Includi << ..\Default_Functions.mcdx

HORIZONTAL TAIL PARAMETERS INITIALIZATION

Hidden Area --> Import of Excel INPUT H-Tail Data

Hidden Area --> Preliminary Mapping of imported Data

Hidden Area --> Import and preliminary mapping of OTHER Excel Data

INPUT H-TAIL PARAMETERS LIST

Input parameters

$b_H = 11.217\ m$

$\eta_H = 0.95$

$\Lambda_{H\_LE} = 35\ deg$

$\Gamma_H = 0\ deg$

$i_H = -2\ deg$

$\xi_{tmax\_H} = 0.4$

$c_{H\_r} = 3.322\ m$

$t\_over\_c_{H\_r} = 0.11$

$\alpha_{0l\_H\_r} = 0$

$C_{l\alpha\_H\_r} = 6.016$

$C_{m\_ac\_H\_r} = -0.07$

$\xi_{ac\_H\_r} = 0.25$

$M_{cr\_H\_2D\_r} = 0.75$

$c_{H\_t} = 1.219\ m$

$t\_over\_c_{H\_t} = 0.11$

$\alpha_{0l\_H\_t} = 0$

$C_{l\alpha\_H\_t} = 6.016$

$C_{m\_ac\_H\_t} = -0.07$

$\xi_{ac\_H\_t} = 0.25$

$M_{cr\_H\_2D\_t} = 0.75$

$\varepsilon_{H\_t} = 0$

$\eta_{e\_in} = 0$

$\eta_{e\_out} = 0.989$

$c_e = 0.671\ m$

Imported parameters

$M_1 = 0.696$

$X_{ac\_W} = 3.928\ m$

$MAC_W = 3.642\ m$

$c_{W\_r} = 5.243\ m$

$S_W = 87.62\ m^2$

$K_{MAC4\_WH} = 0.707$

$\Delta X\_HT_{LE}\_W_{LE} = 16.73\ m$

$\Delta X\_HT_{LE}\_Nose = 27.86\ m$

HTAIL PARAMETERS CALCULATIONS

H-Tail basic parameters

$\lambda_H := \frac{c_{H\_t}}{c_{H\_r}} = 0.367$ $\lambda_H = 0.367$

$S_H := \frac{b_H}{2} \cdot c_{H\_r} \cdot (1+\lambda_H) = 25.47\ m^2$ $S_H = 25.47\ m^2$

$AR_H := \frac{{b_H}^2}{S_H} = 4.94$ $AR_H = 4.94$

$MAC_H := \frac{2}{3} \cdot c_{H\_r} \cdot \left(\frac{1+{\lambda_H}^2+\lambda_H}{1+\lambda_H}\right) = 2.433\ m$ $MAC_H = 2.433\ m$

$X_{MAC\_LE\_H} := \frac{b_H}{6} \cdot \frac{(1+2 \cdot \lambda_H)}{(1+\lambda_H)} \cdot \tan(\Lambda_{H\_LE}) = 1.66\ m$ $X_{MAC\_LE\_H} = 1.66\ m$

$Y_{MAC\_H} := \frac{b_H}{6} \cdot \frac{1+2 \cdot \lambda_H}{1+\lambda_H} = 2.371\ m$ $Y_{MAC\_H} = 2.371\ m$

$Z_{MAC\_H} := Y_{MAC\_H} \cdot \tan(\Gamma_H) = 0\ m$ $Z_{MAC\_H} = 0\ m$

H-Tail, sweep angles

$_f\Lambda(x, \Lambda_{le}, AR, \lambda) := \mathbf{if}\left(AR = 0, \Lambda_{le}, \operatorname{atan}\left(\tan(\Lambda_{le}) - \frac{4 \cdot x \cdot (1-\lambda)}{AR \cdot (1+\lambda)}\right)\right)$

• **Sweep angle function**

$\Lambda_{H\_LE} := {}_f\Lambda(0, \Lambda_{H\_LE}, AR_H, \lambda_H) = 0.611$ $\Lambda_{H\_LE} = 35\ deg$

$\Lambda_{H\_TE} := {}_f\Lambda(1, \Lambda_{H\_LE}, AR_H, \lambda_H) = 0.314$ $\Lambda_{H\_TE} = 18.015\ deg$

$\Lambda_{H\_c4} := {}_f\Lambda(0.25, \Lambda_{H\_LE}, AR_H, \lambda_H) = 0.545$ $\Lambda_{H\_c4} = 31.235\ deg$

$\Lambda_{H\_c2} := {}_f\Lambda(0.5, \Lambda_{H\_LE}, AR_H, \lambda_H) = 0.474$ $\Lambda_{H\_c2} = 27.145\ deg$

$\Lambda_{H\_tmax} := {}_f\Lambda(\xi_{tmax\_H}, \Lambda_{H\_LE}, AR_H, \lambda_H) = 0.503$ $\Lambda_{H\_tmax} = 28.82\ deg$

Hidden Area --> H-Tail, linear laws coefficients

H-Tail, linear laws defined over the whole semi-span

$_f\mathrm{c_H}(y) := A_{c\_H} \cdot y + B_{c\_H}$

$_f\mathrm{t\_over\_c_H}(y) := A_{tc\_H} \cdot y + B_{tc\_H}$

$_f\varepsilon_{\mathrm{g\_H}}(y) := A_{\varepsilon\_H} \cdot y + B_{\varepsilon\_H}$

$_f\alpha_{\mathrm{0l\_H\_2D}}(y) := A_{\alpha 0\_H} \cdot y + B_{\alpha 0\_H}$

$_f\mathrm{C_{l\alpha\_H}}(y) := A_{Cl\alpha\_H} \cdot y + B_{Cl\alpha\_H}$

$_f\mathrm{C_{m\_ac\_2D\_H}}(y) := A_{Cm0\_H} \cdot y + B_{Cm0\_H}$

$_f\xi_{\mathrm{ac\_2D\_H}}(y) := A_{\xi ac\_H} \cdot y + B_{\xi ac\_H}$

$_f\mathrm{M_{cr\_H\_2D}}(y) := A_{Mcr\_H} \cdot y + B_{Mcr\_H}$

Hidden Area --> H-Tail, data vectors for plotting linear laws in LaTeX

H-Tail, 2D mean quantities

$$t\_over\_c_{H\_mean} := \frac{2}{S_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\mathrm{t\_over\_c}_{\mathrm{H}}(y)\, \mathrm{d}y = 0.11$$

$$t\_over\_c_{H\_mean} = 0.11$$

$$C_{m\_ac\_H\_mean} := \frac{2}{S_H \cdot MAC_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y)^2 \cdot {}_{\mathrm{f}}\mathrm{C}_{\mathrm{m\_ac\_2D\_H}}(y)\, \mathrm{d}y = -0.07$$

$$C_{m\_ac\_H\_mean} = -0.07$$

$$C_{l\alpha\_H\_mean} := \frac{2}{S_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\mathrm{C}_{\mathrm{l\alpha\_H}}(y)\, \mathrm{d}y = 6.016$$

$$C_{l\alpha\_H\_mean} = 0.105\ \boldsymbol{deg}^{-1}$$

$$\alpha_{0l\_H\_mean} := \frac{2}{S_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\alpha_{\mathrm{0l\_H\_2D}}(y)\, \mathrm{d}y = 0\ \boldsymbol{rad}$$

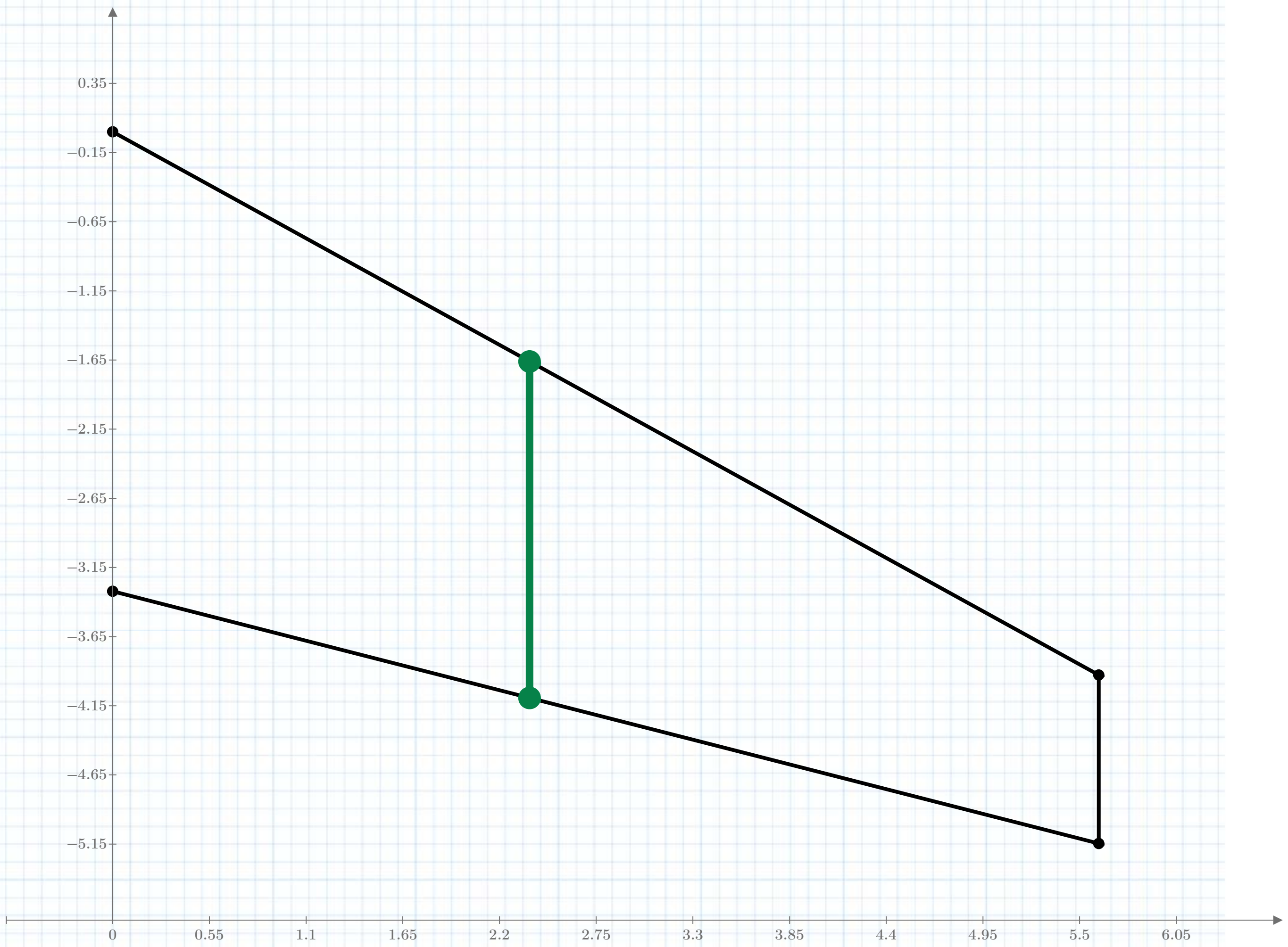
$$\alpha_{0l\_H\_mean} = 0\ \boldsymbol{deg}$$

H-Tail, 3D alpha-zero-lift

$$\alpha_{0L\_H} := \frac{2}{S_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot \left({}_{\mathrm{f}}\alpha_{\mathrm{0l\_H\_2D}}(y) - {}_{\mathrm{f}}\varepsilon_{\mathrm{g\_H}}(y)\right) \mathrm{d}y = 0\ \boldsymbol{rad}$$

$$\alpha_{0L\_H} = 0\ \boldsymbol{deg}$$

H-Tail planform with Mean Aerodynamic Chord



MISCELLANEOUS DATA CALCULATIONS

Induced drag factors, only due to geometric effects

$$e_{H\_alt} := \frac{2}{2 - AR_H + \sqrt{4 + AR_H^{\,2}\left(1 + \tan\left(\Lambda_{H\_tmax}\right)^2\right)}} = 0.657$$

$e_{H\_alt} = 0.657$

$$e_{H\_alt\_\Lambda 0} := 1.78 \cdot \left(1 - 0.045 \cdot AR_H^{\,0.68}\right) - 0.64 = 0.903$$

- **Alternative formula: valid for unswept wings**

$$e_{H\_alt\_\Lambda} := 4.61 \cdot \left(1 - 0.045 \cdot AR_H^{\,0.68}\right) \cdot \cos\left(\Lambda_{H\_LE}\right)^{0.15} - 3.1 = 0.778$$

- **Alternative formula: valid for swept wings**

3d critical Mach number at mean aerodynamic chord

$$M_{cr\_H\_3D\_@MAC\_H} := \frac{{}_{\mathrm{f}}\mathrm{M}_{\mathrm{cr\_H\_2D}}\left(Y_{MAC\_H}\right)}{\cos\left(\Lambda_{H\_LE}\right)} = 0.916$$

$M_{cr\_H\_3D\_@MAC\_H} = 0.916$

Elevator inner and outer stations and area

$$y_{e\_in} := \eta_{e\_in} \cdot \frac{b_H}{2} = 0\ m$$

$y_{e\_in} = 0\ m$

$$y_{e\_out} := \eta_{e\_out} \cdot \frac{b_H}{2} = 5.547\ m$$

$y_{e\_out} = 5.547\ m$

$$c_{H\_mean\_@e} := {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}\left(\frac{y_{e\_in} + y_{e\_out}}{2}\right) = 2.282\ m$$

$c_{H\_mean\_@e} = 2.282\ m$

$$S_e := 2 \cdot c_e \cdot \left(y_{e\_out} - y_{e\_in}\right) = 7.439\ m^2$$

$S_e = 7.439\ m^2$

@Aerodynamic Database ---> (control_surface)_tau_e_vs_c_control_surface_over_c_horizontal_tail

$\tau_e = 0.5$

@Aerodynamic Database ---> (control_surface)_C_h_alpha_vs_flap_chord_over_airfoil_chord

$C_{h\_\alpha\_e} = -0.007$

$C_{h\_\alpha\_e} = -1.174 \cdot 10^{-4}\ deg^{-1}$

@Aerodynamic Database ---> (control_surface)_C_h_delta_vs_flap_chord_over_airfoil_chord

$C_{h\_\delta\_e} = -0.013$

$C_{h\_\delta\_e} = -2.211 \cdot 10^{-4}\ deg^{-1}$

H-TAIL LIFT CURVE SLOPE

H-Tail Lift Curve Slope, function definitions

- **Polhamus Formula Coefficient**

$$
{}_{\mathrm{f}}k_{\mathrm{Polhamus}}\left(M, M_{cr\_3D}, \Lambda_{LE}, \lambda, AR\right) :=
\begin{array}{l}
\text{if } \left(M < M_{cr\_3D}\right) \wedge \left(\Lambda_{LE} < 32\ deg\right) \wedge (\lambda > 0.4) \wedge (\lambda < 1) \wedge (AR > 3) \wedge (AR < 8) \\
\quad \text{if } AR < 4 \\
\quad\quad \text{return } 1 + \dfrac{AR \cdot \left(1.87 - 0.000233 \cdot \Lambda_{LE}\right)}{100} \\
\quad \text{else} \\
\quad\quad \text{return } 1 + \dfrac{\left(\left(8.2 - 2.3 \cdot \Lambda_{LE}\right) - AR \cdot \left(0.22 - 0.153 \cdot \Lambda_{LE}\right)\right)}{100} \\
\text{else} \\
\quad \text{return } 100
\end{array}
$$

(---> Polhamus Formula is not valid)

- **General Formula for Lift Curve Slope**

$$
{}_{\mathrm{f}}C_{\mathrm{L\alpha\_H}}\left(M, k_P, AR, \Lambda_{c2}, C_{l\alpha@MAC}, \Lambda_{LE}\right) :=
\begin{array}{l}
\text{if } k_P \neq 100 \\
\quad \text{return } \dfrac{2 \cdot \pi \cdot AR}{2 + \sqrt{\left(\dfrac{AR^2 \cdot \left(1 - M^2\right)}{{k_P}^2} \left(1 + \dfrac{\tan\left(\Lambda_{c2}\right)}{\left(1 - M^2\right)}\right)\right) + 4}} \\
\text{else} \\
\quad a_0 \leftarrow \dfrac{C_{l\alpha@MAC}}{\sqrt{1 - M^2} \cdot \cos\left(\Lambda_{LE}\right)} \\
\quad \text{return } \dfrac{a_0 \cdot \cos\left(\Lambda_{LE}\right)}{\sqrt{1 - \left(M \cdot \cos\left(\Lambda_{LE}\right)\right)^2 + \left(\dfrac{a_0 \cdot \cos\left(\Lambda_{LE}\right)}{\pi \cdot AR}\right)^2} + \dfrac{a_0 \cdot \cos\left(\Lambda_{LE}\right)}{\pi \cdot AR}}
\end{array}
$$

(---> use Polhamus Formula)

(---> use alternative formula)

H-Tail Lift Curve Slope, classic formula

$$C_{L\alpha\_H\_classic} := \frac{C_{l\alpha\_H\_mean}}{\sqrt{1 - {M_1}^2} + \dfrac{C_{l\alpha\_H\_mean}}{\pi \cdot AR_H \cdot e_{H\_alt}}} = 4.6$$

$$C_{L\alpha\_H\_classic} = 0.08\ deg^{-1}$$

H-Tail Lift Curve Slope, general formula for inner/outer panel and whole wing

$$k_{Polhamus\_H} := {}_{\mathrm{f}}k_{\mathrm{Polhamus}}\left(M_1, M_{cr\_H\_3D\_@MAC\_H}, \Lambda_{H\_LE}, \lambda_H, AR_H\right) = 100$$

$$k_{Polhamus\_H} = 100$$

$$C_{l\alpha\_H\_@MAC\_H} := {}_{\mathrm{f}}C_{\mathrm{l\alpha\_H}}\left(Y_{MAC\_H}\right) = 6.016$$

$$C_{l\alpha\_H\_@MAC\_H} = 0.105\ deg^{-1}$$

$$C_{L\alpha\_H\_@M0} := {}_{\mathrm{f}}C_{\mathrm{L\alpha\_H}}\left(0, k_{Polhamus\_H}, AR_H, \Lambda_{H\_c2}, C_{l\alpha\_H\_@MAC\_H}, \Lambda_{H\_LE}\right)$$

$$C_{L\alpha\_H\_@M0} = 3.606\ rad^{-1} \qquad C_{L\alpha\_H\_@M0} = 0.063\ deg^{-1}$$

$$C_{L\alpha\_H} := {}_{\mathrm{f}}C_{\mathrm{L\alpha\_H}}\left(M_1, k_{Polhamus\_H}, AR_H, \Lambda_{H\_c2}, C_{l\alpha\_H\_@MAC\_H}, \Lambda_{H\_LE}\right)$$

$$C_{L\alpha\_H} = 4.634\ rad^{-1} \qquad C_{L\alpha\_H} = 0.081\ deg^{-1}$$

H-Tail lift coefficient at initial conditions

$$C_{L0\_H} := C_{L\alpha\_H} \cdot \left(i_H - \alpha_{0L\_H} - \varepsilon_{0\_W}\right) = -0.214$$

$$C_{L0\_H} = -0.214$$

Induced drag factor, due to both geometric and aerodynamic effects

$$_{f}e\left(C_{L\alpha}, AR, \lambda, \Lambda_{LE}\right) := \left\| \begin{array}{l} \lambda_e \leftarrow \dfrac{AR \cdot \lambda}{\cos\left(\Lambda_{LE}\right)} \\ R \leftarrow 0.0004 \cdot {\lambda_e}^{3} - 0.008 \cdot {\lambda_e}^{2} + 0.0501 \cdot \lambda_e + 0.8642 \\ \text{return if}\left(AR = 0, 0, \dfrac{1.1 \cdot C_{L\alpha}}{R \cdot C_{L\alpha} + (1-R)\,\pi \cdot AR}\right) \end{array} \right.$$

- Function for calculating wing induced drag factor, icluding aerodynamic and geometric effects

$e_H := {}_{f}e\left(C_{L\alpha\_H}, AR_H, \lambda_H, \Lambda_{H\_LE}\right) = 0.965$

$e_H = 0.965$

H-TAIL AERODYNAMIC CENTER - GRAPHICAL METHOD (DATCOM/NAPOLITANO)

@Aerodynamic Database ---> (x_bar_ac_w)_k1_vs_lambda

$K1_{ac\_H\_Datcom} = 1.361$

@Aerodynamic Database ---> (x_bar_ac_w)_k2_vs_L_LE_(AR)_(lambda)

$K2_{ac\_H\_Datcom} = 0.516$

@Aerodynamic Database ---> (x_bar_ac_w)_x'_ac_over_root_chord_vs_tan_(L_LE)_over_beta_(AR_times_tan_(L_LE))_(lambda)

$X_{ac\_over\_c_{r\_H\_Datcom}} = 0.709$

Aerodynamic center positions

$\xi_{ac\_H} := K1_{ac\_H\_Datcom} \cdot \left(X_{ac\_over\_c_{r\_H\_Datcom}} - K2_{ac\_H\_Datcom}\right) = 0.264$

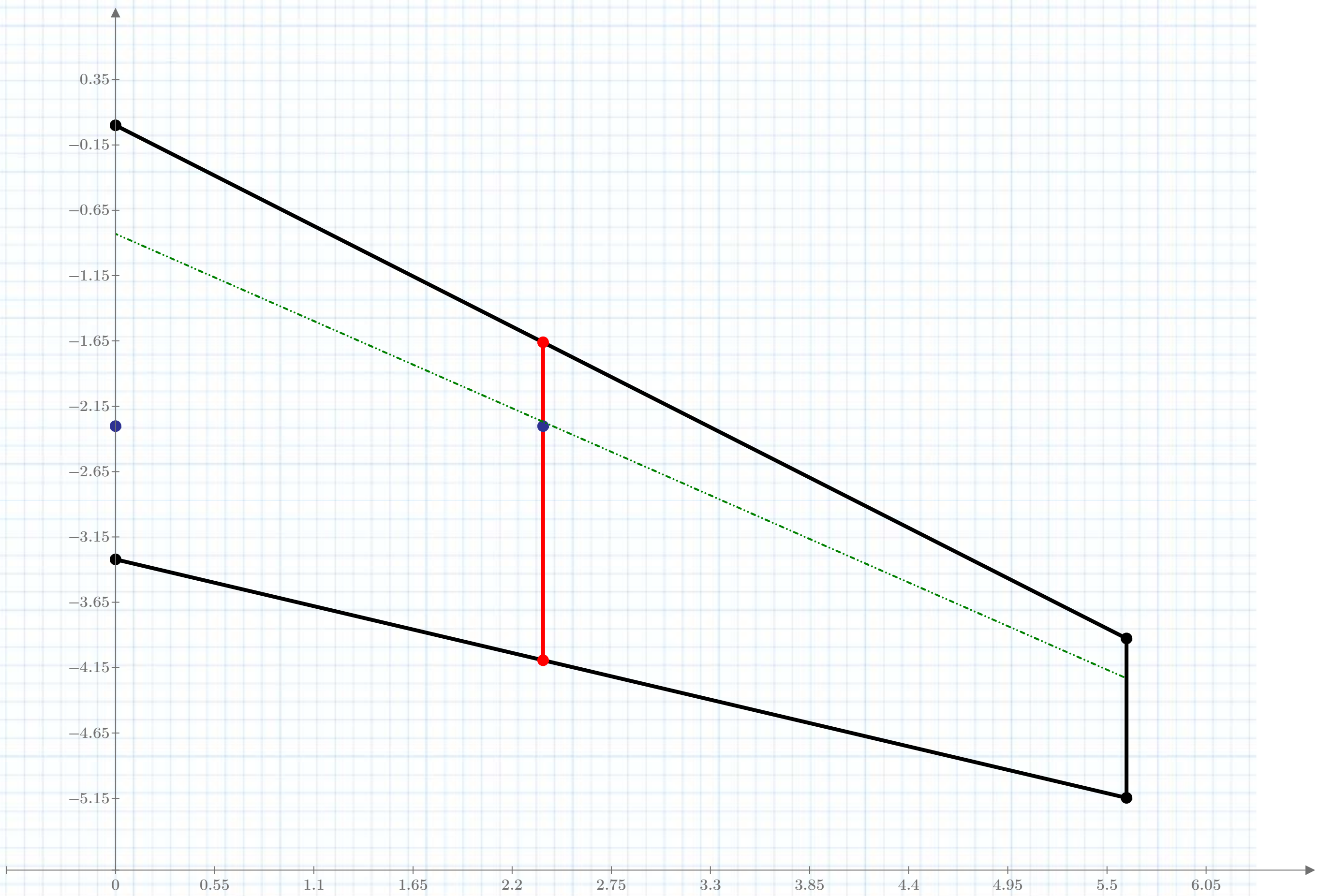
$X_{ac\_H} := \xi_{ac\_H} \cdot MAC_H + X_{MAC\_LE\_H} = 2.302\ m$

$X_{ac\_H} = 2.302\ m$

$x_{ac\_H} := X_{ac\_H} - X_{MAC\_LE\_H} = 0.642\ m$

$x_{ac\_H} = 0.642\ m$

H-Tail planform with 2D aerodynamic center distribution and 3D aerodynamic center



H-Tail Volume Ratio based on aerodynamic centers distance

$$\Delta X\_HT_{ac\_}W_{ac} := \Delta X\_HT_{LE\_}W_{LE} - X_{ac\_W} + X_{ac\_H} = 15.104\ m$$

$$VolumeRatio_{H\_ac} := \frac{S_H}{S_W} \cdot \frac{\Delta X\_HT_{ac\_}W_{ac}}{MAC_W} = 1.206$$

SHRENK'S METHOD FOR BASIC AND ADDITIONAL H-TAIL LOADING

Loading function definitions and remarkable values

$${}_{\mathrm{f}}\mathrm{c}_{\mathrm{eff}}(y) := \frac{{}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\mathrm{C}_{\mathrm{l\alpha\_H}}(y)}{C_{l\alpha\_H\_mean}}$$

- Effective chord distribution function

$$c_{ell\_0} := \frac{4 \cdot S_H}{\pi \cdot b_H} \qquad {}_{\mathrm{f}}\mathrm{c}_{\mathrm{ell}}(y) := c_{ell\_0} \cdot \sqrt{1 - \left(\frac{y}{\frac{b_H}{2}}\right)^2}$$

- Elliptic chord distribution function

$${}_{\mathrm{f}}\alpha_{\mathrm{b}}(y) := \alpha_{0L\_H} - \left({}_{\mathrm{f}}\alpha_{\mathrm{0l\_H\_2D}}(y) - {}_{\mathrm{f}}\varepsilon_{\mathrm{g\_H}}(y)\right)$$

- "Basic" angle of attack function

$${}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_b}}(y) := \frac{1}{2} \cdot {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\mathrm{C}_{\mathrm{l\alpha\_H}}(y) \cdot {}_{\mathrm{f}}\alpha_{\mathrm{b}}(y)$$

- Basic wing loading

$${}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_a}}(y) := \frac{1}{2} \cdot \left({}_{\mathrm{f}}\mathrm{c}_{\mathrm{eff}}(y) + {}_{\mathrm{f}}\mathrm{c}_{\mathrm{ell}}(y)\right)$$

- Additional wing loading function

$${}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l}}(y) := {}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_b}}(y) + {}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_a}}(y)$$

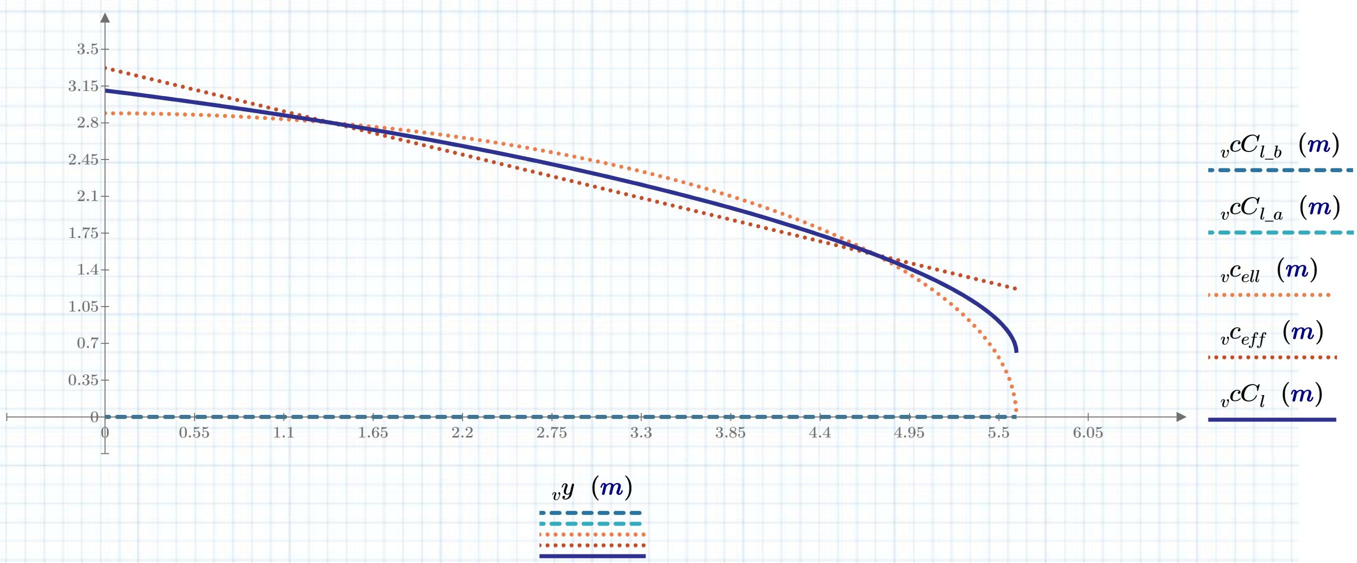
- Wing loading function

$$C_{L\_b} := \frac{2}{S_W} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_b}}(y)\, \mathrm{d}y = 0$$

$$C_{L\_a} := \frac{2}{S_W} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_a}}(y)\, \mathrm{d}y = 0.291$$

- **REMARK:** the effects of wing sweep angle are neglected

Spanwise loading curve plots



3D PITCHING MOMENT COEFFICIENT ABOUT H-TAIL AERODYNAMIC CENTER

Exact formulation

$${}_{\mathrm{f}}\mathrm{x}_{\mathrm{b\_H}}(y) := X_{ac\_H} - \left(y \cdot \tan\left(\Lambda_{H\_LE}\right) + {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\xi_{\mathrm{ac\_2D\_H}}(y)\right)$$

- **Moment arm from section's aerodynamic center to wing 3D aerodynamic center**

$$C_{M\_ac\_H\_b} := \frac{2}{S_H \cdot MAC_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{cC}_{\mathrm{l\_b}}(y) \cdot {}_{\mathrm{f}}\mathrm{x}_{\mathrm{b\_H}}(y)\,\mathrm{d}y = 0 \qquad C_{M\_ac\_H\_b} = 0$$

$$C_{M\_ac\_H\_a} := \frac{2}{S_H \cdot MAC_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\mathrm{C}_{\mathrm{m\_ac\_2D\_H}}(y) \cdot {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y)^2\,\mathrm{d}y = -0.07 \qquad C_{M\_ac\_H\_a} = -0.07$$

$$C_{M\_ac\_H} := C_{M\_ac\_H\_b} + C_{M\_ac\_H\_a} = -0.07 \qquad C_{M\_ac\_H} = -0.07$$

Approximated formulation (Roskam)

$$C_{M\_ac\_H\_b\_Roskam} := \frac{2 \cdot \pi}{S_H \cdot MAC_H} \cdot \int_0^{\frac{b_H}{2}} {}_{\mathrm{f}}\alpha_{\mathrm{b}}(y) \cdot {}_{\mathrm{f}}\mathrm{c}_{\mathrm{H}}(y) \cdot {}_{\mathrm{f}}\mathrm{x}_{\mathrm{b\_H}}(y)\,\mathrm{d}y = 0 \qquad C_{M\_ac\_H\_b\_Roskam} = 0$$

$$C_{M\_ac\_H\_Roskam} := C_{M\_ac\_H\_b\_Roskam} + C_{M\_ac\_H\_a} = -0.07 \qquad C_{M\_ac\_H\_Roskam} = -0.07$$

Integrand functions plot

DOWNWASH

Lifting Line Theory

$${}_f\varepsilon_{\alpha\_LLT\_H}\left(C_{L\alpha}, AR, e, M\right) := \text{if}\left(AR = 0, 0, 2 \cdot \frac{C_{L\alpha}}{\pi \cdot AR \cdot e} \cdot \frac{1}{\sqrt{1-M^2}}\right)$$

• Downwash gradient according to linear theory

$$\varepsilon_{\alpha\_LLT\_@M0\_H} := {}_f\varepsilon_{\alpha\_LLT\_H}\left(C_{L\alpha\_H}, AR_H, e_H, 0\right) = 0.619$$

$$\varepsilon_{\alpha\_LLT\_@M0\_H} = 0.619$$

$$\varepsilon_{\alpha\_LLT\_H} := {}_f\varepsilon_{\alpha\_LLT\_H}\left(C_{L\alpha\_H}, AR_H, e_H, M_1\right) = 0.862$$

$$\varepsilon_{\alpha\_LLT\_H} = 0.862$$

$$\varepsilon_{0\_LLT\_H} := \varepsilon_{\alpha\_LLT\_H} \cdot \left(i_H - \alpha_{0L\_H}\right) = -0.03$$

$$\varepsilon_{0\_LLT\_H} = -1.725\ deg$$

DATCOM Method

$$_{f}K_{AR}(AR) := \frac{1}{AR} - \frac{1}{1+(AR)^{1.7}}$$

$$_{f}K_{\lambda}(\lambda) := \frac{10 - 3 \cdot \lambda}{7}$$

- **Empirical coefficients function definitions**

$$K_M(M, C_{L\alpha\_@M0}, C_{L\alpha}) := \begin{cases} \text{if } M \le 0.7 & \text{return } \sqrt{1 - M^2} \\ \text{else} & \text{return } \dfrac{C_{L\alpha}}{C_{L\alpha\_@M0}} \end{cases}$$

$$_{f}K_{MAC4}(\Delta Z', \Delta X', b) := \frac{1 - \dfrac{\Delta Z'}{b}}{\sqrt[3]{2 \cdot \dfrac{\Delta X'}{b}}}$$

$$K_{AR\_H} := {}_{f}K_{AR}(AR_H) = 0.14 \qquad K_{AR\_H} = 0.14$$

$$K_{\lambda\_H} := {}_{f}K_{\lambda}(\lambda_H) = 1.271 \qquad K_{\lambda\_H} = 1.271$$

$$K_{MAC4\_WH} = 0.707 \qquad K_{MAC4\_WH} = 0.707$$

$$K_{M\_H} := K_M(M_1, C_{L\alpha\_H\_@M0}, C_{L\alpha\_H}) = 0.718 \qquad K_{M\_H} = 0.718$$

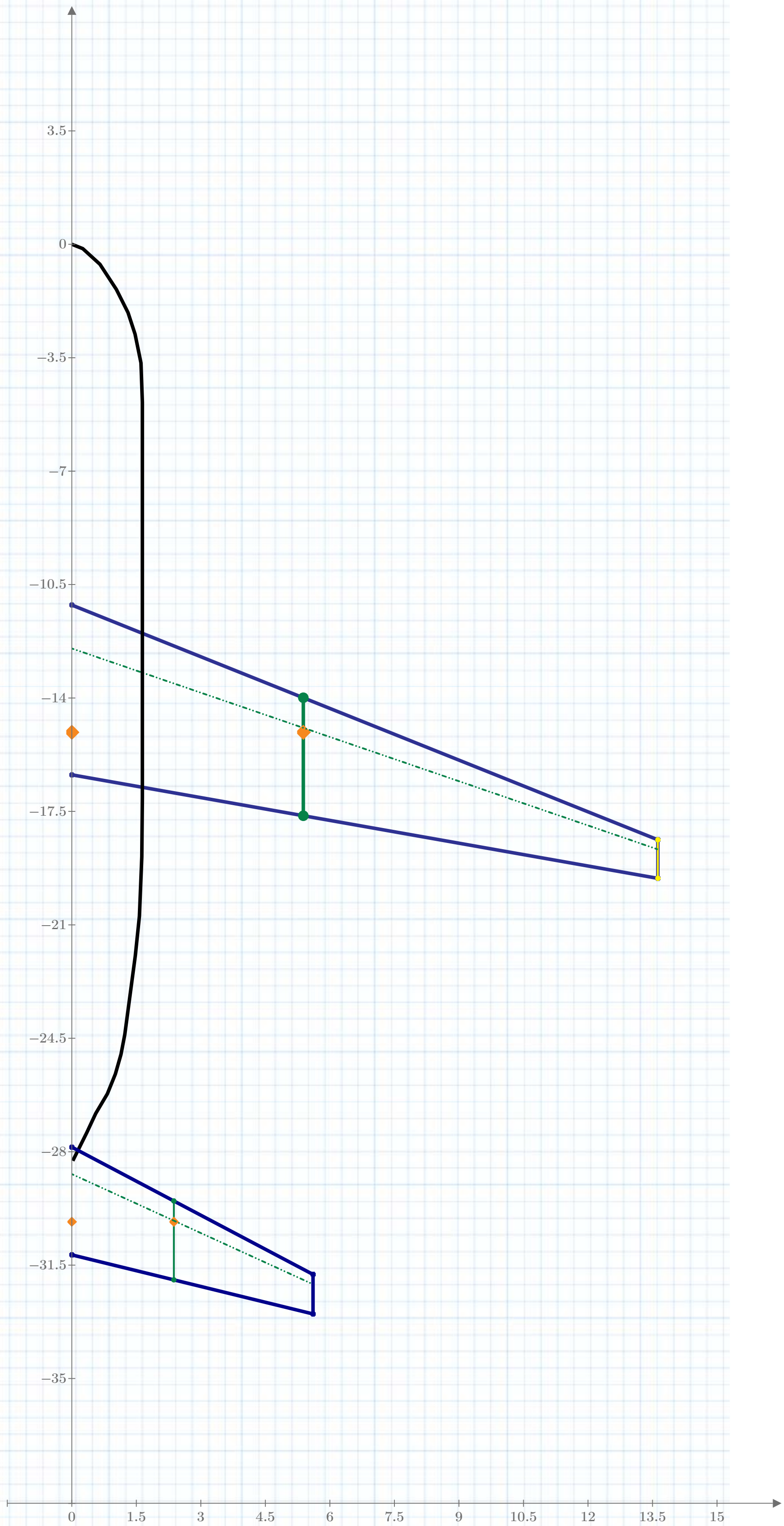
$$\varepsilon_{\alpha\_@M0\_H} := 4.44 \cdot \left(K_{AR\_H} \cdot K_{\lambda\_H} \cdot K_{MAC4\_WH} \cdot \sqrt{\cos(\Lambda_{H\_c4})}\right)^{1.19} = 0.344 \qquad \varepsilon_{\alpha\_@M0\_H} = 0.344$$

$$\varepsilon_{\alpha\_H} := \varepsilon_{\alpha\_@M0\_H} \cdot \sqrt{1 - M_1^2} \qquad \varepsilon_{\alpha\_H} = 0.247$$

$$\varepsilon_{0\_H} := \varepsilon_{\alpha\_H} \cdot (i_H - \alpha_{0L\_H}) = -0.009 \qquad \varepsilon_{0\_H} = -0.495\ deg$$

MISCELLANEOUS PARAMETERS PLOT

WING-BODY-HTAIL PLANFORM



MAPPING AND OUTPUT CREATION

Includi << ../Default_Map_HTail.mcdx

Excel Writing

$First\_Row_{H\_1} := 4$

$Block_{H\_1} := {}_{f}\text{map\_matrix\_transform}\left({}_{m}HTail\_Data\_Map_{imported}\right)$

$Excel\_Output_{H\_1} := {}_{f}\text{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{H\_1}, n_{sheet}, First\_Row_{H\_1}\right)$

$First\_Row_{H\_2} := First\_Row_{H\_1} + \text{rows}\left(Block_{H\_1}\right) + 2 = 20$

$Block_{H\_2} := {}_{f}\text{map\_matrix\_transform}\left({}_{m}HTail\_Data\_Map_{input}\right)$

$Excel\_Output_{H\_2} := {}_{f}\text{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{H\_2}, n_{sheet}, First\_Row_{H\_2}\right)$

$First\_Row_{H\_3} := First\_Row_{H\_2} + \text{rows}\left(Block_{H\_2}\right) + 2 = 58$

$Block_{H\_3} := {}_{f}\text{map\_matrix\_transform}\left({}_{m}HTail\_Data\_Map\right)$

$Excel\_Output_{H\_3} := {}_{f}\text{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{H\_3}, n_{sheet}, First\_Row_{H\_3}\right)$

$First\_Row_{H\_4} := First\_Row_{H\_3} + \text{rows}\left(Block_{H\_3}\right) + 2 = 143$

$Block_{H\_4} := {}_{f}\text{map\_matrix\_transform}\left({}_{m}HTail\_Data\_Map_{LLCoeffs}\right)$

$Excel\_Output_{H\_4} := {}_{f}\text{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{H\_4}, n_{sheet}, First\_Row_{H\_4}\right)$

$First\_Row_{H\_5} := First\_Row_{H\_4} + \text{rows}\left(Block_{H\_4}\right) + 2 = 178$

$Block_{H\_5} := {}_{f}\text{map\_matrix\_transform}\left({}_{m}HTail\_Data\_Map_{Misc}\right)$

$Excel\_Output_{H\_5} := {}_{f}\text{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{H\_5}, n_{sheet}, First\_Row_{H\_5}\right)$

CSV Tabs Writing

$${}_{m}CSV_{H\_1} := \text{augment}\left({}_{v}y, {}_{v}c_{ell}, {}_{v}c_{eff}, {}_{v}cC_{l\_a}, {}_{v}cC_{l\_b}\right) \cdot \frac{1}{m}$$

$CSV\_Output_{H\_1} := \text{WRITECSV}\left(\text{“.\textbackslash Output\textbackslash H–TAIL\_shrenk\_loading(y,c\_ell,c\_eff,cCl\_a,cCl\_b).csv”}, {}_{m}CSV_{H\_1}\right)$

$${}_{m}CSV_{H\_2} := \text{augment}\left({}_{v}y \cdot \frac{1}{m}, {}_{v}x_{b\_H} \cdot \frac{1}{m}, {}_{v}IC_{M\_ac\_H\_b} \cdot \frac{1}{m^2}, {}_{v}IC_{M\_ac\_H\_b\_Roskam} \cdot \frac{1}{m^2}\right)$$

$CSV\_Output_{H\_2} := \text{WRITECSV}\left(\text{“.\textbackslash Output\textbackslash H–TAIL\_shrenk–roskam\_loading(y,x\_b,IC\_M\_b,IC\_M\_b\_Roskam).csv”}, {}_{m}CSV_{H\_2}\right)$

$${}_{m}CSV_{H\_3} := \text{augment}\left({}_{v}y \cdot \frac{1}{m}, {}_{v}c_{H} \cdot \frac{1}{m}, {}_{v}\alpha_{0l\_2D}, {}_{v}\varepsilon_{g}, {}_{v}C_{l\alpha\_H}, {}_{v}C_{m\_ac\_2D\_H}, {}_{v}\xi_{ac\_2D\_H}\right)$$

$CSV\_Output_{H\_3} := \text{WRITECSV}\left(\text{“.\textbackslash Output\textbackslash H–TAIL\_linear\_laws(y,c,alphazl,epsilon,Clalpha,Cmac,Csiac).csv”}, {}_{m}CSV_{H\_3}\right)$

$${}_{m}CSV_{H\_4} := \text{augment}\left({}_{v}X_{H}, {}_{v}Y_{H}\right) \cdot \frac{1}{m}$$

$CSV\_Output_{H\_4} := \text{WRITECSV}\left(\text{“.\textbackslash Output\textbackslash H–TAIL\_planform(X\_H,Y\_H).csv”}, {}_{m}CSV_{H\_4}\right)$

$_{m}CSV_{H\_5} := \text{augment}\left({}_{v}X_{mac.H}, {}_{v}Y_{mac.H}, {}_{v}X_{ac\_H}, {}_{v}Y_{ac\_H}\right) \cdot \frac{1}{m}$

$CSV\_Output_{H\_5} := \text{WRITECSV}\left(\text{“.\textbackslash Output\textbackslash H–TAIL\_planform\_MAC\_and\_AC(XmacH,YmacH,Xac,Yac).csv”}, {}_{m}CSV_{H\_5}\right)$

$_{m}CSV_{H\_6} := \text{augment}\left({}_{v}X_{ac\_2D\_H}, {}_{v}Y_{ac\_2D\_H}\right) \cdot \frac{1}{m}$

$CSV\_Output_{H\_6} := \text{WRITECSV}\left(\text{“.\textbackslash Output\textbackslash H–TAIL\_planform\_ac2D(Xac2D\_H,Yac2D\_H).csv”}, {}_{m}CSV_{H\_6}\right)$

TeX Macro writing on .tex

$_{v}complete\_macros_{H} := \text{stack}\left(Block_{H\_1}^{\langle 2\rangle}, Block_{H\_2}^{\langle 2\rangle}, Block_{H\_3}^{\langle 2\rangle}, Block_{H\_4}^{\langle 2\rangle}, Block_{H\_5}^{\langle 2\rangle}\right)$

$_{v}tex_{H} := {}_{f}\text{write\_matrix}\left(\text{“.\textbackslash Output\textbackslash HTAIL\_TeX\_Macros.tex”}, {}_{v}complete\_macros_{H}, \text{“ ”}\right)$