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Aerodynamic Coefficient Video Notes

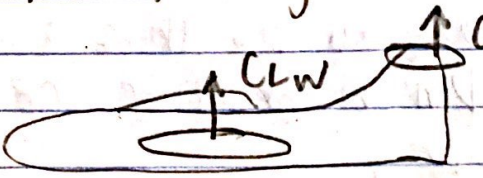
What is an aerodynamic coefficient?

Unitless, dimensionless coefficients that relate the forces and moments to other relevant parameters like the size of the wing etc.

Forces	Moments	
$C_L = \frac{L}{qS}$	$C_l = \frac{RM}{qSb_{ref}}$	Rolling Moment
$C_D = \frac{D}{qS}$	$C_m = \frac{PM}{qS\bar{c}}$	Pitch
$C_Y = \frac{SF}{qS}$	$C_n = \frac{YM}{qSb_{ref}}$	Yaw

b_{ref} = wing span
S = wing planform area
$\bar{c}$ = MAC (w) - Mean aerodynamic chord
q = dynamic pressure (N/m^2)

Adding / subtracting AC's



$C_L \neq C_{L_W} + C_{L_t}$

You cannot add coefficients together, you can only add Forces together and moments together

→

The right way to do this calculation is:

$$C_L = \frac{L}{qS} = \frac{(L_w + L_t)}{q \cdot S_w}$$

All dimensionless coefficients need to be normalized using $q, S, \bar{c}, b_{ref}$

Rotating AC's

$$\bar{C}_m^w = \begin{bmatrix} C_l \\ C_m \\ C_n \end{bmatrix}^w$$ assume these are "expressed" in the wind axis

In simulation we need these moments in the body axis

Wrong:

$$\bar{C}_m^B = C_{b/w}(\alpha, \beta)\, \bar{C}_m^w$$

This wrong because the rotation matrix must be applied to a vector

The right way to do this:

1) Dimensionalize coefficients

$$\bar{M}_{net}^w \begin{bmatrix} C_l \cdot q \cdot S \cdot b_{ref} \\ C_m \cdot q \cdot S \cdot \bar{c} \\ C_n \cdot q \cdot S \cdot b_{ref} \end{bmatrix}$$

2) Apply Rotation Matrix →

2) Apply Rotation

$$\bar{M}_{net}^{b} = C_{b/w}(\alpha, \beta)\, \bar{M}_{net}^{w}$$

3) Renormalize ...

$$C_{\ell}^{b} = \frac{M_{net(1)}}{qS\, b_{ref}}$$

$$C_{M}^{b} = \frac{M_{net(2)}}{qS\, \bar{c}}$$

$$C_{n} = \frac{M_{net(3)}}{qS\, b_{ref}}$$

Overall, this information comes more into play when receiving data about an aircraft. We will be calculating this information so we will know how the data has been Normalized, but this is still vastly important to know.