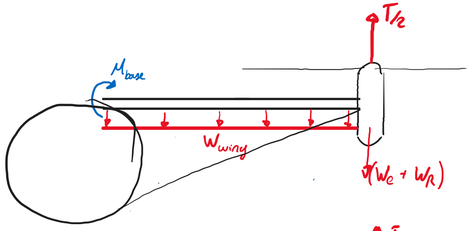
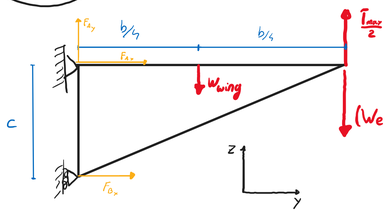
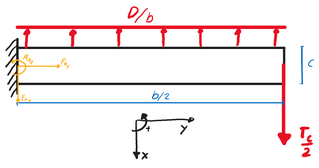
Wing Loads







Assumptions

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

$$\sum F_z = 0 \rightarrow F_{Az} + F_{Bz} = 0 \rightarrow \boxed{F_{Az} = -F_{Bz}}$$

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

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

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

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

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

$$\sum F_y = 0 \rightarrow \boxed{F_{Ay} = 0}$$

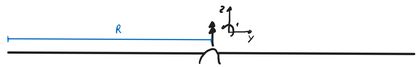
$$\sum F_x = 0 \rightarrow F_{Ax} + \frac{T_c}{2} - \frac{D}{2} = 0 \;\xrightarrow{T_c = 0}\; \boxed{F_{Ax} = 0}$$

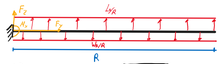
$$\sum M_z = 0 \rightarrow M_{A_z} + \frac{D}{2}\cdot\frac{b}{4} - \frac{T_c}{2}\frac{b}{2} = 0$$

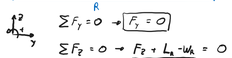
$$M_{A_z} = \frac{D}{2}\frac{b}{2} - \frac{D}{2}\frac{b}{4}$$

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

Rotor Blade Loads







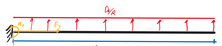
$$\sum F_y = 0 \rightarrow \boxed{F_y = 0}$$

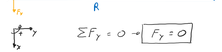
$$\sum F_z = 0 \rightarrow F_z + L_R - W_R = 0$$

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

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

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





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

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

$$\boxed{F_x = D_R}$$

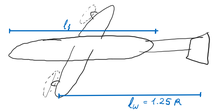
$$\sum M_z = 0 \rightarrow M_z + D_R\frac{R}{2} = 0$$

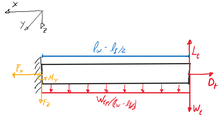
$$\boxed{M_z = -D_R\frac{R}{2}}$$

Assumptions

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

Tail Pole





$$\sum F_z = 0 \rightarrow F_z - D_t = 0$$

$$\boxed{F_z = D_t}$$

$$\sum F_z = 0 \rightarrow F_z + W_{fp} + W_t - L_t = 0$$

$$\boxed{F_z = L_t - g_m\left(m_{fp} + m_t\right)}$$

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

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

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