1) $C_{L_{aw}} = 4.1\ 1/rad$, $S_H = 45.2\ ft^2$, $C_{L_{aH}} = 4.1\ 1/rad$, $C_{ma} = -1.59\ 1/rad$

$\bar{x}_{cg} = 0.5$, $S = 169\ ft^2$, $\bar{c} = 5.825\ ft$, $\bar{x}_{acH} = 3.5$, $\bar{x}_{acWB} = 0.6$

$\frac{d\varepsilon}{d\alpha} = 0.5$, $\eta_H = 0.95$

@ $SM = \frac{-C_{ma}}{C_{L\alpha}} = \frac{-(-1.59)}{4.59} = 0.3464 \longrightarrow 34.64\%$

(b) $SM' = 0.2$, $C'_{ma} = -SM' \cdot C'_{L\alpha}$

$C_{L\alpha\ tail} = C_{L_{\alpha H}} \eta_H \frac{S_H}{S} = (4.1)(0.95)\left(\frac{45.2}{169}\right) = 1.03995\ 1/rad$

$C_{L\alpha} = C_{L_{aWBH}} + C_{L_{aH}} \eta_H \frac{S_H}{S}$, $C_{L_{aWBH}} = C_{L_a} - C_{L_{a\,tail}} = 4.59 - 1.03995$

$C_{ma_H} = -C_{L_{aH}} \eta_H \frac{S_H}{S} (\bar{x}_{acH} - \bar{x}_{cg})\left(1 - \frac{d\varepsilon}{d\alpha}\right) = 3.55005$

$C_{ma_H} = -1.56\ 1/rad$, $C_{ma_{WB}} = C_{ma} - C_{ma_H} = -0.03\ 1/rad$

$\bar{x}_{acWB} = 0.6$, $C_{L_{aw}} = 4.1$, $C_{ma_{WB}} = -0.41$

$C'_{L_a} = C_{L_{aWBH}} + C_{L_{aH}} \eta_H \frac{S'_H}{S} = 3.55 + 0.023 S'_H$

$C'_{ma_H} = -C_{L_{aH}} \eta_H \frac{S'_H}{S}(\bar{x}_{acH} - \bar{x}_{cg})\left(1 - \frac{d\varepsilon}{d\alpha}\right) = -0.03 S'_H$

$C'_{ma} = C_{ma_{WB}} + C'_{ma_H} = -0.03 - 0.0345\ S'_H$

$C'_{ma} = -0.2 C'_{L_a} \longrightarrow S'_H = 22.72\ ft^2$, $S_H = 45.2\ ft^2$

$\frac{S'_H - S_H}{S_H} \times 100 = -49.72\%$

② $X_{cg} = 0.25\bar{c}$, $C_l = 0.03 + 0.08\alpha^\circ + 0.1\delta_E^\circ$

$-10^\circ \leq \delta_E \leq +10^\circ$, $\alpha > 15^\circ$.

②@ $C_{m\delta E} = \frac{\Delta C_m}{\Delta \delta_E}$, $\alpha = 0^\circ$, $\delta_E = 0^\circ$ $C_m \simeq 0.025$, $\delta_E = 5^\circ$ $C_m \simeq -0.11$

$$C_{m\delta E} = \frac{-0.11 - 0.025}{5^\circ - 0^\circ} = -0.027$$

② b $C_m = C_{m0} + C_{m\alpha}\alpha^\circ + C_{m\delta E}\delta_E^\circ$, $\alpha = 0^\circ$, $\delta E = 0$ $C_{m_0} = 0.02$

$\delta_E = 0^\circ$, $\alpha = 0$ $C_m \simeq 0.025$. $\alpha = 10$ $C_m \simeq -0.08$

$$C_{m\alpha} = \frac{-0.08 - 0.025}{10^\circ - 0^\circ} = -0.0105, \quad C_m \simeq 0.025 - 0.0105\alpha^\circ - 0.027\delta_E^\circ$$

(2)(c) $C_m = 0 \rightarrow \alpha^\circ = \frac{0.025 - 0.027\delta_E^\circ}{0.0105}$, $\delta_E^\circ \in [-10^\circ, 10^\circ]$

$\delta_E = -10^\circ : \alpha^\circ \simeq 28^\circ$

$\delta_E = +10^\circ \quad \alpha^\circ \simeq -23.33^\circ$, $\alpha_{stall} = 15^\circ \rightarrow \delta_E^\circ = -4.907$

$[-23.33, 15^\circ]$

(2)(d) $C_m = 0$, $\delta_E^\circ = \frac{0.025 - 0.0105\alpha^\circ}{0.027}$, $C_L = 0.03 + 0.08\alpha^\circ + 0.1\left(\frac{0.025 - 0.0105\alpha^\circ}{0.027}\right)^2$

$C_L = 0.12 + 0.041\alpha^\circ \rightarrow \alpha_{min} = -23.33^\circ \rightarrow C_L = -0.8367$

$\alpha_{max} = 15^\circ$, $C_L = 0.7393 \rightarrow [-0.83, 0.74]$

(2)(e) $W = 93000\,lb$, $S_{ref} = 900\,ft^2$, $\rho_0 = 0.0023769$

$$C_L = \frac{W}{\frac{1}{2}\rho V^2 S}, \quad V = \sqrt{\frac{W}{\frac{1}{2}\rho S C_L}} = \sqrt{\frac{88817.8}{C_L}} \longrightarrow C_L > 0$$

$(0, 0.74)$, $V_{min} @ C_{L_{max-p.s}} = 0.74$, $V_{min} = \sqrt{\frac{88817}{0.74}} \sim 346$

$C_L = 0$, $\alpha = -2.98$ $\delta_E = 2.0855$, $\alpha \in [0, 15]$

$\alpha = 0$, $C_m = 0$, $\delta_E \approx 0.926°$, $C_{L_{\alpha=0}} = 0.03 + 0.08(0) + 0.1(0.926)$

$= 0.1226$

$$V_{max} = \sqrt{\frac{88817.6}{0.1226}} \sim 851.15\,ft/s$$

(3) $C_{l_r} = \dfrac{\partial C_l}{\partial (rb/2V)}$, (a) $C_{l_r} = -\dfrac{C_{l_\alpha}}{12}\left(\dfrac{1+3\lambda}{1+\lambda}\right) - K_1 \cdot C_{l_\alpha} \tan^2 \Lambda$

$$C_{l_r} = \frac{-C_{l_\alpha}}{12}\left(\frac{1+3\lambda}{1+\lambda}\right) - \frac{C_{l_\alpha}}{4}\frac{AR}{AR+4}\tan^2\Lambda$$

(b) $C_{l_r} = (C_{l_r})_{\Gamma=0} = \cos^2\Gamma \simeq 1$

(c) $C_{l_r} = \left[\dfrac{-C_{l_\alpha}}{12}\left(\dfrac{1+3\lambda}{1+\lambda}\right) - \dfrac{C_{l_\alpha}}{4}\dfrac{AR}{AR+4}\tan^2\Lambda\right]\cos^2\Gamma$

(d) $C_{l_r} = \dfrac{-C_{l_\alpha}}{12}\left(\dfrac{1+3(1)}{1+1}\right) = -\dfrac{C_{l_\alpha}}{6}$

④ $C_{n_\beta} = 0.15\ 1/rad$, $C_{n_{\beta WB}} = -0.3\ 1/rad$, $C_{l_{av}} = 4.0\ 1/rad$

$\eta_V = 1$, $1 - \frac{d\sigma}{d\beta} = 2 + 0.75\frac{S_V}{S}$, $x_{V_S} = \frac{b}{2}$, $l_V = \frac{b}{2}$ $\frac{l_V}{D} = 0.5$

$$C_{n_\beta} = C_{n_{\beta WB}} + C_{n_{\beta V}} \quad , \quad C_{n_{\beta V}} = C_{l_{av}} \eta_V \frac{S_V}{S} \frac{l_V}{b} \left(1 - \frac{d\sigma}{d\beta}\right)$$

$$C_{n_{\beta V}} = C_{n_\beta} - C_{n_{\beta WB}} = 0.15 - (-0.3) = 0.45\ 1/rad$$

$$\Rightarrow 0.45 = 4\left(\frac{S_V}{S}\right)(0.5)\left(2 + 0.75\frac{S_V}{S}\right) \longrightarrow \frac{S_V}{S} = 0.1081$$

All Questions Answered by AI

Gemini 2.5 pro