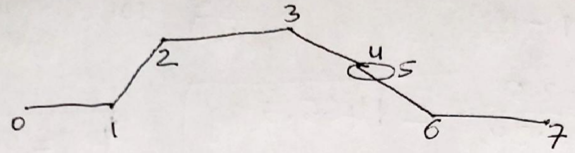
Mataria Pence
Abhijeet
Amrendra
Aditya Raghuwanshi

Mission Profile



$\Rightarrow$ To estimate W_f/W_0 ; $\dfrac{W_f}{W_0} = (1.06)\left(1 - \dfrac{W_7}{W_0}\right)$ [using 6% margin]

$$\frac{W_7}{W_0} = \frac{W_1}{W_0} \cdot \frac{W_2}{W_1} \cdot \frac{W_3}{W_2} \cdot \frac{W_4}{W_3} \cdot \frac{W_5}{W_4} \cdot \frac{W_6}{W_5} \cdot \frac{W_7}{W_6}.$$

- $\left(\dfrac{W_1}{W_0}\right) = 0.97$ (historical data)
- $\left(\dfrac{W_2}{W_1}\right) = 0.98$ (")
- $\left(\dfrac{W_3}{W_2}\right)$ for prop. engine $R = \dfrac{\eta}{c}\left(\dfrac{L}{D}\right) \ln\left(\dfrac{W_2}{W_3}\right)$

  let $\eta = 0.85$

  $C_{bhp} = 0.4 \Rightarrow 2.02 \times 10^{-7}$ fps.   let $\left(\dfrac{L}{D}\right)_{max} = 16.$ $R = 2000$ km.

  $\therefore 2000(km) = \dfrac{0.85}{2.02 \times 10^{-7}} (16) \ln \dfrac{W_2}{W_3}$
  (561680 ft s)

  $\therefore$ ~~$\left(\frac{W_3}{W_2}\right) = 0.90$~~ $\boxed{\dfrac{W_3}{W_2} = 0.90}$

- $\left(\dfrac{W_4}{W_3}\right) = 1$ (descent assumption)
- $\left(\dfrac{W_5}{W_4}\right)$ for prop. engine $E = \left(\dfrac{\eta}{c}\right)\left(\dfrac{L}{D}\right)\left(\dfrac{1}{V_\infty}\right) \ln\left(\dfrac{W_4}{W_5}\right)$

  for η, c same as above.

  E_{max} @ $\dfrac{L}{D} = 0.866 \left(\dfrac{L}{D}\right)_{max}$ and $V_\infty = \dfrac{1}{3^{1/4}} V_{cruise}$.

  let $\left(\dfrac{L}{D}\right)_{max} = 16$ and $V_{cruise} = 60$ m/s.

  $\therefore \boxed{\dfrac{W_5}{W_4} = 0.961}$

- $\dfrac{W_6}{W_5} = 1$ (descent assumption)
- $\dfrac{W_7}{W_6} = 0.995$ (historical data)

$\therefore \left(\dfrac{W_7}{W_0}\right) = (0.97)(0.98)(0.90)(1)(0.961)(1)(0.995)$
$= 0.818$

$\therefore \boxed{\dfrac{W_f}{W_0} = (1.06)(0.181) = 0.192}$

$\Rightarrow$ $W_0 = \dfrac{W_c + W_p}{1 - \frac{W_f}{W_0} - \frac{W_e}{W_0}}$

| 4 Passengers + 1 Pilot with 10 kg luggage

$\therefore W_c + W_p = 425\,kg.$

$\therefore W_0 = \dfrac{425\,kg}{1 - 0.19 - \frac{W_e}{W_0}}$

| $\frac{W_e}{W_0}$ can be assume $\boxed{0.52}$ for aircrafts below 1800 kg.

$\therefore \boxed{W_0 = \dfrac{425}{0.29} = 1465.5\,kg}$

$\boxed{W_f = 278\,kg}$

$\Rightarrow$ (a) Consider Vstall for takeoff at sea level. for steady level flight

$$\left(\frac{W}{S}\right) = \frac{1}{2}\rho V_{stall}^2 (C_{Lmax})$$

at sea level $\rho = 1.225$ ~~let~~ let $V_{stall} = 30\,m/s$.

$C_{Lmax} = 2.3$ (using flaps)

$$\therefore \left(\frac{W}{S}\right) = \left(\frac{1}{2}\right)\frac{(1.225)(30)^2(2.3)}{9.8}\ kg/m^2$$

$$\boxed{\frac{W}{S} = 129\,kg/m^2}$$

(b) Consider level flight at 10000 ft altitude with Vstall and cruise flight for max. Range cond^n.

$$\left(\frac{W}{S}\right) = \frac{1}{2}\rho V_{stall}^2 C_L$$

at 10 k ft $\rho = 0.9093$

$K = \dfrac{1}{\pi AR e}$ let $AR = 10$, $e = 0.7$

| for max R, $C_L = \sqrt{\dfrac{C_{D_0}}{K}}$

- consider flat bottom airfoil with $C_{mac} = -0.05$

$C_{do} = 0.02$

$\therefore K = \dfrac{1}{(3.14)(10)(0.7)} \longrightarrow \therefore C_L = \sqrt{\dfrac{0.02}{K}} = 0.66$

$$\therefore \frac{W}{S} = \left(\frac{1}{2}\right)(0.9093)(30)^2(0.66)/9.8$$

$$\boxed{\frac{W}{S} = 27.55\,kg/m^2}$$

(c) Consider level flight at 10000 ft altitude with $V_{cruise} = 60\,m/s$.

$$\left(\frac{W}{S}\right) = \left(\frac{1}{2}\right)(0.9093)(60)^2(0.66)/9.8$$

$$\boxed{W/S = 110.22\,kg/m^2}$$

let

→ $\frac{W}{S} = 120 \ kg/m^2$

$\therefore S = \frac{1465.5}{120} \ m^2 = \boxed{12.2 \ m^2}$

let

→ $AR = 10 = \frac{b^2}{S}$ $\therefore \boxed{b = 11 \ m}$

→ assume rectangular wing. $\therefore \boxed{c = \frac{b}{AR} = \frac{11}{10} = 1.1 \ m.}$