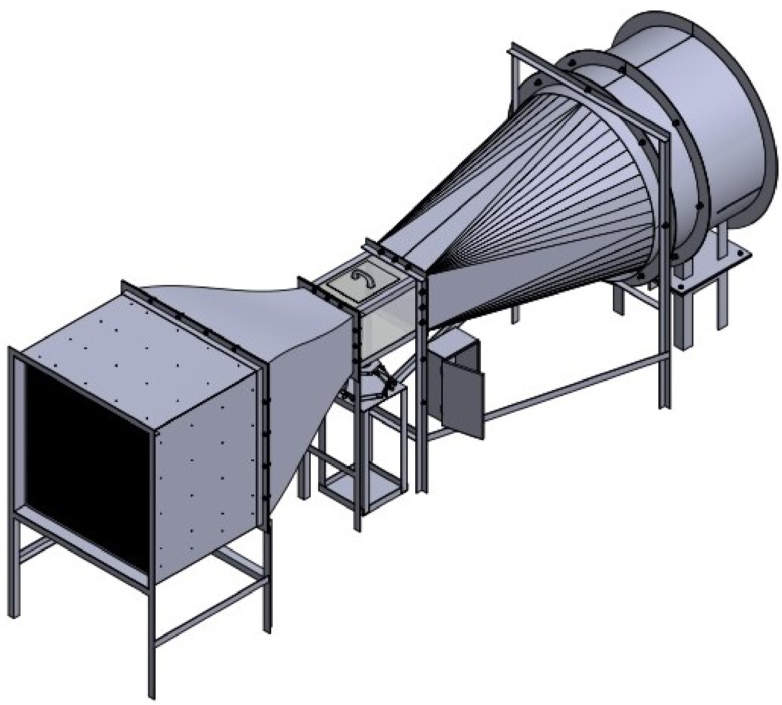
Multi-Purpose Low Speed Open-Circuit Wind Tunnel



Description and Manual

2024

Introduction

The Department of Mechanical Engineering has an Open Circuit Wind Tunnel in its Fluid Dynamics Laboratory. The tunnel has a test section within which scale models can be tested. The tunnel works on a pull principle, where the fan is mounted at the rear. Air flows in through the inlet at the front, passes through a contraction section, test section, diffuser and finally exits via the fan. The fan is controlled using an inverter. The inverter can receive set values from 1 Hz to 50Hz, where the maximum frequency (50Hz) is limited by the electricity net frequency.

Description

Parts

The wind tunnel consists of the following parts, as illustrated in Figure 1 below:

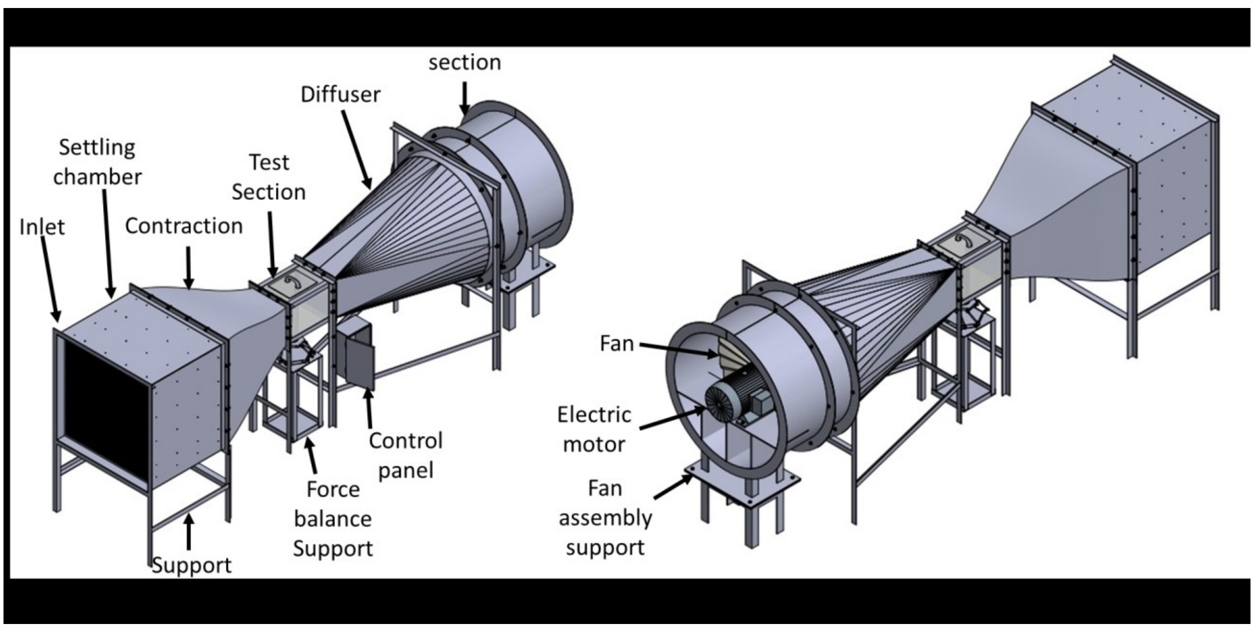


Figure 1: Parts of the Open circuit low speed wind tunnel

Dimensions

Figure 2 shows the key dimensions of the wind tunnel

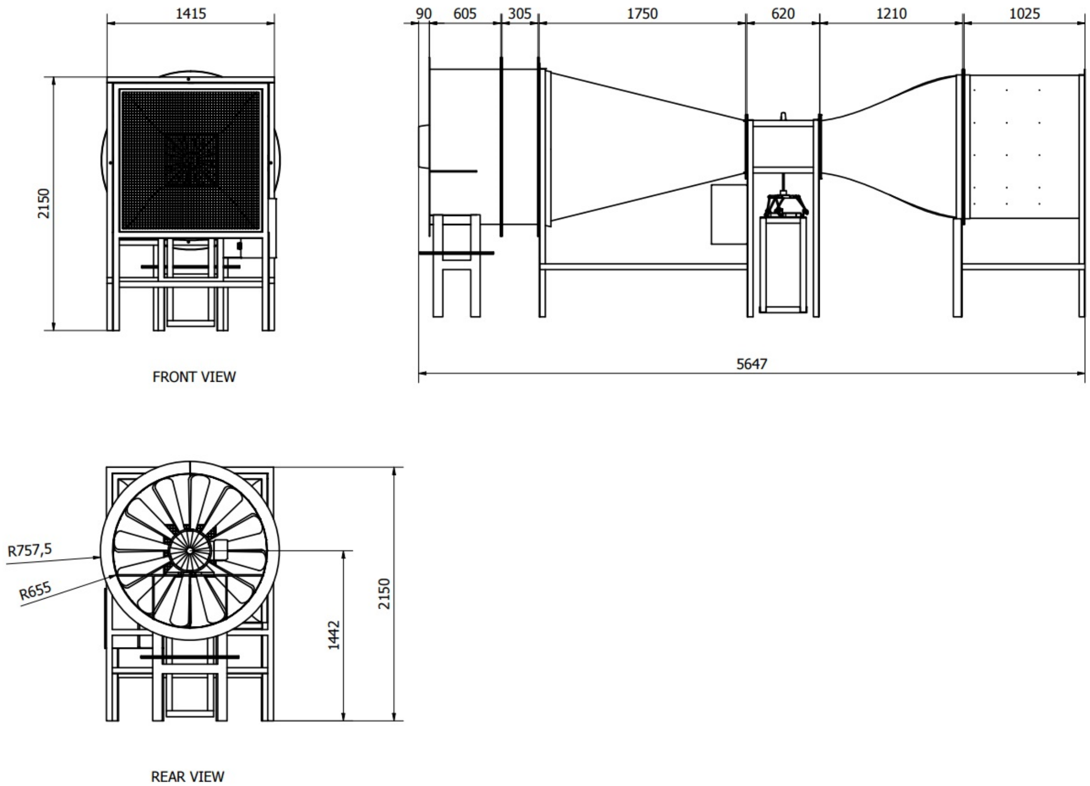


Figure 2: Principle wind tunnel dimensions

Test section

The test section measures 440 x 440 x 650mm. See also Figure 3.

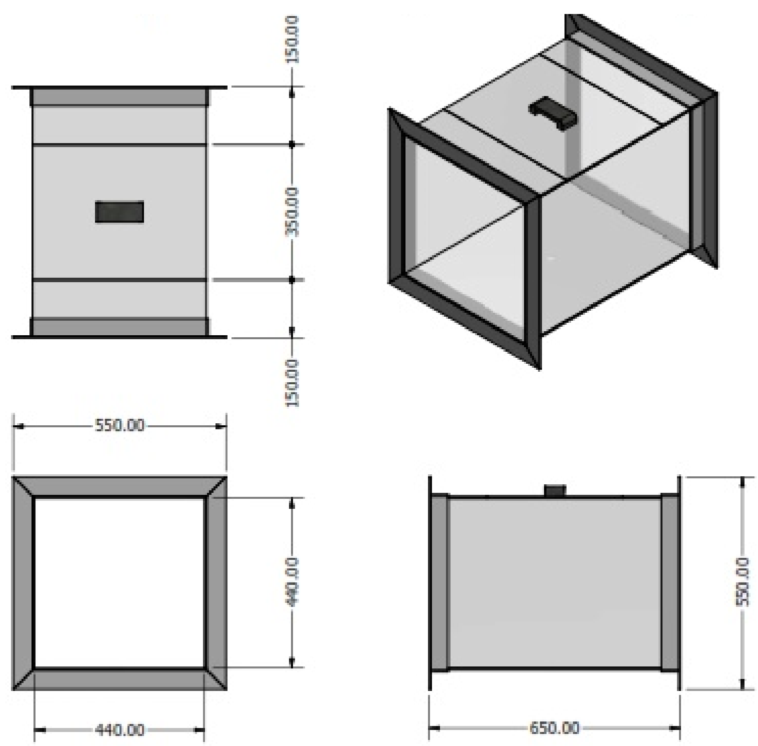


Figure 3: Dimensions of the Test Section

Control

The primary variable to control is the flow velocity in the test section. This is done using the Frequency inverter

Figure 4: The Bedford Frequency Inverter

Frequencies can be adjusted from 5Hz – 50Hz. At 50Hz, the fan runs at its maximum speed, and this in turn induces the maximum flow velocity in the test section.

Preliminary tests in the test section revealed the values tabulated on Table 1 below.

Table 1: Test section velocity values for varying inverter frequencies

Frequency (Hz)	Velocity (m/s)
15	27.386
20	31.81
25	32.286
30	33.588
35	34.996
40	36.2323
45	37.34
50	39.213

The values on Table 1 were measured when the wind tunnel had a clean configuration, i.e. with a complete entrance section (Honeycomb structure and two meshes of different sizes) and a horizontal test section aligned to the rest of the tunnel, with the lid in place and no leakages. The values are also dependent on the existing ambient conditions, namely the temperature and humidity.

Running procedure:

Pre-test procedures

1. Ensure that the test section cover is in place
2. Ensure that the test model is safely secured
3. All measurement probes should be properly fastened, and there should be no lose objects in the test section
4. Confirm that there are no items blocking the entrance or in the way of the fan exhaust.

Running

(See also Figure 5)

1. Power the inverter from the wall switch
2. Set the desired running frequency
3. Press on Run button on the inverter.

Stopping the process.

1. Press on the Red Stop button on the inverter.
2. Wait until the fan comes to a stop before opening the lid/cover.
3. Switch of the power to the Inverter.

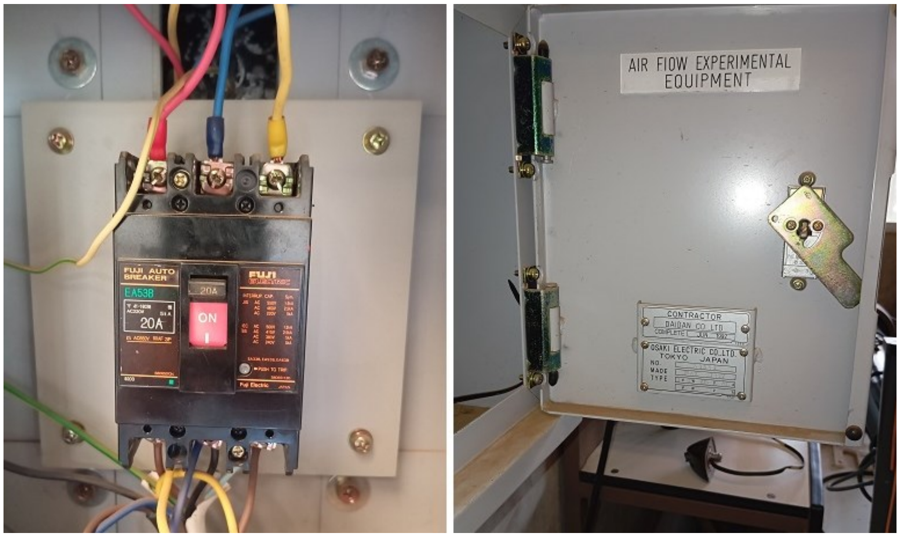
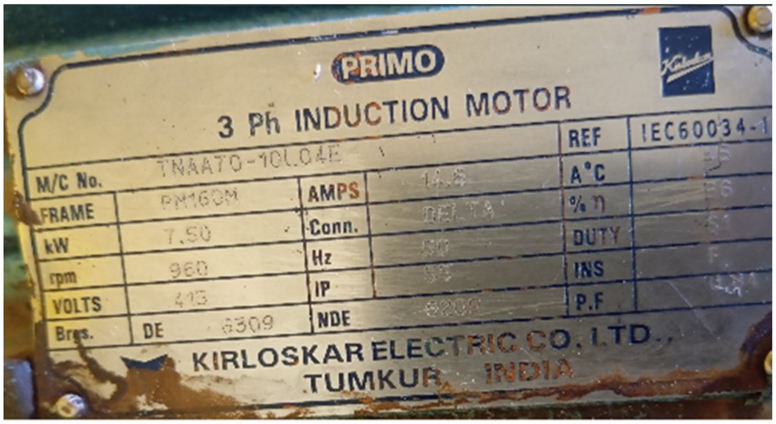


Figure 5: Power Supply Switch

Other Details:

3 Phase Induction Motor



Fan Motor Specifications

Power: 7.5kW
RPM: 960
Voltage: 415 (3-phase)
Amps: 14.5
Hz.: 50
Efficiency: 86%

Figure 6: Motor Specifications

Inverter Specifications

Figure 7: Inverter specifications

Sample Practicals

Practical 1: Calibration of an Open Circuit Wind Tunnel

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Objectives of the practical;

1. To understand the main components of the wind tunnel
2. To understand the working principle of the tunnel
3. To calibrate the tunnel based on the prevailing conditions

Equipment to be used:

1. Wind tunnel
2. Pitot tube with pressure transducer
3. Arduino and Laptop/Computer
4. Barometer
5. Thermometer
6. Anemometer

Instructions

(Detailed instructions to be given during the session)

The students are expected to establish the flow velocity in the test section of the velocity of the wind tunnel for given frequency settings.

(i) Vary the tunnel frequencies should be varied in steps of 5 Hz.
(ii) Record the readings in the table provided.
(iii) Plot a graph to show how the wind tunnel parameters vary with the frequency
(iv) Discuss your results

Reporting:

Each group is expected to compile a report at the end of the practical. The report should have all parts of a standard report, and it should clearly show how the tunnel can be calibrated, sources of errors and how these can be compensated for.

Include the raw data as an annex to your report.

Table format for collecting data

	Frequency (Hz)	Anemometer reading (m/s)	Ambient Temperature (ºC)	Ambient pressure (kPa)	Pitot-Tube Voltage	Δp (kPa)	Flow velocity (m/s)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

Practical 2: Flow visualization over a profile

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The Department of Mechanical Engineering has an Open Circuit Wind Tunnel in its Fluid Dynamics Laboratory. The tunnel has a test section within which scale models can be tested. The tunnel works on a pull principle, where the fan is mounted at the rear. Air flows in through the inlet at the front, passes through a contraction section, test section, diffuser and finally exits via the fan. The fan is controlled using an inverter. The inverter can receive set values from 1 Hz to 50Hz, where the maximum frequency (50Hz) is limited by the electricity net frequency

Objectives of the practical;

4. To understand the principle of flow visualization in a test section
5. To profile flow patterns over a profile for varying flow velocities

Equipment to be used:

7. Wind tunnel
8. Pitot tube with pressure transducer
9. Arduino and Laptop/Computer
10. Barometer
11. Thermometer
12. Smoke generator
13. High Speed camera

Instructions

(Detailed instructions to be given during the session)

The students are expected to establish the change in the flow patterns over the given profile, for varying flow velocities.

(i) Vary the inverter frequency in steps of 10Hz.
(ii) Take an image of the flow for every frequency/velocity
(iii) Determine the change (if any) in the flow patterns as the velocity increases.
(iv) Discuss your results

Reporting:

Each group is expected to compile a report at the end of the practical. The report should have all parts of a standard report, and it should clearly show how the flow develops over the profile, sources of errors and how these can be compensated for.

Include the raw data as an annex to your report.