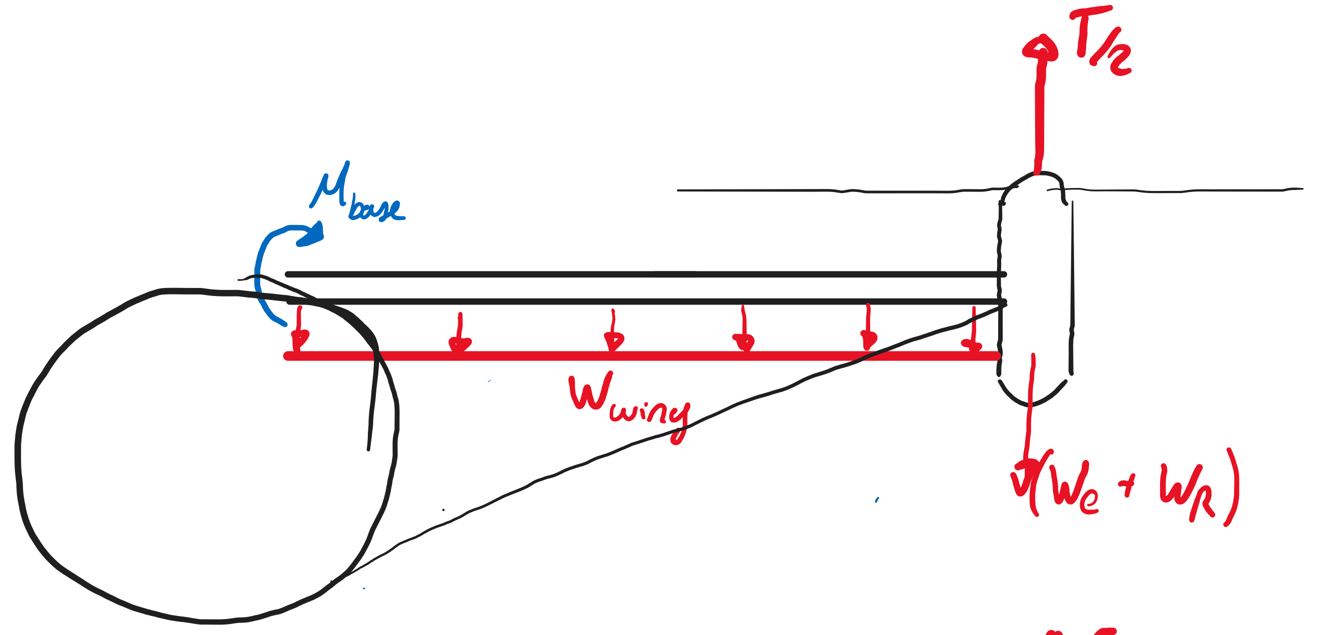
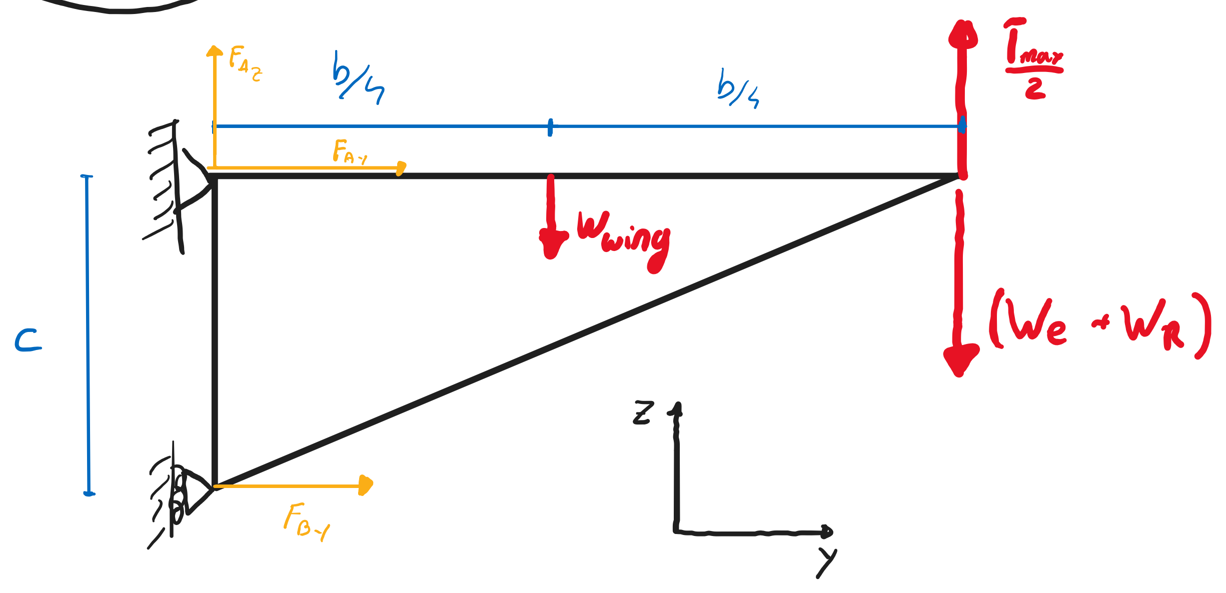
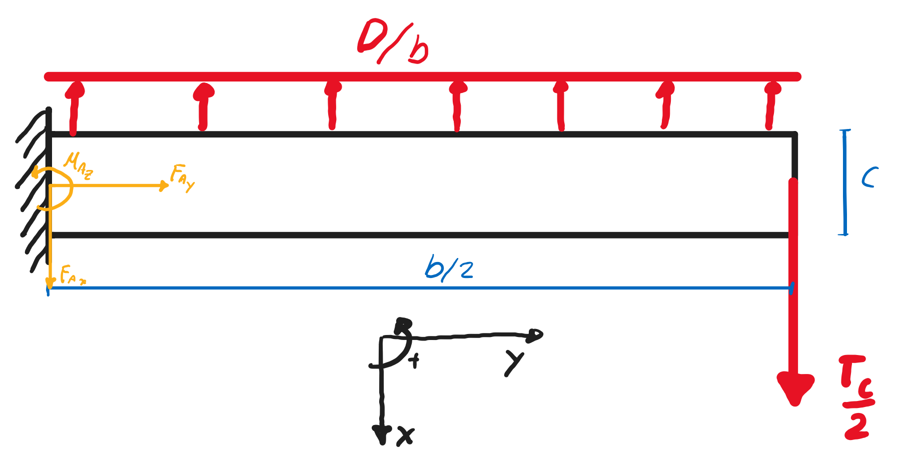
Wing Loads







Assumptions

- Structure 1 is an ideal truss
- No vibrational loads
- Costant wing weight distribution
- Fuselage height = wing chord
- Square wing

$$\Sigma F_z = 0 \rightarrow F_{A_z} + F_{B_z} = 0 \rightarrow \boxed{F_{A_z} = -F_{B_z}}$$

$$\Sigma F_y = 0 \rightarrow F_{A_y} + \frac{T_{max}}{2} - (W_e + W_R) - W_{wing} = 0$$

$$\boxed{F_{A_y} = g_m\left(m_e + m_R + m_{wing} - n_{TO}\frac{MTOM}{2}\right)}$$

$$\Sigma M_{A_x} = 0 \rightarrow F_{B_x} c - W_{wing}\frac{b}{4} + \frac{b}{2}\left(\frac{T_{max}}{2} - (W_e + W_R)\right) = 0$$

$$F_{B_x} = \frac{1}{c}\left(\frac{b}{4} m_w g_m - \frac{b}{2} n_{TO} \frac{MTOM}{2} g_m + g_m m_e + g_m m_R\right)$$

$$\boxed{F_{B_x} = \frac{g_m}{c}\left(\frac{b}{4}(m_w - n_{TO} MTOM) + m_e + m_R\right)}$$

$$\Sigma F_y = 0 \rightarrow \boxed{F_{A_y} = 0}$$

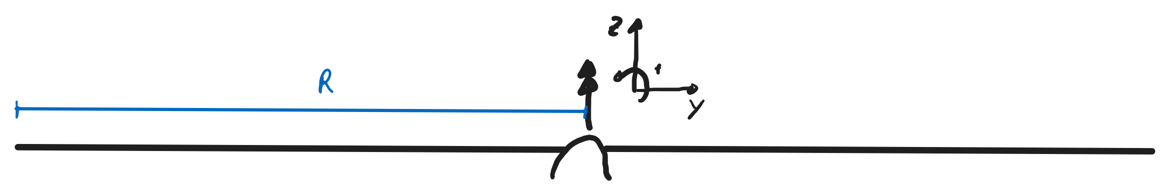
$$\Sigma F_x = 0 \rightarrow F_{A_x} + \frac{T_c}{2} - \frac{D}{2} = 0 \xrightarrow{T_c = D} \boxed{F_{A_x} = 0}$$

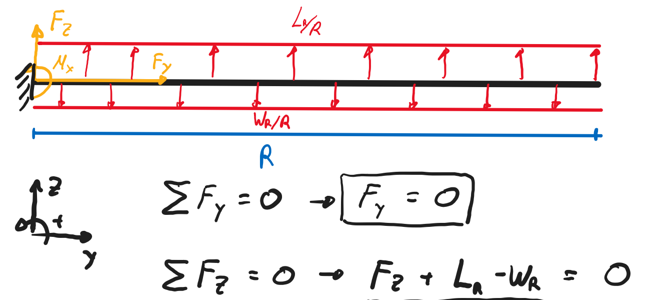
$$\Sigma M_z = 0 \rightarrow M_{A_z} + \frac{D}{2} \cdot \frac{b}{4} - \frac{T_c}{2}\frac{b}{2} = 0$$

$$M_{A_z} = \frac{D}{2}\frac{b}{2} - \frac{D}{2}\frac{b}{4}$$

$$\boxed{M_{A_z} = \frac{Db}{4}}$$

Rotor Blade Loads





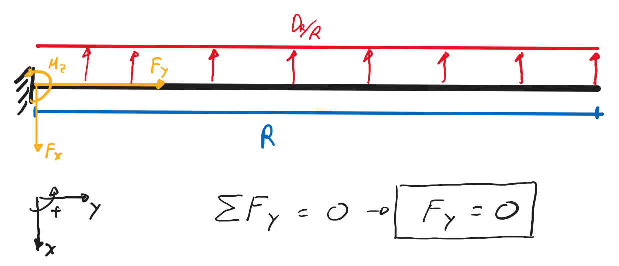
$$\Sigma F_y = 0 \rightarrow \boxed{F_y = 0}$$

$$\Sigma F_z = 0 \rightarrow F_z + L_R - W_R = 0$$

$$\boxed{F_z = W_R - L_R}$$

$$\Sigma M_x = 0 \rightarrow M_x + L_R\frac{R}{2} - W_R\frac{R}{2} =$$

$$\boxed{M_x = \frac{R}{2}(W_R - L_R)}$$



$$\Sigma F_y = 0 \rightarrow \boxed{F_y = 0}$$

$$\Sigma F_x = 0 \rightarrow F_x - D_R = 0$$

$$\boxed{F_x = D_R}$$

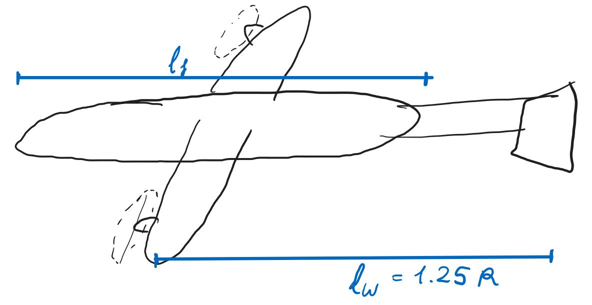
$$\Sigma M_z = 0 \rightarrow M_z + D_R\frac{R}{2} = 0$$

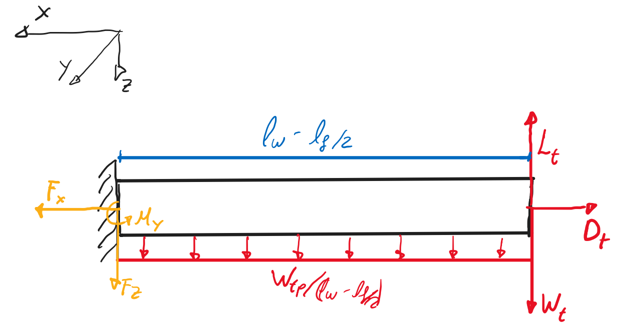
$$\boxed{M_z = -D_R\frac{R}{2}}$$

Assumptions

- Constant rotation speed
- Constant lift & drag distribution
- Constant weight distribution
- Modelled as a cantilever beam

Tail Pole





Assumptions

- Wings are located in the middle of the fuselage
- The tail is at 1.25 R of the wing
- Tail pole can be modelled as a cantilever beam
- Tail's centre of pressure is aligned with the tail pole

$$\Sigma F_x = 0 \rightarrow F_x - D_t = 0$$

$$\boxed{F_x = D_t}$$

$$\Sigma F_z = 0 \rightarrow F_z + W_{tp} + W_t - L_t = 0$$

$$\boxed{F_z = L_t - g_m(m_{tp} + m_t)}$$

$$\Sigma M_y = 0 \rightarrow M_y - W_{tp}\frac{l_w - l_f/2}{2} + \left(l_w - \frac{l_f}{2}\right)(L_t - W_t) = 0$$

$$\boxed{M_y = \left(\frac{l_w}{2} - \frac{l_f}{4}\right)\left(g_m\left(\frac{m_{tp}}{2} + m_t\right) - L_t\right)}$$