

LAB REPORT

AE351

Calibration of six component
force balance

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OBJECTIVE :

To study the calibration procedure of a six component force balance which is generally used to measure the aerodynamic forces acting on a test model.

THEORY :

A six component force balance is used to measure the aerodynamic forces on a model. There are 7 strain gauge inside the transducer to measure two normal forces two side forces one axial force and one moment. Two strain gauges are used to measure the moment while other components are measured using one strain gauge. The signal from a strain gauge pass through a bridge and gives an output voltage proportional to the weight attached. Calibration is necessary before performing each experiment. We use known weight to calibrate the transducer. The voltage output corresponding to the weight is measured and a calibration matrix is formed which is used to measure aerodynamic forces.

$$[F] = [C] [I]$$

[F] : Force Matrix

[C] : Calibration Matrix

[I] : Voltage measurement

EQUIPMENT :

- Six component force balance (HEE, Bangalore): It is a cylindrical body on which an aerodynamics model can be mounted to measure different forces acting on it.
- Calibration body: It is used to facilitate loading of the balance with pure loads (in specific directions at particular locations) in order to calibrate it.
- Calibration rig: It is a truss structure with leveling screws on which the force balance fitted with calibration body is mounted to apply the desired pure loads. The leveling screws are required to align the force balance in horizontal position under the action of the force due to dead weights.
- Precise level gauge: A digital level gauge is used to align the balance in horizontal position.
- Dead weights: These are used to load the balance with constant loads.
- NI SCXI-1520: is an 8-channel universal strain gage input module that offers all of the features you need for simple or advanced strain- and bridge-based sensor measurement.
- NI SCXI-1314 terminal block is used with the SCXI-1520 universal strain/bridge module enabling you to conveniently connect strain gauges through screw terminals
- Data acquisition card: The voltage output of the strain gauges is required to be measured under the loading on the balance. For this a data acquisition card PXI- 1002 with maximum of 16 voltage input channels is used.

- Labview software: Labview software facilitate to provide/acquire the input/output voltage signals to/from the strain gauge bridges using a specially built VI program.

PROCEDURE :

- Set up the calibration apparatus with zero weights.
- The data acquisition unit sends a current to the 7 strain gauge in order to activate them.
- Place the calibration body on the transducer.
- Using a bridge nulling VI we set the zero of the transducer.
- Add weight to the transducer one by one at the required loading point (N1) for normal force.
- On adding weight the transducer send signal to the data acquisition unit which amplifies the signal and sends it to the NIPCI-6251 card.
- The card processes the data and using VI we can save the output voltage vs loading data.
- We use the same steps to deloading of the weights.
- Using the collected data we can create a calibration matrix to measure the unknown forces using the calibration equation.

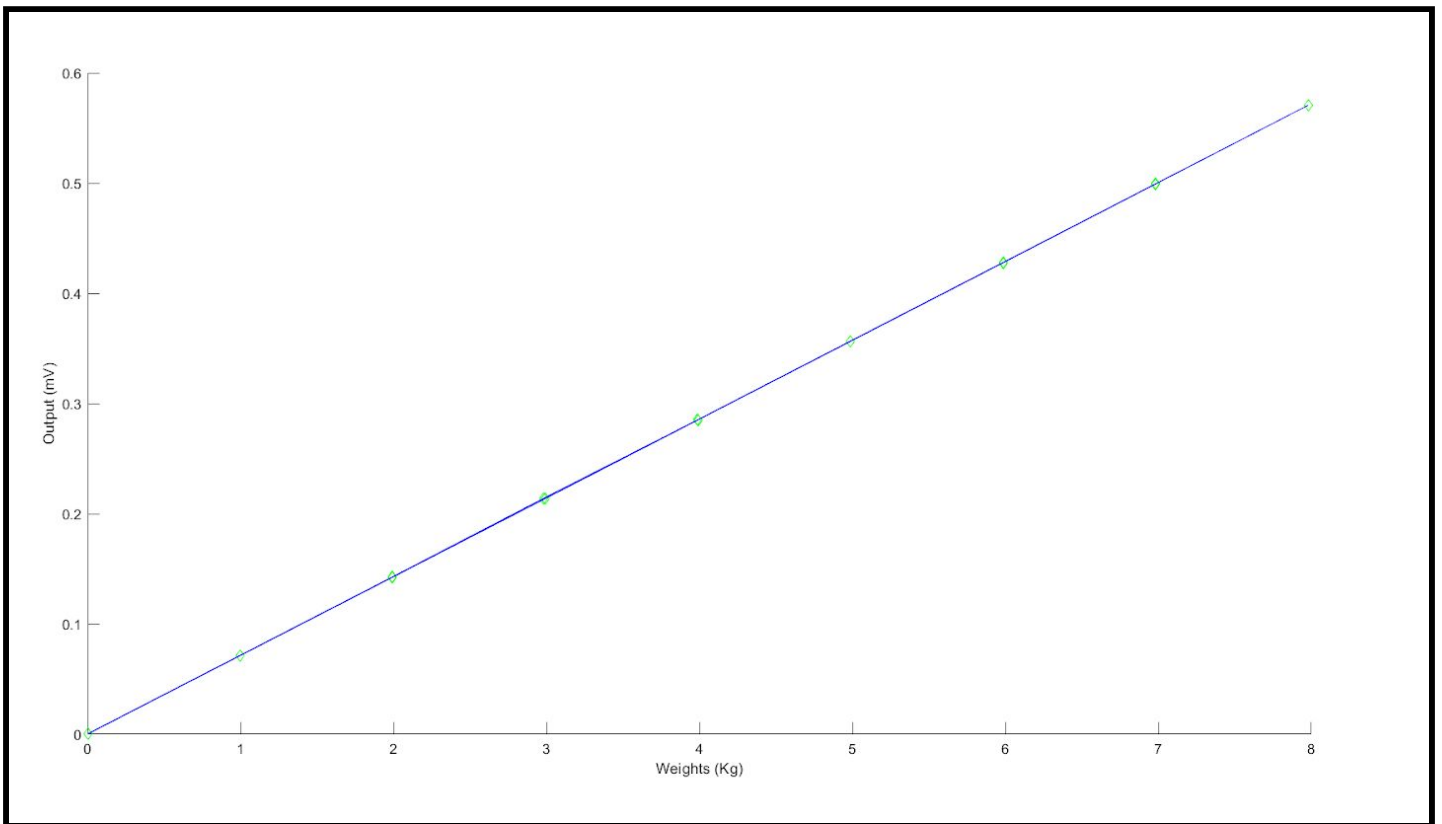
DATA AND GRAPH :

Calibration of Balance - A carried out on 1/10/2020 2:46:55 PM using "SCXI 1520"
N1 Loading

0.000000	-0.000007	0.000002	0.000054	-0.000010	0.000029	0.000048
0.997000	-0.000847	0.071202	-0.000421	-0.001068	0.000172	-0.000595
1.994500	-0.001831	0.142396	-0.001037	-0.002207	0.000169	-0.001299
2.991800	-0.003056	0.213677	-0.001530	-0.003300	0.000131	-0.001913
3.989250	-0.004484	0.284988	-0.002163	-0.004456	0.000075	-0.002448
4.986600	-0.005976	0.356269	-0.002676	-0.005533	0.000157	-0.003043
5.984200	-0.007681	0.427597	-0.003244	-0.006681	0.000169	-0.003662
6.981600	-0.009728	0.499101	-0.003821	-0.007874	0.000169	-0.004207
7.978700	-0.011870	0.570570	-0.004434	-0.008991	0.000041	-0.005036
6.981600	-0.009876	0.499359	-0.003996	-0.007855	0.000015	-0.004181
5.984200	-0.007931	0.427956	-0.003242	-0.006690	0.000008	-0.003517
4.986600	-0.006377	0.356644	-0.002704	-0.005611	0.000062	-0.002890
3.989200	-0.004775	0.285280	-0.002115	-0.004480	0.000129	-0.002325
2.981800	-0.003429	0.214030	-0.001571	-0.003409	0.000219	-0.001745
1.994500	-0.002214	0.142806	-0.000993	-0.002225	0.000199	-0.001181
0.997000	-0.001134	0.071530	-0.000410	-0.001118	0.000120	-0.000665
0.000000	-0.000203	0.000296	0.000042	-0.000004	0.000063	-0.000129

Data in column one gives the loading

Data in column three gives the corresponding output from N1 transducer



CONCLUSION :

We have successfully calibrated the six component strain gauge.

PRECAUTIONS:

Do not load the transducer over the weight limit. The weight limit for normal forces is 10 kg and for side and axial forces it is 5kg. Make sure the setup is sturdy and do not create any disturbance while taking the readings