

MAE 3272 Module 2 Abstract

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Force transducers are an invaluable engineering tool for directly measuring physical forces quickly and precisely. This lab module sought to design, construct, and calibrate an S-beam load cell using conventional strain gauges arranged in a Wheatstone full bridge configuration with LabView data acquisition software. With the goal of maximizing sensitivity, a shear and bending moment analysis of the system determined the optimal strain gauge placement to be on the tops and bottoms of the ends of each beam since this is where the maximum strain occurs, and with two gauges in tension and two in compression to satisfy the full bridge circuit. This analysis also showed that the maximum load the cell could sustain without yielding was 385 [lbf]. To calibrate the cell, a "load vs. output voltage" curve was generated by successively placing a number of known weights onto the cell and recording the resultant voltage change through the Wheatstone bridge. A linear least squares fit was applied to these data, from which an unknown load was determined using the average of its characteristic output voltages. The experimental least squares line had a slope of -0.011348 [mV/lbf], whereas the computed sensitivity from beam bending, gauge factor, and input voltage was -0.0294 [mV/lbf]. One possible reason for this factor of three discrepancy could be how close the gauges were to the spacer cubes. Because the spacers effectively impose a fixed support end condition, the traditional long beam bending equations don't apply to the region near them. Despite this, the linearity of the "output voltage vs. load" curve was still excellent, with a third standard deviation of 0.057 [volts] or 0.502 [lbf]. This was confirmed during testing of a 14.4 [lbf] experimental load, which was repeated five times with a bias of only 0.053 [lbf], yielding an average measurement of 14.38 [lbf]. The excellent repeatability, linear fit, and prediction of unknown loads thus confirm the efficacy of the S-beam load cell as a force transducer.