Method 6 explained in Mathcad, by Francois de Villiers:
- Solve gamma (glide angle) using horizontal equilibrium
- Solve V (flight speed) using vertical equilibrium
- Solve Py (calage point) using equilibrium of moments

$$L_w = K_l \cdot \frac{1}{2} \cdot \rho \cdot C_l \cdot V^2 \cdot A \quad \text{....1}$$

$$D_p = cd_p \cdot \frac{1}{2} \cdot \rho \cdot V^2 \cdot A_p \quad \text{.....3}$$

$$D_w = K_d \cdot \frac{1}{2} \cdot \rho \cdot C_d \cdot V^2 \cdot A \quad \text{.....2}$$

$$D_l = cd_{line} \cdot \left(\frac{1}{2} \cdot \rho \cdot V^2\right) \cdot A_{line} \quad \text{......4}$$

$$L_w \cdot \cos(\gamma) + (D_w + D_l + D_p) \cdot \sin(\gamma) - M_{wing} \cdot g - M_{line} \cdot g - M_{ql} \cdot g - M_{pilot} \cdot g = 0 \quad \text{.....5}$$

$$-L_w \cdot \sin(q) + (D_w + D_l + D_p) \cdot \cos(q) = 0 \quad \text{.....6}$$

1 to 4 into 5

$$\frac{V^2 \cdot \rho \cdot (A_p \cdot cd_p \cdot \cos(q) + A_{line} \cdot cd_{line} \cdot \cos(q) + A \cdot C_d \cdot K_d \cdot \cos(q) - A \cdot C_l \cdot K_l \cdot \sin(q))}{2} = 0$$

multiply by 2 and divide by V^2 and rho

$$0 = A_p \cdot cd_p \cdot \cos(\gamma) + A_{line} \cdot cd_{line} \cdot \cos(\gamma) + A \cdot C_d \cdot K_d \cdot \cos(\blacksquare) - A \cdot C_l \cdot K_l \cdot \sin(\gamma)$$

so gamma is not a function of velocity !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

solve for γ

$$\gamma := 2 \cdot \operatorname{atan}\left(\frac{\sqrt{A^2 \cdot C_d^2 \cdot K_d^2 + A^2 \cdot C_l^2 \cdot K_l^2 + 2 \cdot A \cdot A_p \cdot C_d \cdot K_d \cdot cd_p + 2 \cdot A \cdot A_{line} \cdot C_d \cdot K_d \cdot cd_{line} + A_p^2 \cdot cd_p^2 + 2 \cdot A_p \cdot A_{line} \cdot cd_p \cdot cd_{line} + A_{line}^2 \cdot cd_{line}^2} - A \cdot C_l \cdot K_l}{A_p \cdot cd_p + A_{line} \cdot cd_{line} + A \cdot C_d \cdot K_d}\right)$$

from 5

$$L_w \cdot \cos(\gamma) + (D_w + D_l + D_p) \cdot \sin(\gamma) - M_{wing} \cdot g - M_{line} \cdot g - M_{ql} \cdot g - M_{pilot} \cdot g = 0$$

1 to 4 into 5 and solve for V

$$V := \frac{\sqrt{2} \cdot \sqrt{\rho \cdot g \cdot (M_{ql} + M_{line} + M_{wing} + M_{pilot}) \cdot (A_p \cdot cd_p \cdot \sin(\gamma) + A_{line} \cdot cd_{line} \cdot \sin(\gamma) + A \cdot C_l \cdot K_l \cdot \cos(\gamma) + A \cdot C_d \cdot K_d \cdot \sin(\gamma))}}{2 \cdot \left(\frac{A_p \cdot \rho \cdot cd_p \cdot \sin(\gamma)}{2} + \frac{A_{line} \cdot \rho \cdot cd_{line} \cdot \sin(\gamma)}{2} + \frac{A \cdot C_l \cdot K_l \cdot \rho \cdot \cos(\gamma)}{2} + \frac{A \cdot C_d \cdot K_d \cdot \rho \cdot \sin(\gamma)}{2}\right)}$$

$$g := \frac{g}{\frac{m}{sec^2}}$$

$cd_{line} \equiv 1.07857$

$C_l := 0.55619$ $\quad A := 12.4577$ $\quad K_l := 1$ $\quad g = 9.807$ $\quad A_{line} := 1 \cdot 0.2515$

$C_d := 0.03560$ $\quad \rho := 1.225$ $\quad K_d := 1.4$ $\quad A_p \equiv 0.4380$

$M_{pilot} := 65.9$ $\quad cd_p := 0.6$

$M_{wing} := 5$

$M_{line} := 0.295$

$M_{riser} := 0.050$ ...riser included in lines

$M_{ql} := 0.048$ 6x8

$M_t := M_{pilot} + M_{wing} + M_{line} + M_{ql} = 71.243$

$$\gamma := 2 \cdot \operatorname{atan}\left(\frac{\sqrt{A^2 \cdot C_d^2 \cdot K_d^2 + A^2 \cdot C_l^2 \cdot K_l^2 + 2 \cdot A \cdot A_p \cdot C_d \cdot K_d \cdot cd_p + 2 \cdot A \cdot A_{line} \cdot C_d \cdot K_d \cdot cd_{line} + A_p^2 \cdot cd_p^2 + 2 \cdot A_p \cdot A_{line} \cdot cd_p \cdot cd_{line} + A_{line}^2 \cdot cd_{line}^2} - A \cdot C_l \cdot K_l}{A_p \cdot cd_p + A_{line} \cdot cd_{line} + A \cdot C_d \cdot K_d}\right)$$

$\gamma = 9.463 \cdot deg$

$$V := \frac{\sqrt{2}\cdot\sqrt{\rho\cdot g\cdot\left(M_{ql} + M_{line} + M_{wing} + M_{pilot}\right)\cdot\left(A_p\cdot cd_p\cdot\sin(\gamma) + A_{line}\cdot cd_{line}\cdot\sin(\gamma) + A\cdot C_l\cdot K_l\cdot\cos(\gamma) + A\cdot C_d\cdot K_d\cdot\sin(\gamma)\right)}}{2\cdot\left(\frac{A_p\cdot\rho\cdot cd_p\cdot\sin(\gamma)}{2} + \frac{A_{line}\cdot\rho\cdot cd_{line}\cdot\sin(\gamma)}{2} + \frac{A\cdot C_l\cdot K_l\cdot\rho\cdot\cos(\gamma)}{2} + \frac{A\cdot C_d\cdot K_d\cdot\rho\cdot\sin(\gamma)}{2}\right)}$$

$V = 12.743$

$W_w := M_{wing}\cdot g$ $\qquad W_l := M_{line}\cdot g$

$W_p := M_{pilot}\cdot g$

$C_{pz} := 0.299$ $\qquad C_{py} := 0.489$

$G_y := 0.902$ $\qquad G_z := 0.499$

$GL_y := 1.003$ $\qquad GL_z := 2.507$

$\alpha := 9.45\cdot deg$

$P_z := 4.770 + 0.2$

$\theta := (\gamma - \alpha)$ $\qquad P_z = 4.97$

$DL_y := 1.0387$ $\qquad DL_z := 2.1802$

$$\begin{aligned}&-\left(C_{py} - G_y\right)\cdot W_w\cdot\cos(\theta) - \left(C_{pz} - G_z\right)\cdot W_w\cdot\sin(\theta)\ \ldots \quad = 0\\ &+ -\left(C_{py} - GL_y\right)\cdot W_l\cdot\cos(\theta) - \left(C_{pz} - GL_z\right)\cdot W_l\cdot\sin(\theta)\ \ldots\\ &+ -\left(C_{py} - P_y\right)\cdot W_p\cdot\cos(\theta) - \left(C_{pz} - P_z\right)\cdot W_p\cdot\sin(\theta)\ \ldots\\ &+ \left(C_{py} - DL_y\right)\cdot D_l\cdot\sin(\alpha) + \left(C_{pz} - DL_z\right)\cdot D_l\cdot\cos(\alpha)\ \ldots\\ &+ \left(C_{py} - P_y\right)\cdot D_p\cdot\sin(\alpha) + \left(C_{pz} - P_z\right)\cdot D_p\cdot\cos(\alpha)\end{aligned}$$

$PP = P_z\cdot\tan(\theta) + P_y$

$D_p := cd_p\cdot\frac{1}{2}\cdot\rho\cdot V^2\cdot A_p$ $\qquad L_w := K_l\cdot\frac{1}{2}\cdot\rho\cdot C_l\cdot V^2\cdot A$

$D_l := cd_{line}\cdot\left(\frac{1}{2}\cdot\rho\cdot V^2\right)\cdot A_{line}$ $\qquad D_w := K_d\cdot\frac{1}{2}\cdot\rho\cdot C_d\cdot V^2\cdot A$

$$P_y := -\frac{W_w\cdot\cos(\theta)\cdot\left(C_{py} - G_y\right) - D_p\cdot\cos(\alpha)\cdot\left(C_{pz} - P_z\right) + W_l\cdot\cos(\theta)\cdot\left(C_{py} - GL_y\right) + W_w\cdot\sin(\theta)\cdot\left(C_{pz} - G_z\right) + W_l\cdot\sin(\theta)\cdot\left(C_{pz} - GL_z\right) + W_p\cdot\sin(\theta)\cdot\left(C_{pz} - P_z\right) - C_{py}\cdot D_p\cdot s}{D_p\cdot\sin(\alpha) - W_p\cdot\cos(\theta)}$$

$P_y = 0.723$

$$\text{in}(\alpha) + C_{py}\cdot W_p\cdot\cos(\theta) - D_l\cdot\cos(\alpha)\cdot\left(C_{pz} - DL_z\right) - D_l\cdot\sin(\alpha)\cdot\left(C_{py} - DL_y\right)$$

$PP := \left(P_z\cdot\tan(\theta) + P_y\right)$ $\qquad PP = 0.725$

$chord_{center} := 2.121$

$Calage_p := \frac{P_y}{chord_{center}}\cdot 100 = 34.107$ $\qquad PP_p := \frac{PP}{chord_{center}}\cdot 100 = 34.162$

$\frac{L_w}{D_w} = 11.1595$ $\qquad \left(P_y - C_{py}\right)\cdot m = 234.41\cdot mm$

$\left(PP - C_{py}\right)\cdot m = 235.579\cdot mm$

$\left(PP - P_y\right)\cdot m = 1.169\cdot mm$

$\frac{L_w}{D_w} = 11.1595$

$\frac{L_w}{\left(D_w + D_p + D_l\right)} = 5.9993$