Revitalization and Calibration of an Aerolab Three-Component Pyramidal Balance

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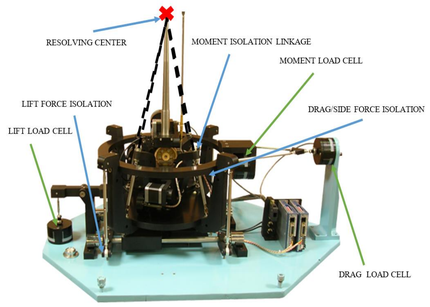
The Balance



- The balance in question is a Three Component Pyramidal Balance
  - Uses a series of linkages which translate forces from the test rod to the load cells
  - The load cells utilize small metal rods which deform based on the amount of applied load. Based on the amount of strain that is induced, a certain voltage is output from the load cell. These types of load cells are known as Wheatstone bridges.
  - The balance is referred to as a three component balance because there are three load cells each of which measures a different force. Those forces are as follows:
    1. Drag
    2. Lift
    3. Pitching Moment

Objective

- The objective of this project is to revitalize the university's old Aerolab balance in an effort to cut down on unnecessary expenditure and to design a system to maximize the balance's data gathering capabilities.

Initial State of the Balance

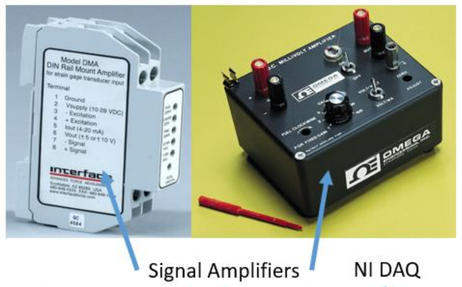
- Cleveland State owns an Aerolab Balance from 1966.
- It is coupled with a signal generator which only has a crude amplifier inside of it.
- The balance became obsolete, was stored, and was damaged over time.

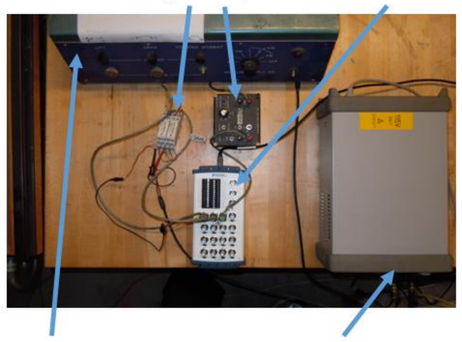
The balance had the following issues:

- Can measure primarily large forces only.
- The balance cannot communicate with computers due to its age.
- It also has a great deal of structural and wiring damage.

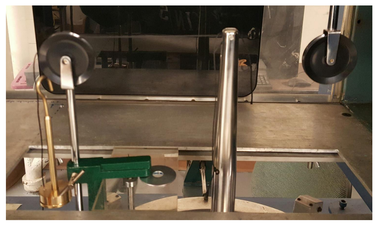
Revitalizing the Balance

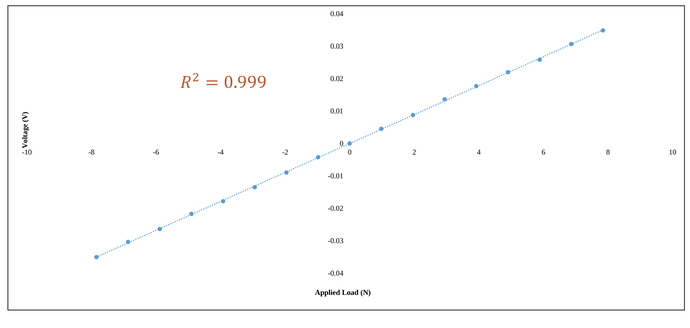
- The problem of the structural damage and missing parts was solved.
- To allow for communicating with computers:
  - A signal generator and series of amplifiers were added to system.
  - A National Instruments DAQ was used to communicate the signal to the computer





Calibration





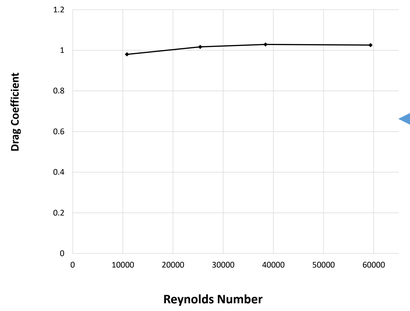
$$V = 0.0045F_d - 2 \times 10^{-5}$$

Verification Test

- *Drag Coefficient* , C_d

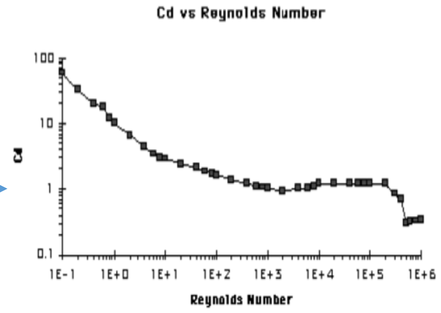
$$C_d = 2F_d/(\rho d L U^2)$$

- A one inch diameter steel rod has a very well known drag coefficient value at any given Reynolds number.
- Measured C_d can be compared to the known values at a given Reynolds number to verify data output.



Experimental

Theoretical

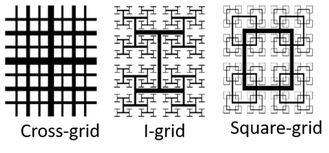


Experimental $C_d \approx 1$

Theoretical $C_d \approx 1$

What has this been used for?

- The balance has been used to measure the drag coefficient on wind fences with fractal grid patterns



Future Work

- Verify the voltage outputs from the other two load cells.
- Use the balance to measure the drag, lift, and pitching moment of an airfoil.

References

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Acknowledgements

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