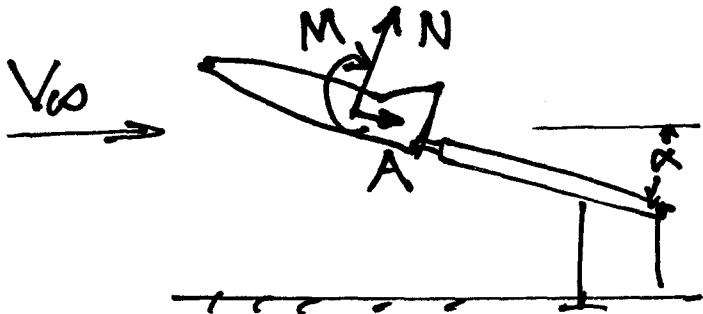


EWT - STING BALANCE DATA PROCEDURE 1



100 SHEETS
100101 100102 100103 100104 100105

The sting balance in the USNA EWT's measure normal (N), axial (A), and pitching moment loads. These must be corrected in several steps...

I. Get balance "tare" measurements, to account for model weight. These are wind-off measurements at each AOA tested. Collect 5-10 samples per AOA.

$$\vec{F}_{\text{tare}} = \begin{bmatrix} N_{\text{tare}} \\ A_{\text{tare}} \\ M_{\text{tare}} \end{bmatrix}$$

- Normal force (lb)
- Axial force (lb)
- Pitching Moment (in-lb)

II. Get measured aerodynamic loads. These are wind-on measurements at each AOA & velocity tested. Collect 5-10 samples per AOA.

$$\vec{F}_m = \begin{bmatrix} N_m \\ A_m \\ M_m \end{bmatrix}$$

III. Average tare & measured values over each AOA & velocity tested.

IV. Calculate the net aerodynamic loads.

$$\vec{F}_{\text{net}} = \vec{F}_M - \vec{F}_{\text{tare}}$$

V. The net loads must be corrected for load component interactions within the sting itself.

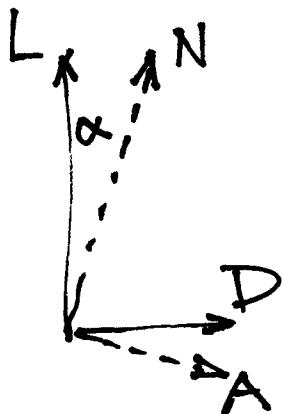
$$\vec{F}_{\text{corr}} = K^{-1} \vec{F}_{\text{net}} \quad (K \setminus F_{\text{net}} \text{ in MATLAB})$$

The load interaction matrix, K , is...

$$K = \begin{bmatrix} 1.0004 & 0.0053 & 0.0031 \\ -0.0432 & 1.0034 & -0.0081 \\ -0.0068 & 0.0535 & 0.9915 \end{bmatrix}$$

This matrix is crucial! Make sure it's entered correctly & the inverse is done properly. This affects the accuracy of the results, especially axial force.

VI Transform from $N \& A$ to $L \& D$.



$$L = N\cos\alpha - A\sin\alpha$$

$$D = N\sin\alpha + A\cos\alpha$$

VII. Calculate coefficients.

$$C_L = L/\bar{\rho}S$$

$$C_D = D/\bar{\rho}S$$

$$C_m = M/\bar{\rho}Sc$$

To get $\bar{\rho}$, use the recorded velocity in the output data file...

a) Determine avg. V at each AOA & velocity tested. (\bar{V})

b) Calculate the dynamic pressure...

$$\bar{\rho} = \frac{1}{2} \rho_{std} \bar{V}^2$$

(0.002377 slug/f³

NOTES: EWT Data Acquisition

1. Run the program "USNAEWT2-1.exe"
2. Pick a ref. AOA at which to "zero" the instrumentation (for tare & wind-on measurements). Set model to that AOA & "zero" the system. (wind off).
3. After saving a series of data points, write the data to a file. Make sure you specify a unique directory & filename. Save tare & wind-on measurements in separate files.
4. To create a new data file, shut down the program & restart. Don't forget to "zero" with the wind off!
5. The data files can be ^{opened} ~~opened~~ with Excel. Save as an Excel format.