Experiment 6 : Direct Measurement of Lift and Drag

AS2510 Low Speed Lab

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Aim

To determine the lift and drag generated by NACA0015 airfoil using direct measurement techniques. Using this, plot the variation of these coefficients relative to the angle of attack

Apparatus

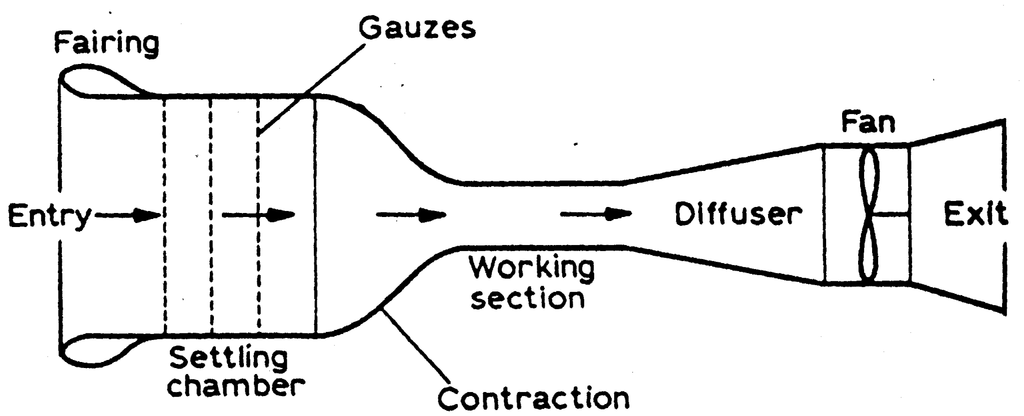

Figure 1: Schematic of open return wind tunnel used in experiment

The apparatus is similar to the one depicted above. The tunnel cross-section in the working section is 150 mm x 150 mm throughout. A NACA0015 Airfoil model (with chord length c = 65 mm) is kept in the working section.

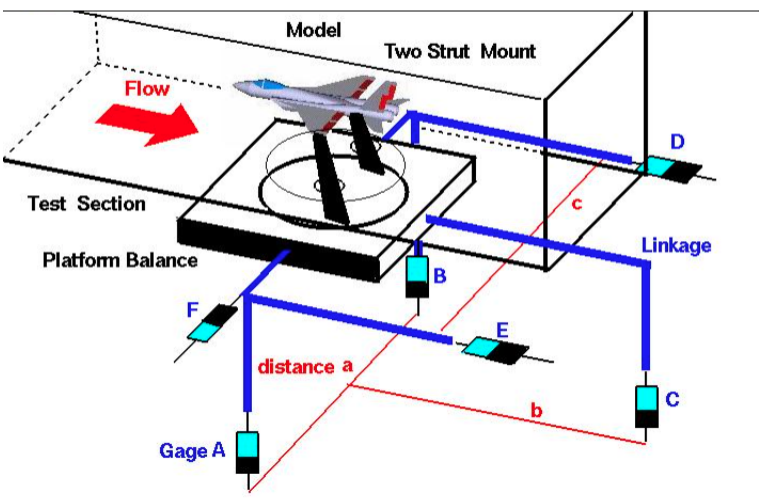

Figure 2: Load Cell Setup

We use a load cell to measure the forces acting on the airfoil. A load cell is a type of transducer which is used precisely for force transducer. The weight acts on a body and produces the electric signal, which can be measured and made uniform.

In our experiment, two strain gauges oriented perpendicular to each other are used to measure lift and drag.

Principle

When strain is applied to the strain gauge, the resistance of the strain gauge sensor changes, the Wheatstone bridge becomes unbalanced, a current flows through the voltmeter. Since the net change in the resistance is proportional to the applied strain, therefore, resultant current flow through the voltmeter is proportional to the applied strain. So, the voltmeter can be calibrated in terms of strain or force.

Once the Lift and Drag are measured, we can calculate their coefficients, and study their variation with the angle of attack.

$$C_L = \frac{L}{0.5\rho U_\infty^2 S} \qquad C_D = \frac{D}{0.5\rho U_\infty^2 S}$$

Procedure

1. Set-up the apparatus with a steady flow
2. measure the lift and drag
3. calculate the Lift and Drag coefficients.

Results

Calculations & Results

ρ = 1.225 kkg/m^3
U_∞ = 20 m/s
c = 65mm, b = 150mm
S = b $\times$ c = 0.065m $\times$ 0.15m = 0.00975m^2

α (°)	Lift (N)	Drag (N)	C_L	C_D
2.3	0.76	0.04	0.3182	0.0167
4.1	1.02	0.05	0.4270	0.0209
6	1.23	0.06	0.5149	0.0251
8.1	1.51	0.09	0.6321	0.0376
10.2	1.7	0.11	0.7117	0.0460
12	1.75	0.15	0.7326	0.0691
14	1.3	0.45	0.5442	0.1884

Table 1: Experiment Readings of Lift and Drag

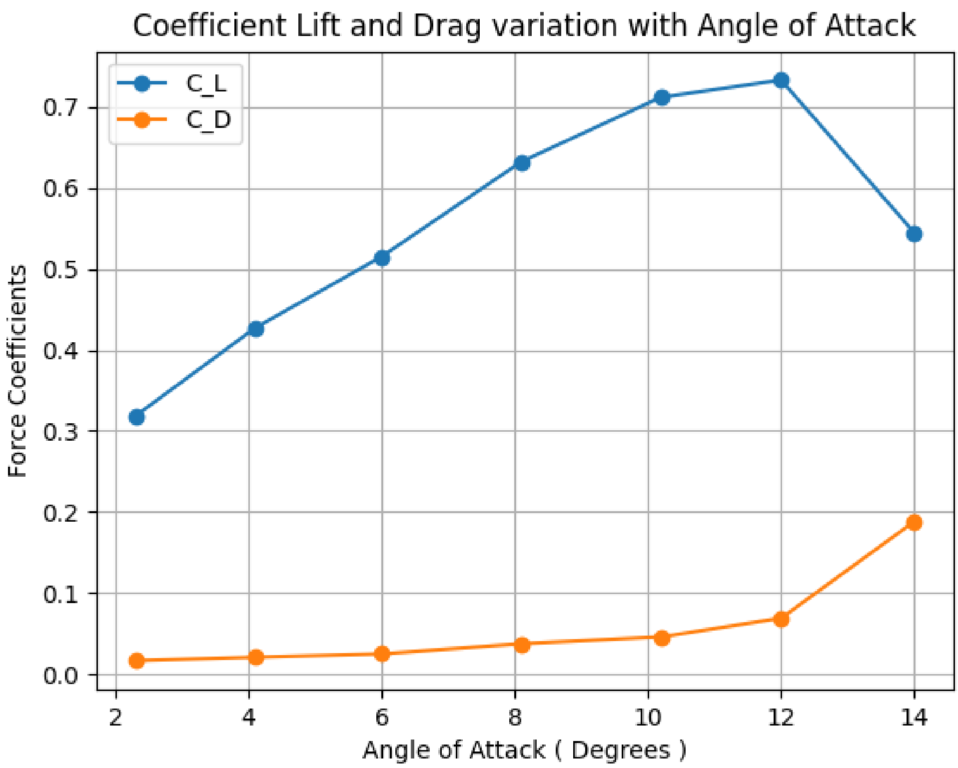

Figure 3: Plot showing the variation of Experimental Force Coefficients with the Angle of Attack

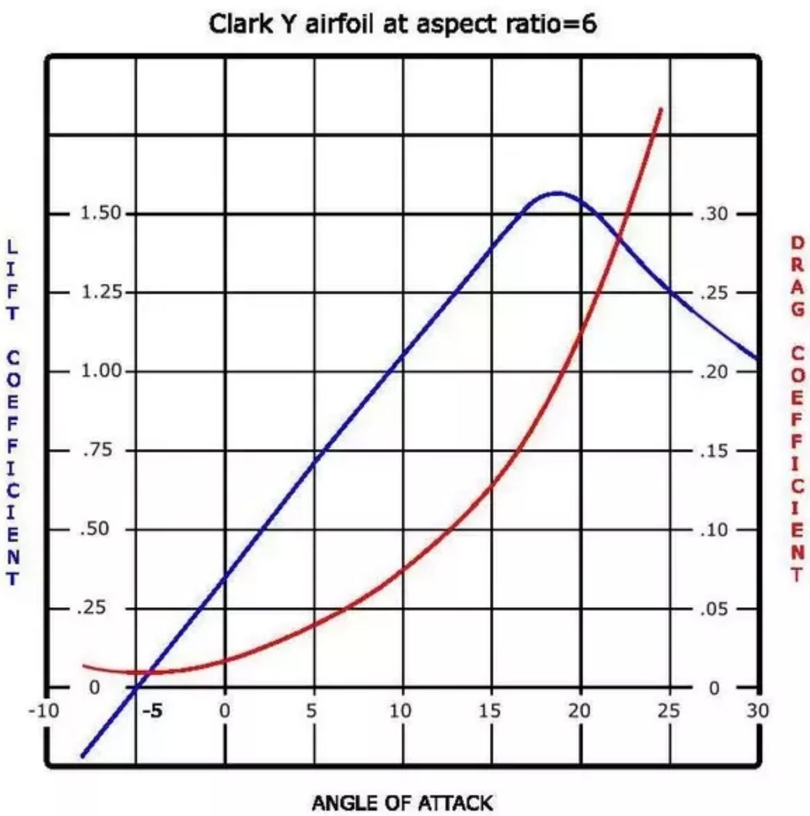

Figure 4: Plot showing the expected variation of Force Coefficients with the Angle of Attack

Inference

We can see that the Force Coefficients follow the expected variation. The region of the stall is evident as the Coefficient of Lift drops and the Coefficient of Drag increases rapidly.

Furthermore, direct force measurement is an accurate method to determine the characteristics of forces experienced by a body due to fluid interactions.