$$\phi = \frac{\left(\frac{16h}{b}\right)^2}{1+\left(\frac{16h}{b}\right)^2} = \frac{\left(\frac{16 \cdot 7.8M}{79.75M}\right)^2}{1+\left(\frac{16 \cdot 7.8M}{79.75M}\right)^2} = 0.71005$$

ϕ ‖

Richard Lam

$\mu = 0.02$

$F=ma$

$F = 575000\,kg \cdot 9.81\frac{m}{s^2}$

weight $= \downarrow$ $5640750\,N$

$$V_{LO} = 1 \cdot V_{stall} = \sqrt{\frac{2W}{\rho_\infty \cdot S \cdot C_{L,max}}} = \sqrt{\frac{2 \cdot 5640750N}{1.225\frac{kg}{m^3} \cdot 845m^2 \cdot 1.423}}$$

✓ Takeoff speed → $\boxed{V_{LO} = 87.51\ \frac{m}{s}}$

$0.7 \cdot 87.51 = 61.257$

$$L = q_\infty S\, C_{L,max} = \frac{1}{2}\rho_\infty V_\infty^2 S\, C_{L,max} = \frac{1}{2} \cdot 1.225\frac{kg}{m^3} \cdot \left(61.257\frac{m}{s}\right)^2 \cdot 845m^2 \cdot 1.423$$

✓ $\boxed{L = 2763625.24\ N}$

$$D = q_\infty S\left(C_{D,0} + \phi\frac{(C_{L,max})^2}{\pi e AR}\right) = \frac{1}{2} \cdot 1.225\frac{kg}{m^3} \cdot \left(61.257\frac{m}{s}\right)^2 \cdot 845m^2 \cdot \left(0.013 + 0.71005\frac{1.423^2}{\pi \cdot 0.9 \cdot 7.526}\right)$$

$$AR = \frac{b^2}{S}$$

$$AR = \frac{(79.75M)^2}{845M^2} = 7.526$$

✓ $\boxed{D = 156472.39\ N}$

$$D_{Landing} = \frac{1}{2} \cdot 1.225\frac{kg}{M^3} \cdot \left(49.78\ \frac{M}{s}\right)^2 \cdot 845M^2 \cdot \left(0.0143 + 0.71005\frac{1.203^2}{\pi \cdot 0.9 \cdot 7.526}\right)$$

- zero fuel

$321000\,kg \cdot 9.81\frac{m}{s^2}$

$= 3149010\,N$

✓ $\boxed{D_{L\,zero} = 80275.39\ N}$ zero fuel

✓ Landing speed

$$\sqrt{\frac{2 \cdot 3149010N}{1.225\frac{kg}{m^3} \cdot 845m^2 \cdot 1.203}} = \boxed{71.12\frac{m}{s}} \cdot 0.70 = 49.78\frac{m}{s}$$

$$D_{Landing} = \frac{1}{2} \cdot 1.225\frac{kg}{m^3} \cdot \left(66.63\frac{m}{s}\right)^2 \cdot 845 \cdot \left(0.0143 + 0.71005\frac{1.203^2}{\pi \cdot 0.9 \cdot 7.526}\right)$$

$95.18\frac{m}{s} \cdot 0.7 = 66.63\frac{m}{s}$

$\boxed{D_L = 143774.52\ N}$

$$F_{eff} = -T_R - [D + \mu_r (W - L)]_{ave}$$

MATLAB eq:

$$\sqrt{\frac{2\cdot(T-(D-(RF\cdot(W-L))))\cdot X}{M}}$$ = Take off velocity Profile

$$(T_R + (D_L + (\mu_r (W - L)))) \cdot (L_{OR} - x)$$

$$\sqrt{\frac{2\cdot(T\_r+(D\_L+(RFB\cdot(W))))\cdot(LoR-X)}{M}}$$ = Landing Velocity Profile

$$= \sqrt{\frac{2\cdot(974400N-(156472.39N-(0.02\cdot(5640750N-2763625.24N))))\cdot 1}{575000\ kg}}$$

$$\boxed{X=1 \quad = 1.74 \tfrac{m}{s}}$$

Continue to x = 3618m

$$\sqrt{\frac{2\cdot F_{eff}\cdot X}{M}}$$

$$X = \frac{MV^2}{2F_{eff}}$$

$$\Downarrow$$

$$V = \sqrt{\frac{2\cdot F_{eff}\cdot X}{M}}$$

Figure 1: Calculation of V1

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