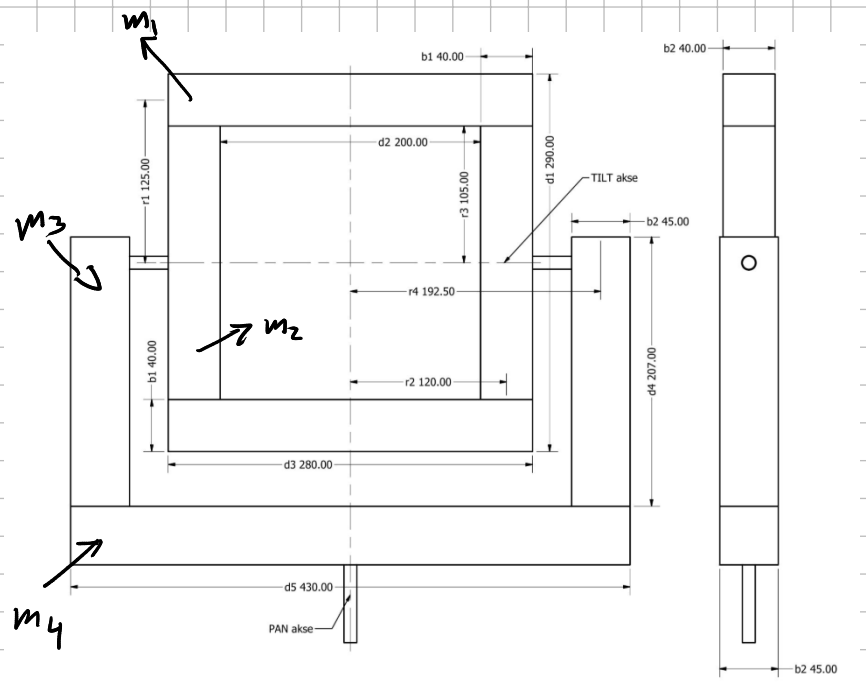
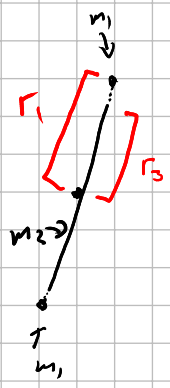




Torque

$$\tau_m = I \cdot \alpha$$

TILT Inertial Moment

$$I = 2m_1 r_1^2 + \frac{1}{6} m_2 r_3^2$$

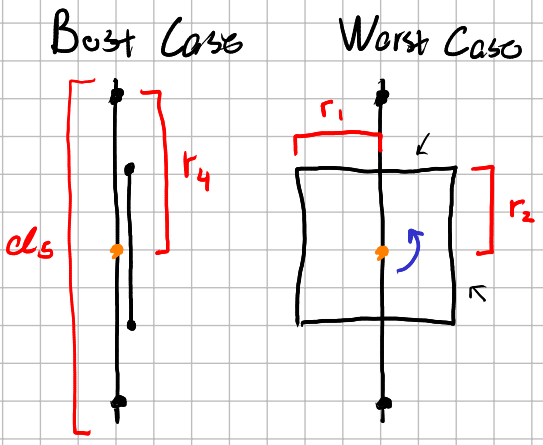
We approximate the frame as a rod with point masses at its ends.

PAN Inertial Moment

Base:

$$I_B = 2m_3 r_4^2 + \frac{1}{12} m_4 \left(\frac{d_5}{2}\right)^2$$

$$= 2m_3 r_4^2 + \frac{1}{48} m_4 d_5^2$$



Mounted tilt system:

$$I_p = I_0 + Md^2$$

$$I_w = \frac{2}{12} \cdot \frac{m_t}{4} \cdot r_1^2 + \frac{m_t}{4} r_2^2 + \frac{2}{12} \cdot \frac{m_t}{4} \cdot r_2^2 + \frac{m_t}{4} \cdot r_1^2 + I_B$$

$$I_w = \left(\frac{1}{6} r_1^2 + r_2^2 + \frac{1}{6} r_2^2 + r_1^2\right) \frac{m_t}{4} + I_B$$

$$= \left(\frac{7}{6} r_1^2 + \frac{7}{6} r_2^2\right) \frac{m_t}{4} + I_B = \left(r_1^2 + r_2^2\right) \frac{7}{24} m_t + I_B$$

Dynamic r1 : The angle is 0/180 in best case and 90/270 in worst case

$$r_1 = \sin(\theta_{tilt})$$