Characterisation & Testing of a Wind Tunnel

Group A2 – Brendan, Eman, Paul, Michael

TUS

Aim of the Project

The aim of this project is to develop an understanding of fans and fans performance. Create a test procedure for testing the flow rates in the wind tunnel, and design some test pieces to test the air flow properties around the test pieces.

Objectives

1. Research the area of wind tunnels, their uses in industry & fan performance.
2. Create a detailed test plan of experiments that will be performed in order to determine the capabilities of the wind tunnel.
3. Perform a series of tests to determine the velocity profile across the wind tunnel when empty, and with two test pieces.
4. Calculate the various flow states through the testing chamber during the various test and generate graphics/table to present the findings.

Background

A wind tunnel is a machine or facility that allows researchers to study the effects of air movement on objects. Objects are held stationary inside a tube, A wind tunnel is a machine or facility that allows researchers to study the effects of air movement on objects. Objects are held stationary inside a tube, and air is blown around it to study the interaction between the object and the moving air.

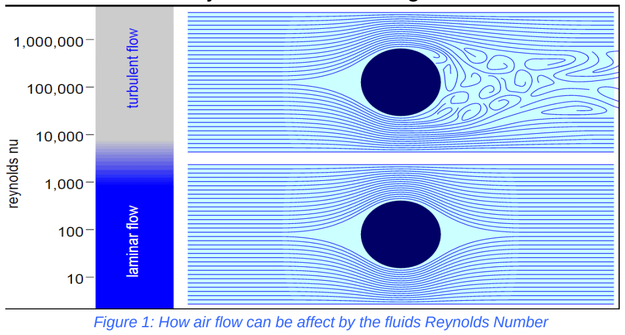

Figure 1: How air flow can be affect by the fluids Reynolds Number

Test Piece Designs

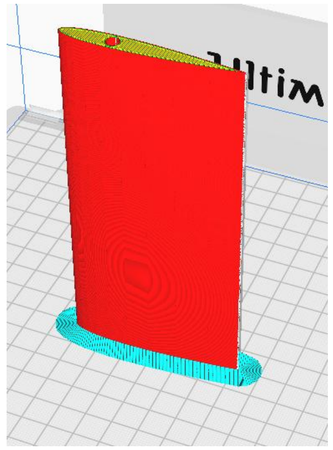

Figure 3: Slicing of an foil for 3D-printing

This design was opted for due to its simplicity and easy ability to 3D print. Air foil designs are interesting as it helps us understand how a particular shape influences lift and drag

Modifications

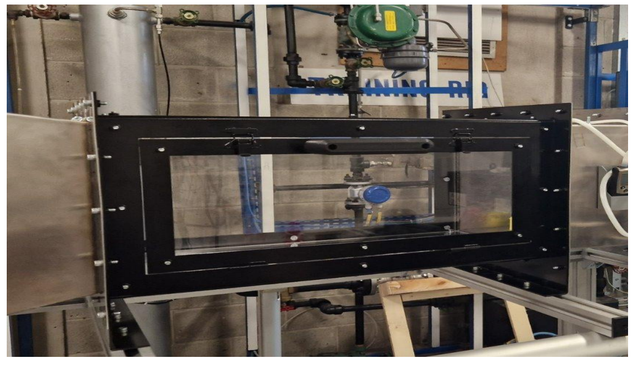

Figure 3: Installation of laser cut Perspex

Original Perspex removed due to the sharp corners producing turbulence into the airflow. Laser cut panels were installed to fit tight against the testing chamber removing the sharp edges to produce a more laminar flow. Each panel was cut with a chamfer and countersunk holes for the screw heads to sit into to remove their inference with air flowing through the testing chamber.

Testing

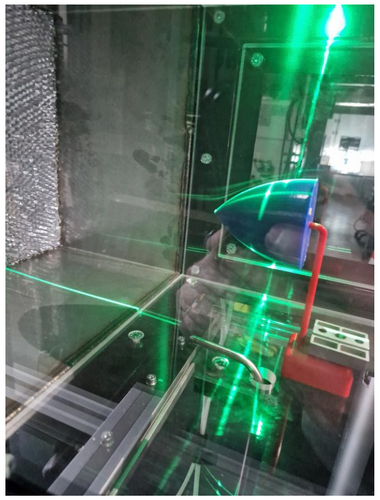

Figure 4: Visual testing of a nose cone.

Visual testing using a cross sectional laser and burning of incense to produce smoke. The airflow can be seen with the smoke passing over the test piece and across the path of the laser. In this case the airflow is laminar due the lack of turbulence and air separation from the test piece.

Results

Boundary layer formation can be demonstrated using the recorded values for the displacement of the Pitot tube against the recorded velocity values. It can be seen in the graph that the boundary layers impact on the free stream velocity is greatest between 0 & 15mm. At higher speeds the airflow becomes more turbulent as shown @ S4/S5 with the boundary layer being erratic.

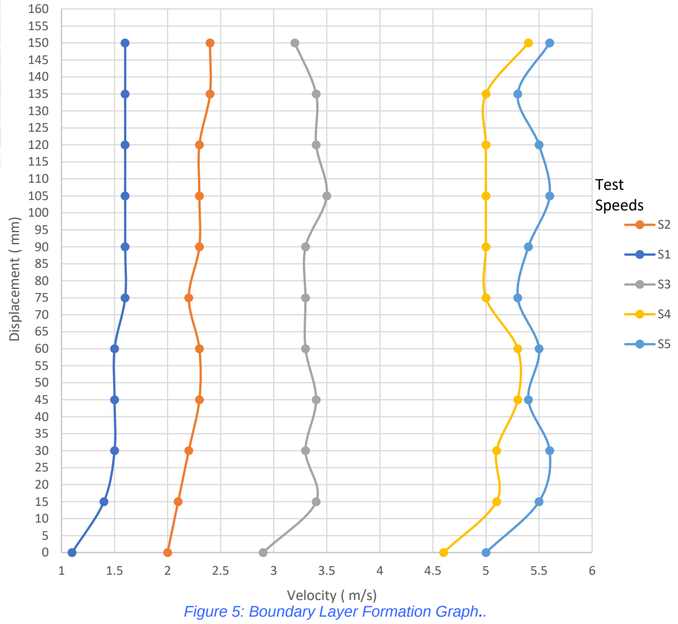

Figure 5: Boundary Layer Formation Graph..

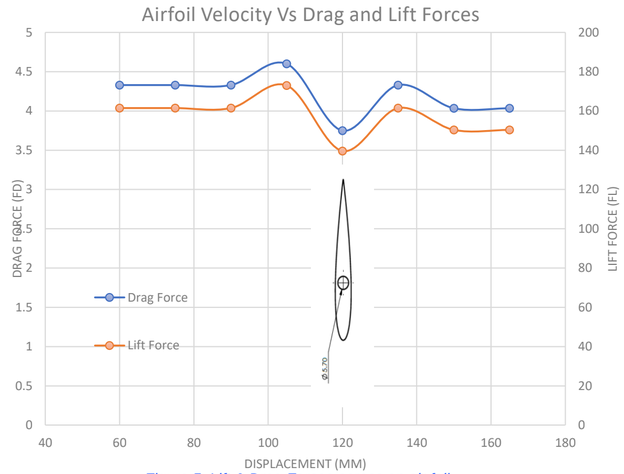

Figure 5: Lift & Drag Forces across an air foil.

The Lift & Drag forces across a plane of an airfoil. Directly in the middle of the wake of the airfoil both forces dip in the region of low pressure while increasing on either side of the air foil

Conclusion

- Air flow and states can be visually demonstrated through the use of wind tunnels. Its can be a good tool to clearly demonstrate the properties of air flow under unique and repeatable variables.
- Lift and drag forces can be calculated and scaled to full sized prototypes with a good degree of accuracy.
- Boundary layers are heavily influenced by the velocity & flow state of a fluid.
- By analysing the results of testing it is possible to increase the aerodynamic performance of bodies and scale to full sized bodies.

Acknowledgments

- The team would like to give special thanks to the project supervisor, Dr. Emma Kelly who gave us guidance throughout the project and was always available to answer any concerns or questions that arose for the duration of the project.