National Institute of Technology Silchar
Department of Mechanical Engineering
Instrumentation and Measurement Laboratory (ME 215)
Fourth Semester

Experiment No. 3

Title: Measurement of Load/Force using Load Cell

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A. Aim of the experiment: Measurement of Load/Force using Load Cell

B. Apparatus: Load Transducer

C. Theory

The new tech load transducer employs foil type of strain gauges bonded to the load sensitive diaphragm. The transducer is a single body piece machined from special steel, treated for maximum stability. The design ensures high inherent linearity whilst maintaining low hysteresis and good ultimate safety factors. The design uses a full bridge strain gauge configuration. These transducers are well suited for the static as well as dynamic load measurement.

Strain Gauges are thin elastic materials made up of stainless steel and are fixed inside the load cells using proprietary adhesives. The strain gauge has a specific resistance that is directly proportional to its length and width.
When a force is applied on the load cell, it bends or stretches causing the strain gauge to move with it. And, when the length and cross-section of the strain gauge changes, its electrical resistivity also gets altered, thereby changing the output voltage.

While performing the experiment, there are good chances of encountering errors. Error is defined as difference between true value and calculated value. These errors can be of various types, like Gross errors, which occur due to human mistakes. Systematic Errors which occur either due to Instrument mishandling, defects in instruments, etc. Apart from this, environmental errors can take place.

Besides errors reduction, there is a term named Sensitivity. It is defined as change in the output of the sensor per unit change in the parameter being measured. Sensitivity depends on a number of variable factors. The mechanical properties of a transducer may vary with temperature and cause a variation in sensitivity, but it’s the electrical part which is responsible for greatest changes. High Sensitivity of measuring element increases the chances of a quick response.

D. Procedure:

1. The load cell was connected at the 9-pin connector.
2. The switch was turned ON and the power indicator was observed. The Red LED on the front panel glowed up.
3. Some time was given to stabilize the instrument for stabilization (warm up time)
4. The load cell was balanced through corresponding Zero ten turn trim pot
5. The gain of load cell was set by SPAN ten turn trim pot
6. Then the micro switch was pushed to ascertain the reading position of CAL.

C. Mathematical Formulation

i. Errors:

Error = (Measured Value – Actual Value)

Error% = $\frac{Error}{Actual\,Value} \times 100 = \frac{Measured\,Value - Actual\,Value}{Actual\,Value} \times 100$

ii. Sensitivity (Slope of the Calibration curve or graph):

Sensitivity = $\frac{\Delta Ao}{\Delta Ai}$ where, ΔAo is Infinitesimal change in output

ΔAi is infinitesimal change in input

iii. Mean Deviation, Deviation, Maximum Deviation, Standard Deviation:

Mean Deviation (y_{mean}) = $\frac{\sum_{i=1}^{n} y_i}{n}$

Deviation (d) = $y_n - y_{mean}$

Maximum Deviation = max ($\sum y_n$)

Standard Deviation S = $\sqrt{\frac{\sum d^2}{n}}$ where, d is individual deviation and n is the number of readings.

Observation Table:

S.No	Forward				Backward			
	Load applied (Kg)	Display Reading (V)	Analog Reading (V)	Error %	Load applied (Kg)	Display Reading (V)	Analog Reading (V)	Error %
1	00	00	0.0	0	1.50	1.177	1.22	3.5
2	0.25	0.197	0.20	1.5	1.25	0.982	1.02	3.7
3	0.50	0.392	0.41	4.3	1.00	0.787	0.82	4.0
4	0.75	0.589	0.61	3.4	0.75	0.591	0.62	4.7
5	1.00	0.785	0.81	3.1	0.50	0.395	0.41	3.7
6	1.25	0.982	1.02	3.7	0.25	0.198	0.20	1.0
7	1.50	1.177	1.22	3.5	0.00	0.03	0.01	-

Forward Mean: 0.589
Backward Mean: 0.594
Standard Deviation (Forward): 0.392
Standard Deviation (Backward): 0.386

D. Results

The Graph plotted between the load applied and the Display reading indicates that it follows a linear pattern and the forward and the backward readings overlap each other quite comfortably. Also the graph between the load applied and the Analog reading is linear in nature, thereby showing the linear relationship between them and the forward and the backward plots for the data set is overlapping each other.

Standard Deviation for both Forward and Backward readings are as follows:

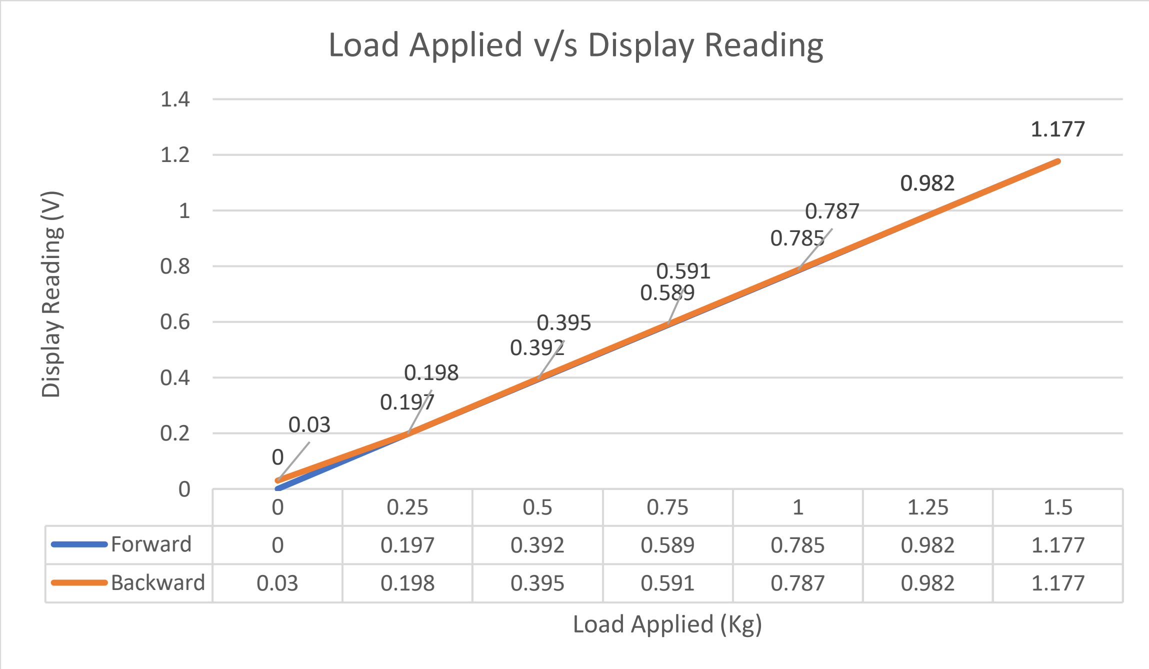
$S_{forward}$= 0.392 $S_{backward}$= 0.386

E. Conclusions

After observing the outputs of the experiment, we can see that the strain gauges are suitably located as the outputs are linearly proportional to the input given. With the error percentage within the acceptable limits, the experiment can be said to have been performed satisfactorily. Hence, the load applied is measured quite comfortably using the Load cell.

F. Graphs

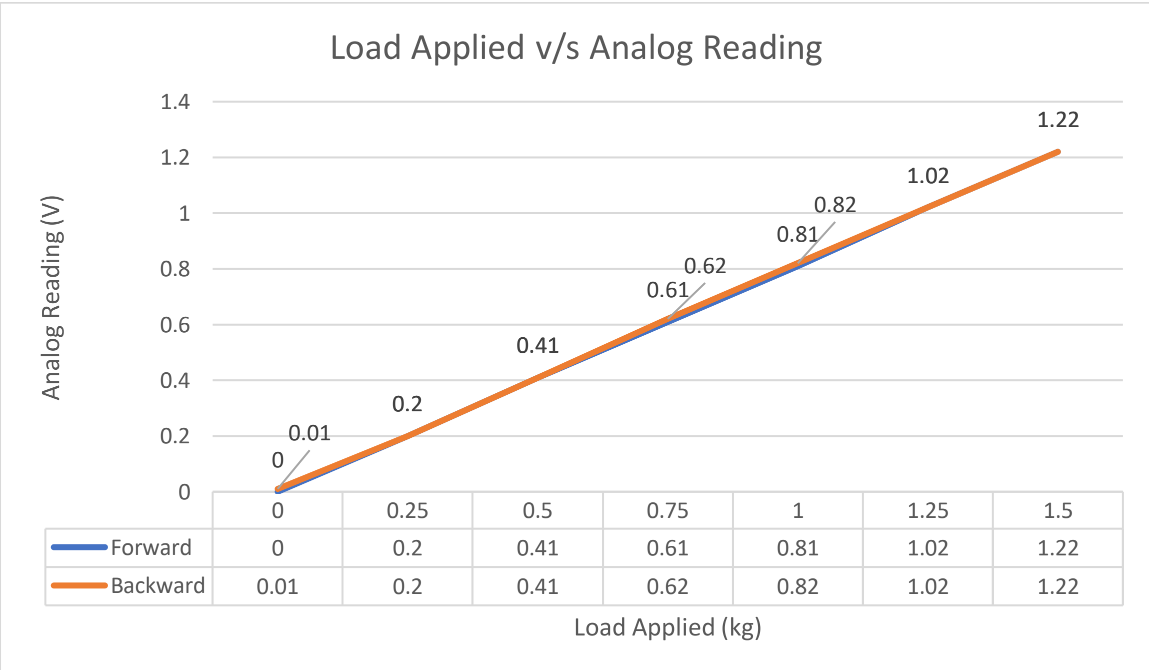
i)



	0	0.25	0.5	0.75	1	1.25	1.5
Forward	0	0.197	0.392	0.589	0.785	0.982	1.177
Backward	0.03	0.198	0.395	0.591	0.787	0.982	1.177

Slope: $\frac{0.195}{0.25} = 0.78$

ii)



	0	0.25	0.5	0.75	1	1.25	1.5
Forward	0	0.2	0.41	0.61	0.81	1.02	1.22
Backward	0.01	0.2	0.41	0.62	0.82	1.02	1.22

Slope: $\frac{0.21}{0.25} = 0.84$