6.1 Calculate R_{min} and ω_{max} for the BD5J

HW3

$$K \approx \underbrace{\frac{1}{\pi AR_e} = \frac{1}{\pi\, 7.65}}_{\text{But wait, } C_D = 0.02 + 0.062 C_L^2 \text{ from Chap 5 HW.}} \qquad AR = \frac{17^2}{37.8} = 7.65$$

$$V_{R_{min}} = \sqrt{\frac{4k}{\rho}\left(\frac{W}{S}\right)\left(\frac{T}{W}\right)^{-1}} = \sqrt{\frac{4\cdot 0.062\ \cancel{ft^3}\,ft}{0.00237\ \cancel{slugs}}\cdot\frac{960\ \cancel{lbf}}{37.8\ \cancel{ft^2}}\cdot\frac{960\ \cancel{lbf}}{202\ \cancel{lbf}}\cdot\frac{\cancel{slug}\ ft}{\cancel{lbf}\ s^2}}$$

$$= 112\ ft/s$$

$$n_{R_{min}} = \sqrt{2 - \frac{4kC_{D_0}}{(T/W)^2}} = \sqrt{2 - \frac{4\cdot 0.062\cdot 0.02}{(202/960)^2}}$$

$$= 1.37$$

Check C_L

$$C_L = \frac{2Wn}{\rho S V^2} = \frac{2\cdot 960\ lbf \cdot ft^3 \cdot 1.37 \cdot s^2}{0.00237\ slugs \cdot 37.8\ ft^2 \cdot 112^2\ ft^2}$$

$$= 2.33$$

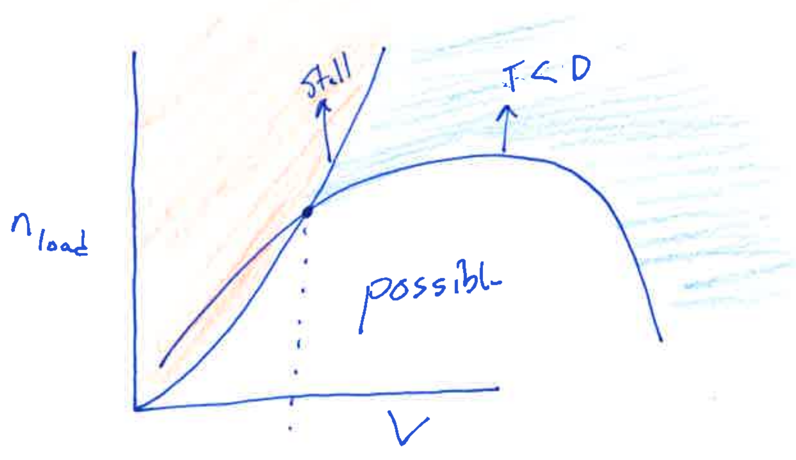
For an AR = 7.65 wing using the 64-212 airfoil (flaps up) $C_{\ell_{max}} \approx 1.6$

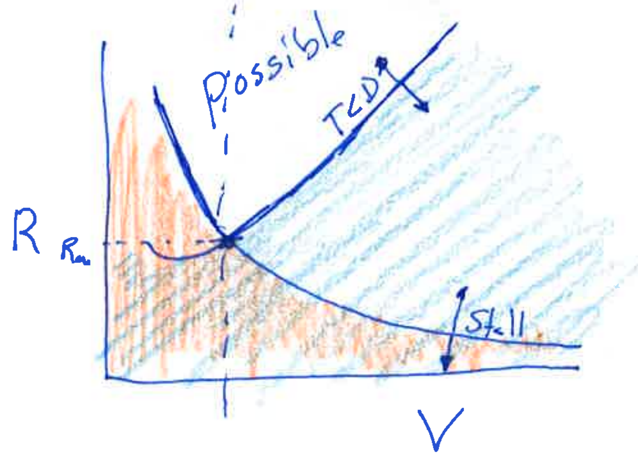
$$C_{L_\alpha} = \frac{C_{\ell_\alpha}}{1 + \frac{C_{\ell_\alpha}}{\pi AR}} \approx 5$$

Clearly, $2.33 > 1.6$ and so R_{min} is more complicated than the Eq 6.33

proper way to calculate R_{min}

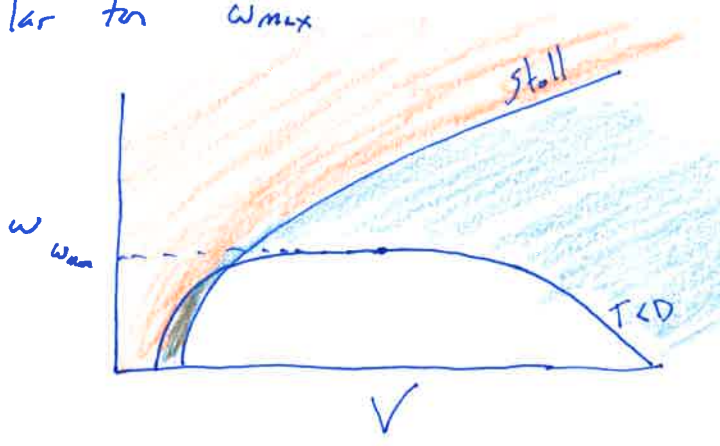
See Excel File.





R_{min} 430 ft at 130 ft/s Limited by $C_{L max}$

Similar for ω_{max}



$\omega_{max} = 19°/s$

Limited by T/D

6.5

$V = 620$ mph

$h = 35^{kft}$

Calc H_e

$$H_e = h + \frac{V_\infty^2}{2g}$$

$$= 35000^{ft} + \frac{620^2 \cancel{mi^2}}{\cancel{hr^2}} \cdot \frac{5280^2 \cancel{ft^2}}{1 \cancel{mi^2}} \cdot \frac{\cancel{hr^2}}{3600 \cancel{s^2}} \cdot \frac{1}{2} \cdot \frac{\cancel{s^2}}{32.2 \cancel{ft}}$$

$$= \boxed{47840 \text{ ft}}$$

6.7

$\mu = 0.04$

$$S_g = \frac{1}{2 g K_A} \ln\left(1 + \frac{K_A}{K_T} V_{Lo}^2\right) + N V_{Lo}$$

$$\approx$$

$$S_g = \frac{1}{\rho}\left(\frac{W}{S}\right)\frac{1}{C_{L_{Lo}}}\frac{1}{g K_T}$$

$K_T = \frac{T}{W} - \mu$ $\quad$ K_A = Complicated... $\quad$ Eq 6.86

$= \frac{202}{960} - 0.04 = 0.170$

Simple
$$S_g = \frac{1 \; ft^3}{0.00237 \; slugs} \left| \frac{960 \; lbf}{37.8 \; ft^2} \right| \frac{}{2.0} \left| \frac{1 \; s^2}{32.2 \; ft} \right| \frac{}{0.170} \left| \frac{slug \; ft}{lbf \; s^2} \right.$$

$= 978 \; ft$

Complicated!
S_g : See EXCEL sheet

$= 1104$ ft

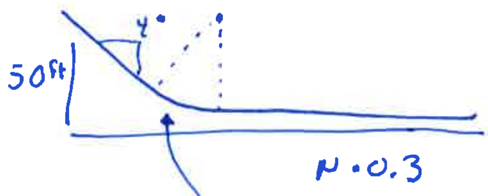
Clear 35 ft

$$S_{a_{35}} \approx 3.9 \, V_s \approx 3.9 \, V_{To} \approx 404 \; ft$$

$$\boxed{S_{to} \approx 1508 \; ft}$$ + pilot Reaction $\approx$ 1 sec $\boxed{1600 \; ft}$

C_{Lmax} assumption strongly affects this calculation. I used $C_{Lmax} = 2.0$ which is likely too high for ~~[illegible]~~ reality!

6.8



$\theta_a = 4°$

$$R \approx 4.29 \frac{V_s^2}{g} \approx 4.29 \; \frac{103^2 \, ft^2}{s^2} \frac{s^2}{32.2 \, ft} = \overset{1413}{\cancel{444}} \, ft$$

~~Approach:~~ $\cancel{\theta_a}$

Flare:

$$S_f = R \sin \theta_a = \overset{1413}{\cancel{444}} \sin 4° = \cancel{31} = 98 \, ft \approx 1 \text{ second} \checkmark$$

$$h_f = R(1 - \cos \theta_a) = \overset{1413}{\cancel{444}}(1 - \cos 4°) \approx 3.4 \, ft$$

meh, a bit low....

Approach

$$S_a = \frac{h_{ob} - h_f}{\tan \theta_a} = \frac{50^{ft} - 3.4^{ft}}{\tan 4°} = 666^{ft}$$

Ground Roll

$$J_T = \cancel{\frac{T_{rev}}{W}}^{\,0} + \mu_r = 0.3$$

Ignore some terms...

$$J_A = \frac{\rho}{2}\left(\frac{W}{S}\right)^{-1}\left(C_{D_0} + \cdots \frac{G}{\pi AR} C_L^2 - \mu_r C_L\right)$$

$$= \text{EXCEL Spreadsheet}$$

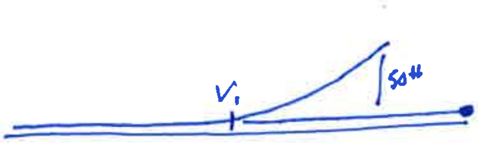
$$=$$

$$S_g = N V_{TD} + \frac{1}{2 g J_A} \ln\left(1 + \frac{J_A}{J_T} V_{TD}^2\right)$$

$$= 870^{ft}$$

$$\text{Total} = 98 + 666 + 870 = \cancel{8}\, 1633 \, ft$$

Balanced Field Length



1) Decision at V_1 @ 1100 ft (to clear 50 ft obs')
2) Decelerate from V_1 .

$$1100\text{ ft} + 870\text{ ft} = \boxed{1970\text{ ft}}$$