Introduction to UTM Low Speed Wind Tunnel Facility

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This report gives an overview of the configuration and capabilities of the low speed wind tunnel facility at University Teknologi Malaysia, Skudai, Johor, in aerodynamic application for aeronautical and non-aeronautical wind tunnel testing.

1.0 INTRODUCTION

The Universiti Teknologi Malaysia Low Speed Wind Tunnel (UTM-LST) was commissioned in 2001 and has been in service for more than eight years. Our clients include researchers, designers, manufacturer from universities and industries such as USM, UM, UTeM, UPM, UPNM, Avcen Ltd, PROTON, MINDEF, MODENAS, Salutary Avenue Group and others. The UTM wind tunnel has the capability to provide a wide range of testing including aircrafts, ground surface vehicles and industrial aerodynamics such as buildings, bridges, street-lantern lights and wind turbines.

The general arrangement of the wind tunnel is shown in Figure 1. There are three important components in the wind tunnel, namely, the test section, the fan-motor and the settling chamber.

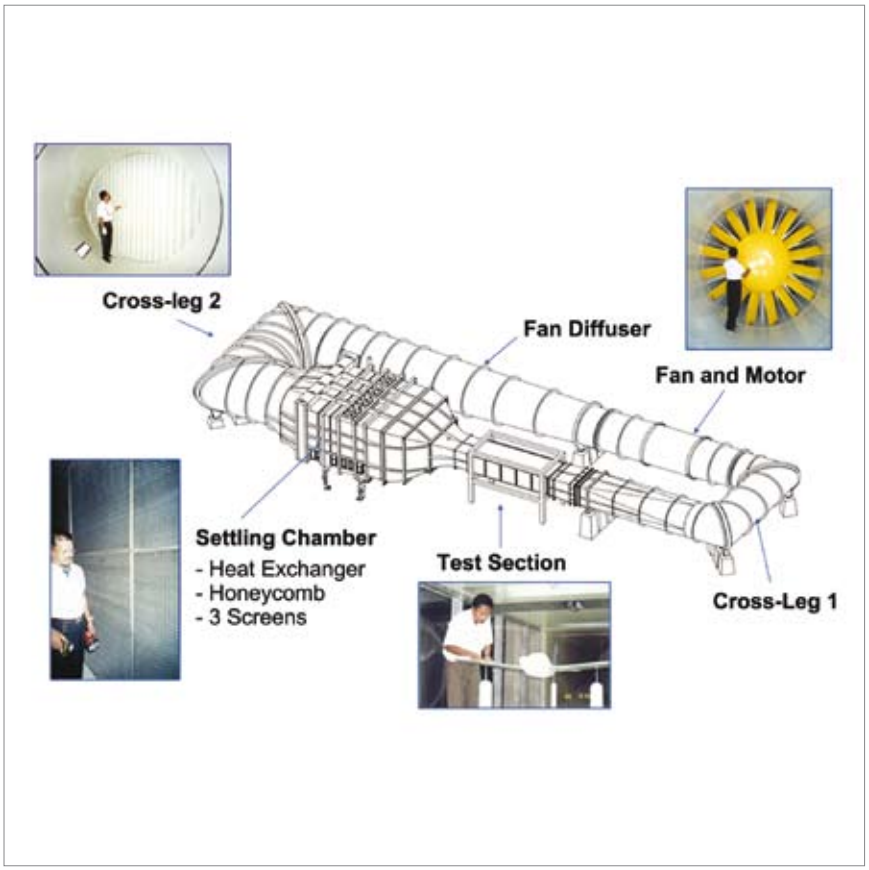

Figure 1: Major components of the wind tunnel

1.1 Test Section

The UTM-LST is capable of delivering a maximum airspeed of 80 m/s (160 knots or 288 km/hr) inside the test section. The test section (Figure 2) is 2.0m wide, 1.5m high and 5.5m long. The wind tunnel has excellent flow quality (flow uniformity < 0.15%, temperature uniformity < 0.2°, flow angularity uniformity < 0.15°, turbulence < 0.06%). With good flow quality and facility, UTM-LST is confident of delivering high accuracy and good repeatability of wind tunnel test results [1].

1.2 Fan Motor and Drive System

The UTM-LST is propelled by a 430kW AC motor from ABB with an Allen Bradley drive system. The measured power consumption of the motor with the test section wind speed is shown in Figure 3.

1.3 Settling Chamber

The settling chamber is an area where the flow is controlled using honeycomb and three screens. A heat

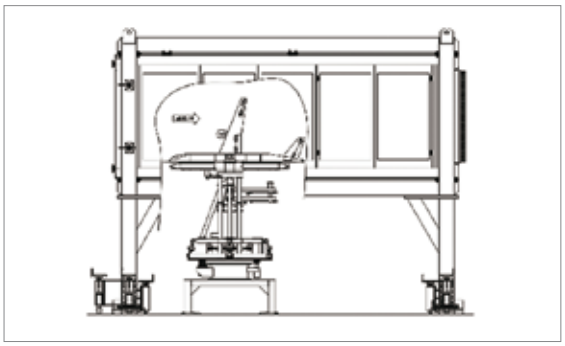

Figure 2: The test section with a model installed and attached to a 6-component balance/load-cell to measure aerodynamic forces and moment in 3-dimensional loads.

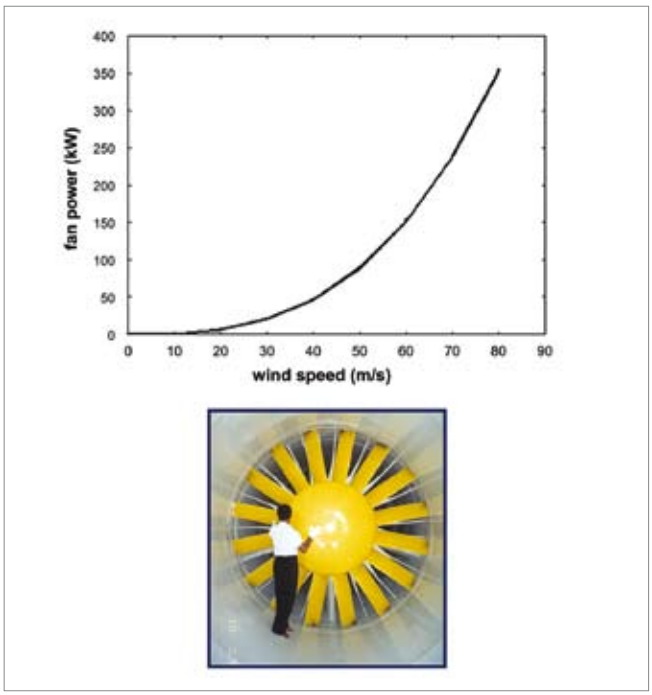

Figure 3: Fan-motor and its power consumption as a function of wind speed.

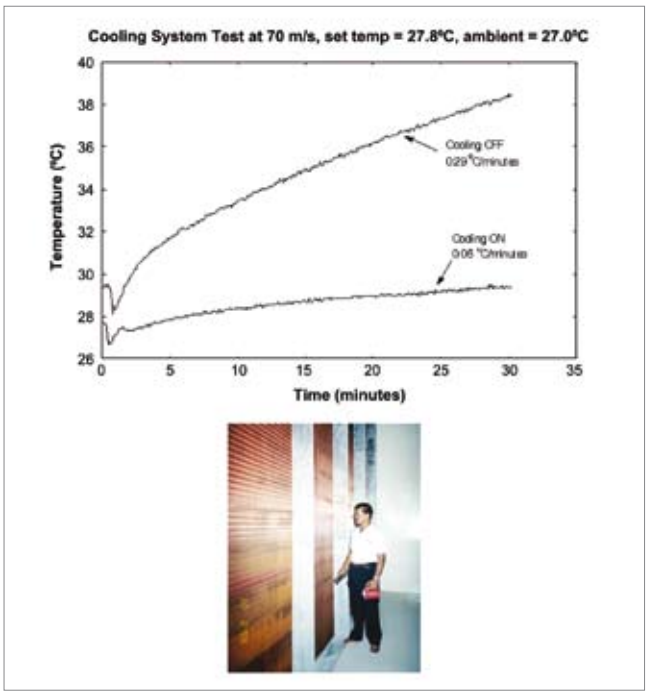

Figure 4: Heat exchanger to maintain air temperature of the test section

Figure 5: Honeycomb (left) is used to straighten the flow and the screen (right) is used to reduce the turbulence intensity

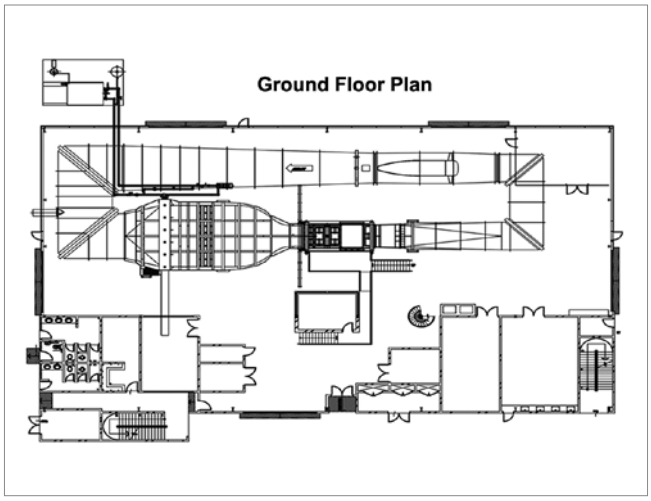

Figure 6: Layout of the wind tunnel and the control room

exchanger is used to remove the heat generated from air friction and to regulate the temperature of the test section. Figure 4 shows the effect of the heat exchanger on the test section temperature. Honeycomb is used to straighten the flow while the screens are used to reduce the turbulence intensity (Figure 5).

2.0 FACILITY ARRANGEMENT

The wind tunnel is housed inside the Aeronautical Engineering Laboratory building. The plan view of the layout is depicted in Figure 6. The wind tunnel is furnished with a compressed air facility for general purpose applications. The test section is connected to the wind tunnel control room via a metal structure platform.

3.0 BALANCE AND MODEL SUPPORT SYSTEM

The wind tunnel is equipped with a 6-component balance for load measurements. The balance is a pyramidal type with virtual balance moment at the centre of the test section. The balance has the capability to measure aerodynamic forces and moments in 3-dimensions. The aerodynamic loads can be tested at various wind directions by rotating the model via a turntable. The accuracy of the balance is within 0.04% based on one standard deviation. The maximum load range is ±1200N for axial and side loads (*i.e.* drag force and side force).

Figure 7: Wind tunnel balance and model support system

Figure 8: Various support systems for the test models

The wind tunnel is originally furnished with a 3-strut support system as shown in Figure 7. This type of model support system is commonly used in most well known wind tunnels (*e.g.* DNW Holland, NLR German, IAR-NRC Canada and ILST Indonesia).

Various model support systems had been designed to accommodate various types of model test requirements. It ranges from a simple single strut to a 4-strut support system. Figure 8 shows some of the examples of model support systems in the UTM wind tunnel.

4.0 SURFACE PRESSURE MEASUREMENT

The surface pressure measurement is done using an electronic pressure scanner with 128 port scanivalve system. Figure 9 shows a lift curve slope of NACA 0012 captured from surface pressure measurements.

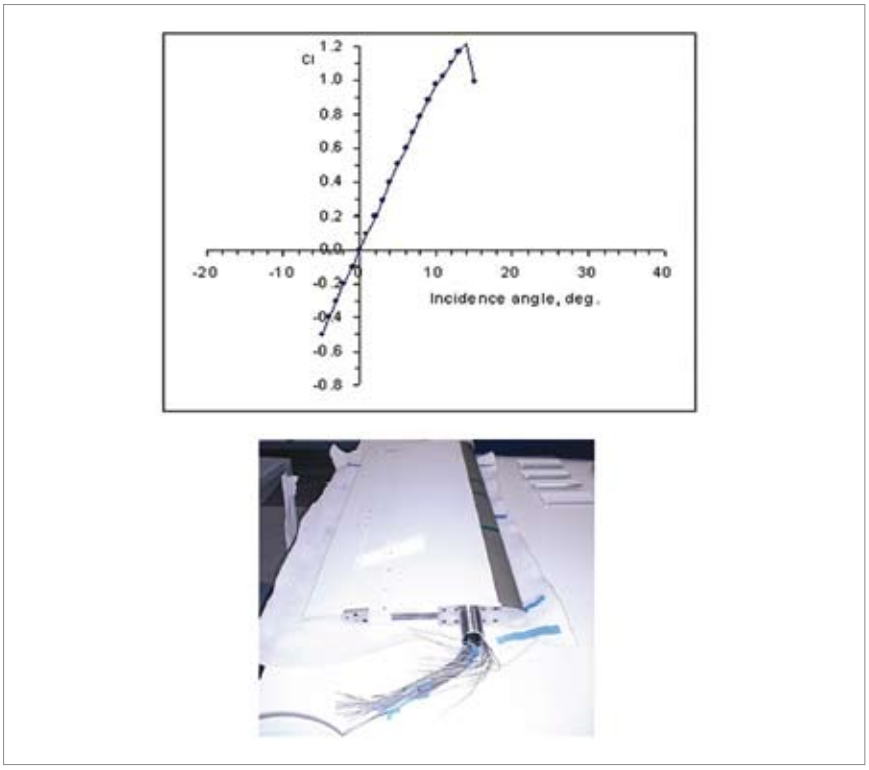

Figure 9: Surface pressure measurement on NACA 0012 Aerofoil

Figure 10: Flow visualisation using smoke and oil

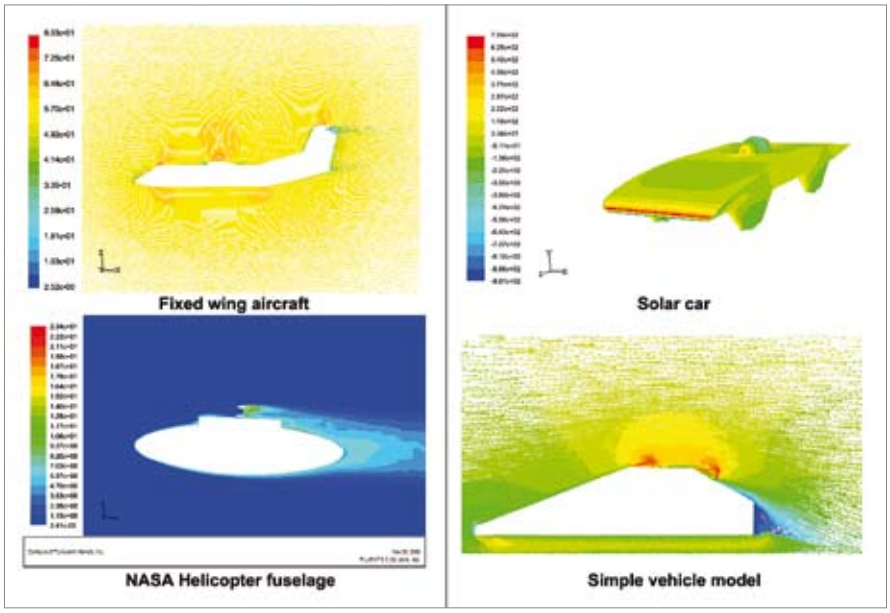

Figure 11: CFD computational results using Fluent at UTM-LST

Figure 12: Facility control with fully integrated DARS

5.0 FLOW VISUALIZATION AND CFD CORRELATION

Flow visualisation is a qualitative technique to visualise the flow pattern on the surface of the model. Smoke is commonly used for flow visualisation. An example over a car is illustrated in Figure 10.

The UTM-LST is also equipped with Fluent, a commercial Computational Fluid Dynamics (CFD) software package for fluid flow simulation. Figure 11 shows some of the results using this package at UTM-LST.

6.0 FACILITY CONTROL SYSTEM

The wind tunnel is equipped with a fully integrated automatic Control, Data Acquisition and Reduction System (DARS). The operation and post-processing data of the tests is done inside the control room. The measurement of air properties, 6-component balance, pressure transducer, hot-wire and other transducer are read and stored in the control room. These are illustrated by Figure 12.

7.0 CONCLUSION

The UTM-LST has been in service for more than eight years to facilitate the teaching, research and industrial application of the aeronautical and non-aeronautical fields in Malaysia. With this state-of-the-art test facility in terms of flow-quality, instrumentation and DARS, our vision is to become a centre of excellence for wind tunnel testing in Malaysia as well as within the region. ■

REFERENCE

[1] Universiti Teknologi Malaysia Low-Speed Wind Tunnel (UTM-LST) Aerodynamic Commissioning Report, Report No: 4070/R185, Aiolos Engineering Corp. 2001.