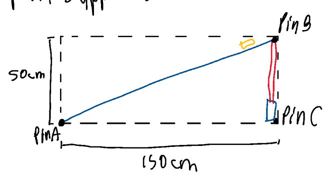
Portfolio

Saturday, December 6, 2025 9:32 PM

2D Design 150cm long, 50cm tall

Fixed length

3 pin supports



Using Acuator RSX

Step 1:

Bar in design to be rigid

Follow steps to update portfolio

a) Create sections to define problem, constraints, and design degrees of freedom

constraints:

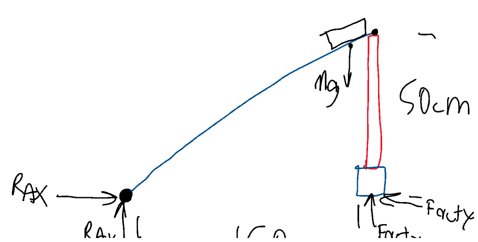
- 150cm long, 50cm tall
- Rigid bar, fixed length
- 3 pin supports mounted to ground
- linear actuator

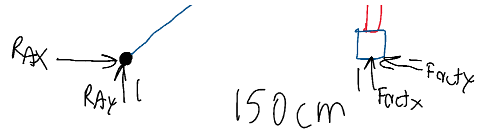
Degrees of freedom

- Only rotation about the z axis for both designs
- Static analysis

since this is the longest the bar can be, and also using the largest/tallest actuator, so the mass can be pushed the greatest distance.

FBD diagram (when slightly extended to show all possible forces at initial part, as this is when the max deflection occurs:





$$\Sigma F_x = R_{Ax} - F_{actx} = 0$$

$R_{Ax} = F_{actx} = 0$ assuming neither of these forces would have anything to cause a force on the other

$$\Sigma F_y = R_{Ay} - Mg + F_{acty} = 0$$

$$R_{Ay} = mg - F_{acty}$$

$$\Sigma M_A = r_{1\perp} \cdot F_{act} - \underset{\substack{\uparrow \\ \text{mass} \cdot \text{gravity} \\ \text{of weight}}}{r_{2\perp} \cdot Mg} = 0 \leftarrow \text{assume quasistatic}$$

$r_{1\perp} = r_{2\perp}$ since the mass is placed at the end of the rod for the greatest distance moved

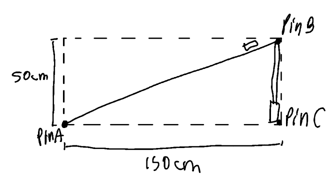
$\therefore$

$F_{act} = mg$

$\therefore$

$R_{Ay} = mg - mg = 0$

c) Find beam presentations

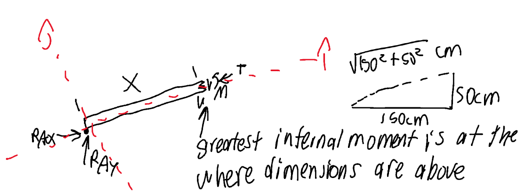


Step 2:

bar in mechanism no longer rigid

Find max deflection

$$EIy'' = M(x)$$



greatest internal moment is at the bottom before moving, where dimensions are above

$$\Sigma F_{\nearrow} = 0 = T - \cancel{R_{Ax}}^{\,0} - \cancel{R_{Ay}}^{\,0} = 0$$

$T = 0$

$$\Sigma F_{\uparrow} = V - R_{Ay\uparrow} + R_{Ax\uparrow} = 0$$
$$V = 0$$

$$\Sigma M_A = M - V \cdot x = 0$$
$$M = V \cdot x = 0$$
$$\therefore$$
$$y = \text{deflection} = 0$$

b) any shape will work, but analyzing for most effective shape:

$$P_{cr} = \frac{\pi^2 E I}{L^2}$$

$$I = \frac{L^2 P_{cr}}{\pi^2 E}$$

if the mass were placed in a different position, i.e. where $P_{cr} = mg$, where $m = 10kg$, $g = 9.81 m/s^2$

and the material was titanium, $E = 115 GPa = 115 \cdot 10^9 Pa$

$$I = \frac{\left(\sqrt{50^2+150^2}\, cm \cdot \frac{1m}{10^2 cm}\right)^2 (10kg \cdot 9.81 m/s^2)}{\pi^2 (115 \cdot 10^9 Pa)} = 1.37 \cdot 10^{-10} m^4 = 1.37 \cdot 10^{-10} \cdot 10^{12} mm^4 = 1.37 \cdot 10^2 mm^4$$

the S75·11.2 S-shape beam will work

c) The final beam design is: