L to increase height lifted

increase L to increase weight lifted



$$\sum M_{Pin\,1} = L \cdot F_{actuator} - 150 \cdot F_w = 0$$

$$L \cdot F_{actuator} = 150 \cdot m_g$$

$$m_{max} = \frac{L}{150} F_{actuator}$$

$$\frac{SL}{L} = \frac{H_{max}}{150cm}$$

$$H_{max} = \frac{150cm \cdot 150cm}{L}$$

L = 50cm because any extra height above 1.5m seems excessive and we still have an acceptable m_{max} of 9989.806 kg

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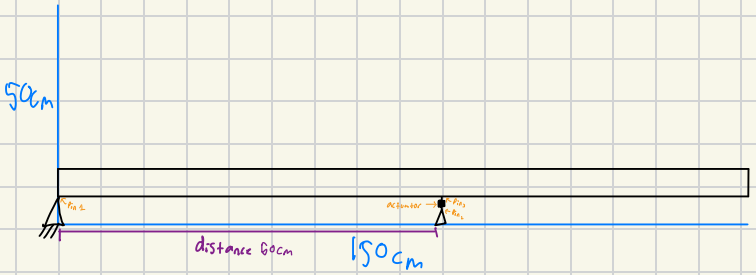
Portfolio spread sheet

	A	B	C
1	L	m(max) kg	H(max) m
2	1	199.7961264	225
3	10	1997.961264	22.5
4	20	3995.922528	11.25
5	30	5993.883792	7.5
6	40	7991.845056	5.625
7	50	9989.80632	4.5
8	75	14984.70948	3
9	100	19979.61264	2.25
10	125	24974.5158	1.8

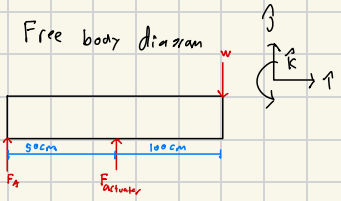
Portfolio Part 2



Assume weight is maximum possible weight

$m = 9989\ kg$ at end

Free body diagram



$w = mg$

$\sum F_y \quad F_A + F_{actuator} = w$ $\qquad w = 9989 \cdot 9.81$

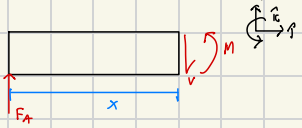
$\sum M_A \quad 50cm\ F_{act} = 150cm\ w$ $\qquad w = 97.99\ kN$

$F_{act} = 3w$ $\qquad F_{act} = 293.98\ kN$

$F_A = w - F_{act} = -195.98\ kN$

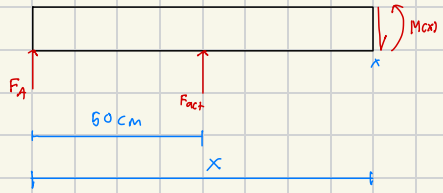
Break into Spans

Span 1 Pin to actuator



$\sum M_x \quad F_A \cdot x = M(x)$

Span 2 actuator to weight



$\sum M_x \quad M(x) = F_A \cdot x + F_{act}(x - 0.5m)$

Span 1

$EI\,y'' = M(x)$

$EI\,y'(x) = \frac{F_A x^2}{2} + C_1$

$EI\,y_1(x) = \frac{F_A x^3}{6} + C_1 x + C_2$

Use BC $y(0) = 0 \rightarrow C_2 = 0$

Span 2

$EI\,y'' = M(x)$

$EI\,y_2' = \frac{F_A x^2}{2} + F_{act}\left(\frac{x^2}{2} - 0.5m\,x\right) + C_3$

$EI\,y_2(x) = \frac{F_A x^3}{6} + F_{act}\left(\frac{x^3}{6} - \frac{0.5m\,x^2}{2}\right) + C_3 x + C_4$

$y_1'(0.5) = y_2'(0.5)$ $\qquad \frac{F_A (0.5)^2}{2} + C_1 = \frac{F_A (0.5)^2}{2} + F_{act}\left(\frac{(0.5)^2}{2} - 0.5 \cdot 0.5\right) + C_3$

$y_1(0.5) = y_2(0.5)$ $\qquad \frac{F_A (0.5)^3}{6} + C_1 (0.5) = \frac{F_A (0.5)^3}{6} + F_{act}\left(\frac{(0.5)^3}{6} - \frac{(0.5)^3}{2}\right) + C_3 (0.5) + C_4$

$y_2(1.5) = 0$ $\qquad 0 = \frac{F_A (1.5)^3}{6} + F_{act}\left(\frac{(1.5)^3}{6} - \frac{(1.5)^3}{2}\right) + C_3 (1.5) + C_4$

Use software to solve system of equations

$C_1 = \frac{2241575}{9} \qquad C_3 = \frac{5144605}{18} \qquad C_4 = \frac{73495}{6}$

Use graphing software for max deflection location

$X = 1.5$

$y_{max} = y(1.5) = \frac{330727.5}{EI}$

Limiting deflection to under 2%

$y_{max} = y(1.5) = \frac{330727.5}{EI}$

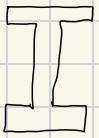
$y_{max} < 0.02 \cdot L \rightarrow y_{max} < 0.03m$

$E_{steel} = 200\ GPa \qquad I > \frac{330727.5}{200 \times 10^9 \cdot 0.03}$

$I > 0.000055121$ note: At first this number seemed very low but typical allowance bending is in the range of mms so a lower number makes some sense

I initially wanted to use I-beam cross section since they are strong in bending and there is no torsion which is what they are weakest at.

The proposed cross section



But I think shear will be the limiting case so

I went with a rod instead

$I = \frac{\pi}{4} r^4$

$\left(\frac{4I}{\pi}\right)^{1/4} = r$

$r = 0.0915m$