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Lecture 05a
Introduction to Wind Tunnel Testing and Data Acquisition

The YouTube video entitled 'Wind Tunnel Testing: Introduction and Data Acquisition' that covers this lecture is located at https://youtu.be/c0Lv-mJ_65o.

Outline

-Introduction
-Data Acquisition
-Other Types of Wind Tunnel Testing
    -Flow Visualization
    -Pressure Testing

Introduction

Like we mentioned previously, we need to quantify how $\overline{F}_A{}^b$ and $\overline{M}_{A,\text{cg}}{}^b$ are functions of the states and control inputs. We can go to a wind tunnel to quantify how these vary with respect to non-changing flight conditions (aka steady aerodynamics). In other words, we can see how the forces and moments are a function of α, β, δ_A, δ_E, etc, but we cannot find how the forces/moments are a function of p, q, r, etc.

Let's look at a few motivations slides first (go to PowerPoint slides).

There are three main portions to wind tunnel testing

1. Data Acquisition
2. Data Reduction
3. Data Analysis

Data Acquisition

UWAL uses a 6 component balance (measures lift, drag, side, pitch, yaw, and roll).
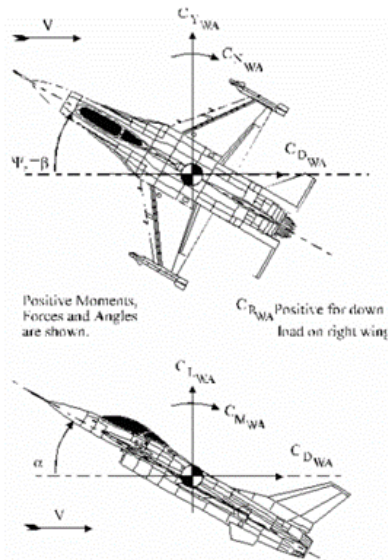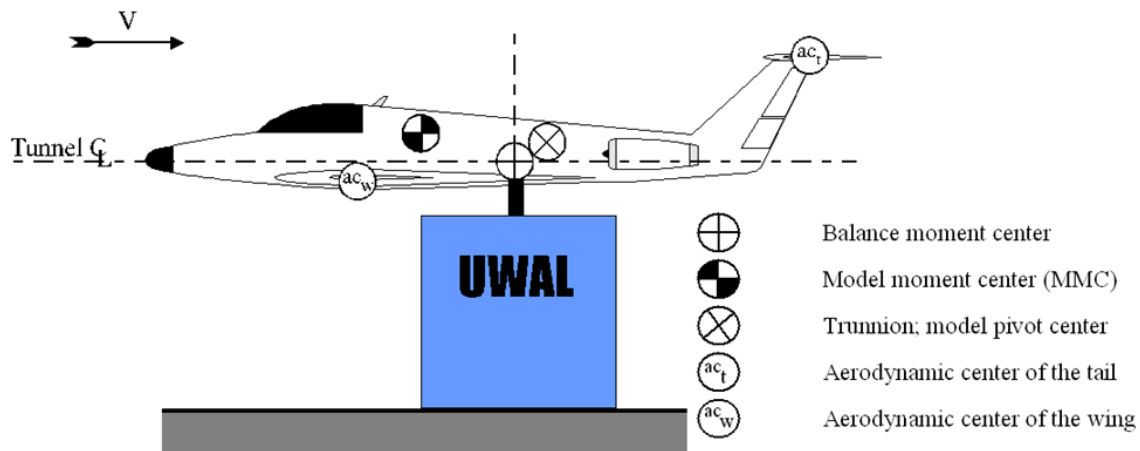
The positive measurements are given as

Figure 3: Wind Axis Diagram

A drawing of the model

The general procedure of data acquisition is

1. Balance outputs raw voltages for each component, balance needs to first be calibrated to obtain mapping between voltages and engineering units (ie lbf or in-lbf).
2. Wind off Zero (WOZ) taken with no wind to "tare out" non-zero values.
3. Wind is brought up to desired airspeed (desired q).
4. Model is pitched and yawed to desired orientation.
5. Data is taken (sampled and averaged at 100Hz for 5 seconds when wind is within 1% of desired range).
6. Save relevant data variables.

Note: Force and moment coefficients are functions of Reynolds number, so it is important to only take

data at the desired dynamic pressure.

Other Types of Wind Tunnel Testing

In addition to force and moment data, there are several other types of data that can be acquired during a wind tunnel test.

Flow Visualization

This is used for visualizing the flow. There are several methods such as

-Smoke flow vis

-Minitufts

-Oil drops

-China Clay (mixture of kerosene, clay powder, and DayGlo pigment)

These are typically messy and sometimes to avoid fouling the balance, the hole between the strut and the fairing is taped up. Therefore, it is impossible to gather force/moment data.

This also has the potential to gum up pressure ports if they are present.

Pressure Testing

This can be used as an alternative method to obtain forces/moments by integrating pressures over the model.
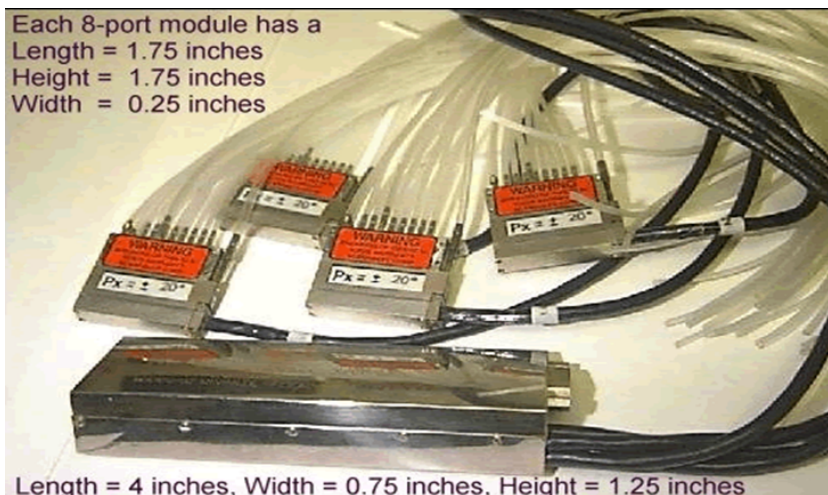
This does add some complexity to the test.