

Design, Construction and Testing of a Force Balance for the LNEC Wind Tunnel

Proposal for Master Thesis
in Aerospace or Mechanical Engineering

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Goals

The main objective of this work is to design, build and test a force balance to be installed in the aerodynamic wind tunnel at the Civil Engineering National Laboratory (LNEC).

The wind tunnel is used to test different models, including wind turbines, buildings, bridges, aircraft and vehicles, to characterize their aerodynamic behavior. This is accomplished by placing the model in the test section of the tunnel and then subject it to a controlled air flow generated by the wind tunnel fan. The effect of the flow past the model is then analyzed.

Among the different types of instrumentation possible to be used to determine the aerodynamic forces and moments on the model, the most basic one will be selected - the force balance - that measures these forces and moments directly.

The design goal is a six-component balance to measure all three forces and three moments components.

Tasks

To meet the goals proposed, the work should be composed of the following main tasks:

- Bibliography Review
Literature research about wind tunnel design and testing, aerodynamic measurement techniques, force and moment measurement sensors.
Estimated duration: 3 weeks.
- Wind tunnel measurement techniques
Comprehensive review of wind tunnel measurement techniques, including i) direct force and moment measurements, ii) model instrumentation with pressure taps, iii) measurement of flow around the model with pressure rakes, velocity probes or laser Doppler velocimetry, and iv) flow visualization techniques. Benchmark of solutions.
Estimated duration: 3 weeks.
- Design of force balance
Benchmark of different force balance concepts. Definition of mechanical and electrical technical requirements. Detailed design of the force balance concept chosen, including attachment to the wind tunnel test section.
Estimated duration: 6 weeks.
- Sensors and data acquisition system
Detailed specification and selection of force and moment measurement sensors and data acquisition system.
Estimated duration: 3 weeks.

- Construction of balance
Procurement of all parts in the bill of materials. Manufacturing of the structure following the detailed design rendering. Assembly of sensors and preliminary tests. Estimated duration: 8 weeks.
- Calibration of balance
Definition of calibration process and development of standard applied loads to be used in the calibration. Estimated duration: 2 weeks.
- Demonstration of balance
Definition of the measurement process and selection of a representative model. Comprehensive characterization of aerodynamic behavior and identification of limitations of the instrumentation setup. Estimated duration: 2 weeks.
- Thesis write-up
Write-up of the dissertation thesis and corresponding oral presentation support material. The different technical topics covered should be described in detail, and a rigorous presentation is expected, both in visual and verbal terms, in a document logically structured. Estimated time: 5 weeks.

Requirements

The proposed work requires knowledge covered in courses such as:

- Mechanics of Materials
- Fluid Mechanics / Aerodynamics
- Solid Mechanics
- Manufacturing Processes
- Structural Mechanics
- Computational Mechanics
- Machine Components Design

The courses mentioned are only illustrative of the scientific content of the work to be executed, so they are not mandatory requirements. As such, the student that shows interest in this proposal is advised to previously discuss it with the supervisor.

Localization

Laboratório Nacional de Engenharia Civil (LNEC) and Instituto Superior Técnico (campus Alameda)

Observations

Possibility of Scholarship to be discussed.

The student is strongly encouraged to start documenting the work since the first day. The recommended language for writing the dissertation is English.

Curriculum

- MEAer - branch of Aircraft
- MEMec - branch of Mechanical Design

Calendar

The work to be developed has an estimated duration of six months, in accordance to the present curricular plan at IST. During that period, the student is expected to meet on a regular basis with the supervisor for follow up and discussion of ideas.

The student has full autonomy to manage his time in the way it suits him best, however a calendar is suggested according to the tasks described previously.

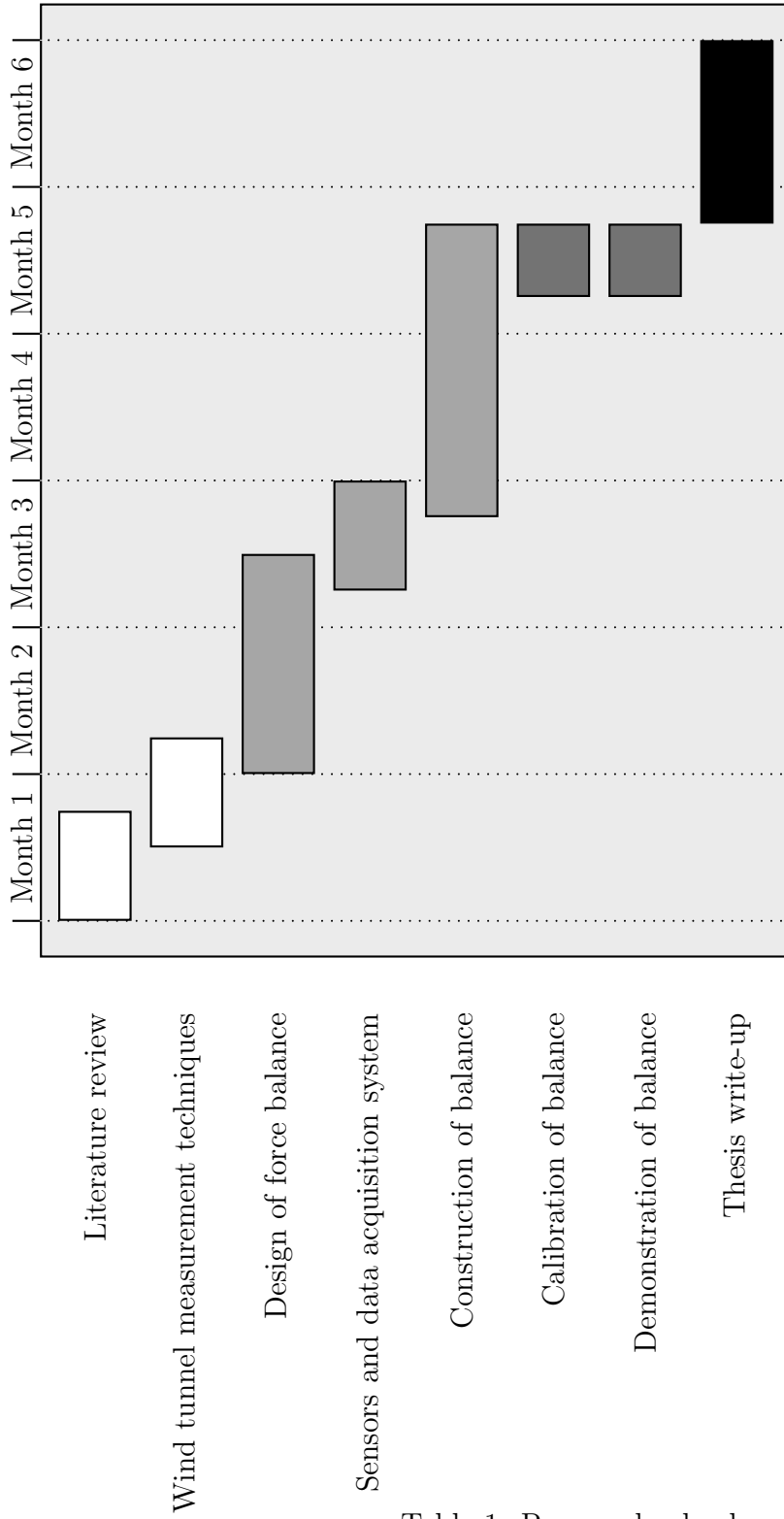


Table 1: Proposed calendar.