Validation of Suspension Component Loading Using Strain Gages

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The Marquette SAE Baja team utilized strain gages provided by Micro-Measurements® to record data that will help with the design verification and future designs of the vehicle. The goal of the design competition is to have the fastest vehicle that can endure four hours over rough terrain. This requires a design optimized for strength and weight, without compromising durability. The goal of this project was to record strain data to verify load input calculations and suspension component designs.

Company/Institute: Eagle Racing, Marquette University, Baja SAE

Industry/Application Area: Stress Measurement (Automotive/Suspension)

Product Used:

- CEA-06-250UT-10C
- GAK-2-200 Gage Application Kit
- 3145-RTV Protective Coating

The Challenge

The Marquette SAE Baja team has improved the design of its cars over the past few years, however, the team never had the capability to access real world data from sensors on the vehicle. This year the senior design team took on the task of designing and implementing a comprehensive data acquisition system or DAQ. Strain gages were used throughout the suspension components to collect data relating the input forces on the suspension and component factors of safety in real world tests. The challenge included implementing the system and verifying the accuracy of the outputs.

The Solution

To record the stress and loading on the suspension members, Micro-Measurements®tee rosette gages were used in seven locations on different suspension components. This type of strain gage allows use of a half bridge configuration, while only having to mount a single sensor in each location, enabling an easier installation on the suspension components. The half bridge configuration allows for measurement of both tension/compression and bending forces, while compensating for temperature changes in the material. A strain gage amplification board was designed and calibrated to provide a 12V output when the part is at the maximum yield strain of the 4130 steel parts being tested. This allowed the data to stay within the DAQ voltage limits, while allowing the voltage to be converted to a strain value.

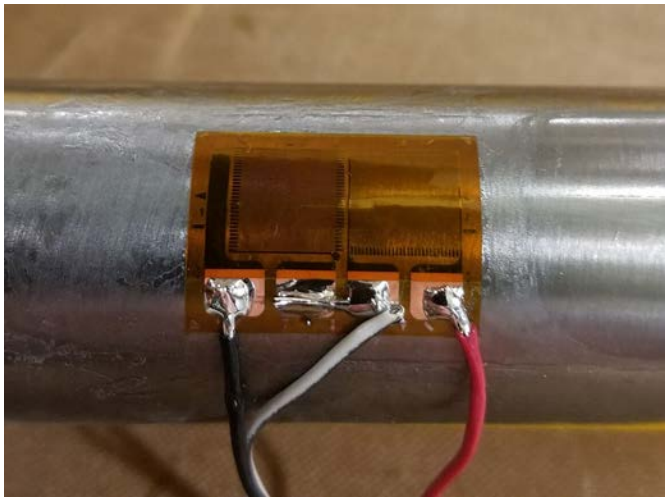

Figure 1: Installed and soldered strain gage

After installing, soldering, and applying the 3145 RTV protective coating to all of the sensors we were ready to calibrate the system. The sensors were calibrated while the suspension components were in a no load condition, and the equations in the DAQ were adjusted accordingly.

Initial testing of the system was conducted before driving the vehicle to ensure all gages were working correctly, and the sampling rate of the DAQ was sufficient to see peak loads in the data. The vehicle was driven over defined obstacles, such as a railroad tie, to determine the input loads on the components in these situations. The results in figure 2 show the strain observed on the upper and lower suspension arms, front and rear.

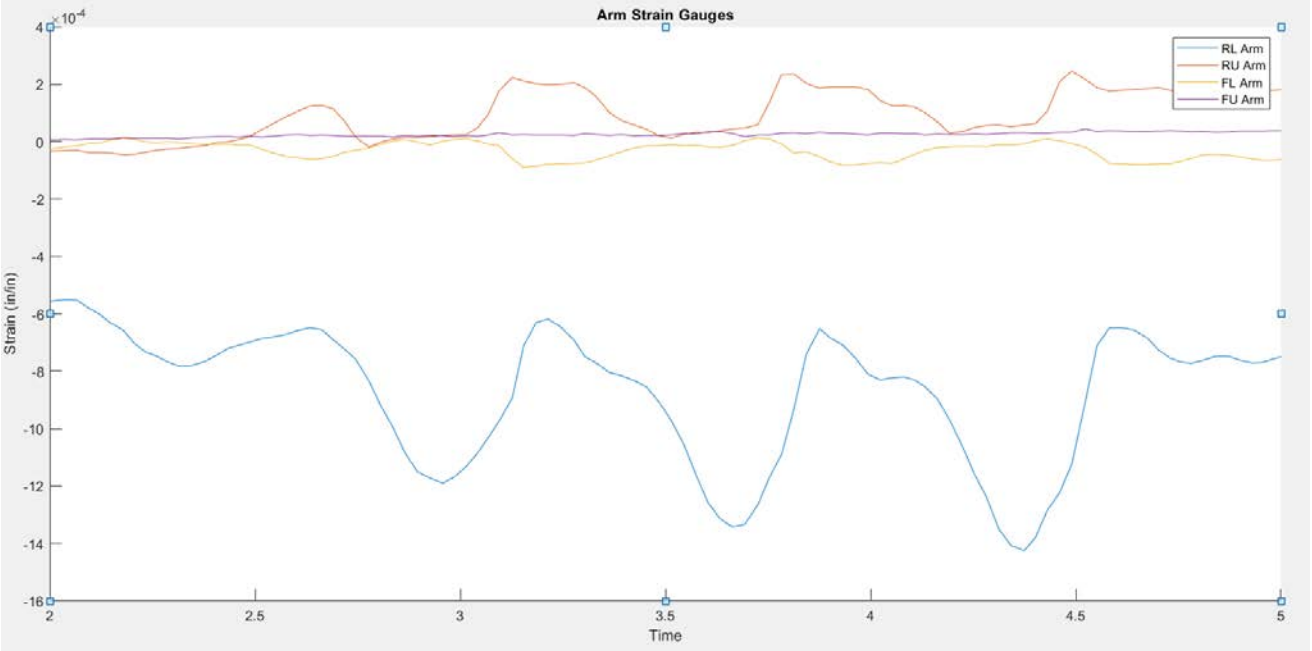

Figure 2: Suspension arm strain testing

The User Explains

The dynamic testing of the vehicle with the strain gage data provided useful results for the forces and responses on the vehicle under certain conditions. The graphs in figure 3 show what the various sensors recorded while the vehicle was driven in a figure 8 pattern. The data illustrated how the loading on the front and rear suspension arms changed as the steering position, shock displacement, and shock pressure also changed. The real time data provided with the Micro-Measurements® strain gages will be an advantage in the design process of future Eagle Racing Baja vehicles.

The rack position graph in figure 3 illustrates the steering angle of the car, which allows the direction and amount of steering input to be correlated with the loads on the suspension. This data allows the team to understand the response and load characteristics of the suspension as a whole system. The maximum strain on the components shows the real-world factor of safety, based on the maximum allowable strain of the material. From the data we can see that the rear lower arms are the most stressed component and the upper arms are not as highly stressed.

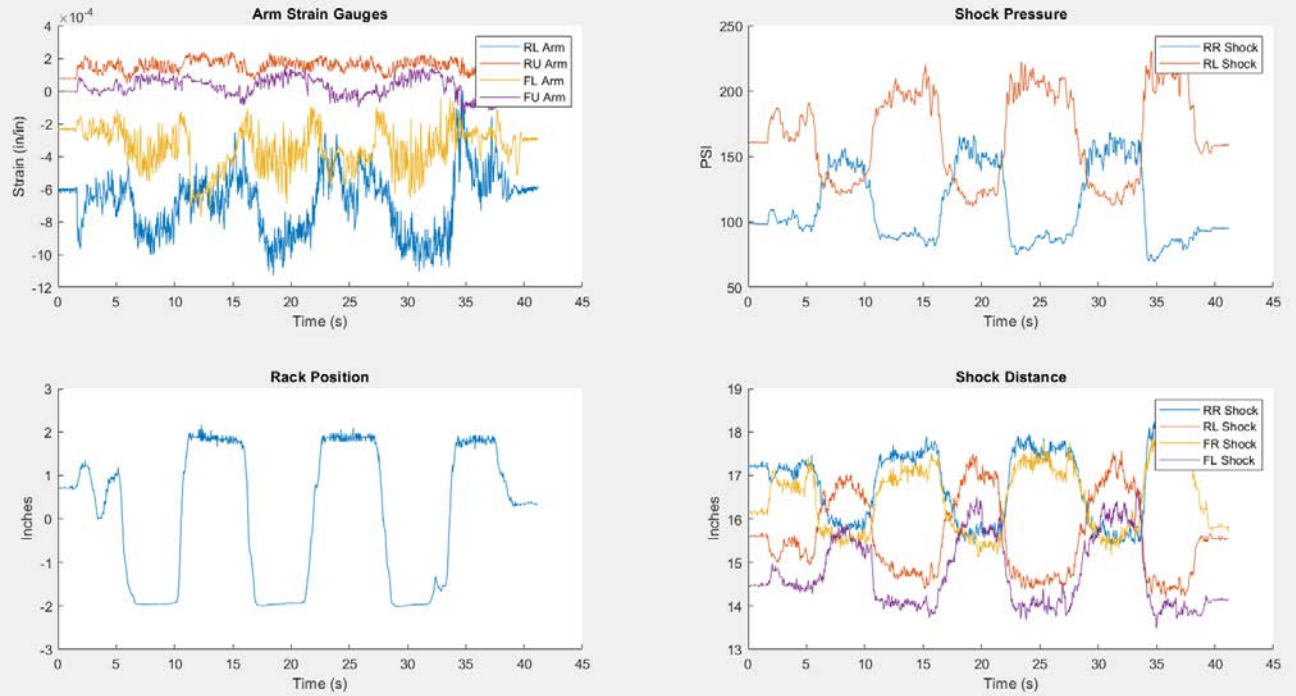

Figure 3: Graphs correlating various sensors during dynamic testing.

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Acknowledgement:

The Marquette Baja SAE team would like to thank Micro-Measurements for their support with strain gage selection and installation. This testing will provide a good starting point for the team in the future, and can expand the use and knowledge base for strain testing on the vehicle.

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