Cycle Advancements for Rugged Terrain (CART)

2017 SEH Symposium
April 28, 2017

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Project Background

- In developing countries, small motorcycles are a common form of transportation.
- These motorcycles are often dangerously overloaded with people and goods, creating danger for riders and pedestrians.

Project Background

- We have made a universal motorcycle hitch.

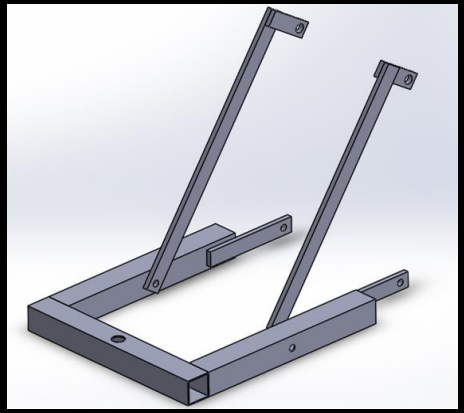
- This hitch increases safety and utility when transporting goods and people.

Specifications

- Create a design which:
  - Local craftsmen can manufacture
  - The materials used are readily available
- The hitch should:
  - Haul a trailer and a load of 200-300 pounds safely
  - Not fail after extended use

Previous Progress

- Last year, the CART team:
  - Created a prototype hitch
  - Performed test rides with hitch and trailer
  - Hitch performed very well



This Year’s Goals

- This year, the CART team aimed to:
  - Develop strategies to run tests on the hitch
  - Determine whether or not the hitch would fail after extended usage

Methodology

- Options for determining the lifespan of the hitch:
  - Pull the trailer with 200 lbs on it until the hitch on the motorcycle fails
  - Create a testing rig to count how many cycles until the hitch fails
  - Perform various tests with strain gages and calculate the fatigue life

Methodology

- Options for determining the lifespan of the hitch:
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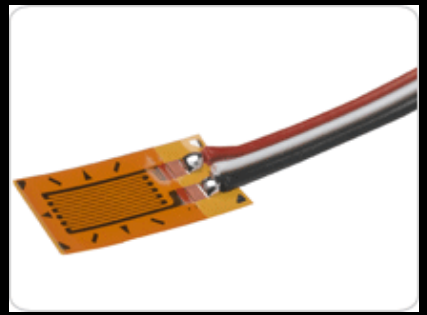
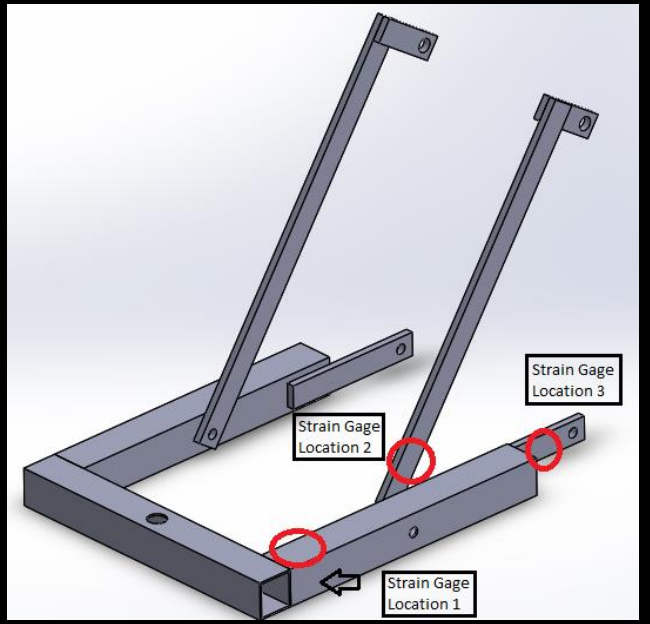
Strain Gages

- Strain gages are used to measure deformation
- Gages were installed on three different locations of the hitch





Types of Tests Completed

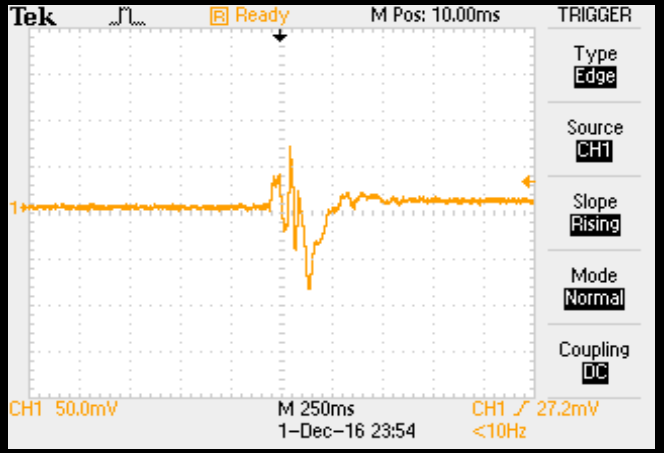
- Impact Test
  - Dropping a weight on the trailer to gather strains during large impact
- Simulation test
  - To simulate strains that would commonly occur during normal operation

Impact Testing Procedure

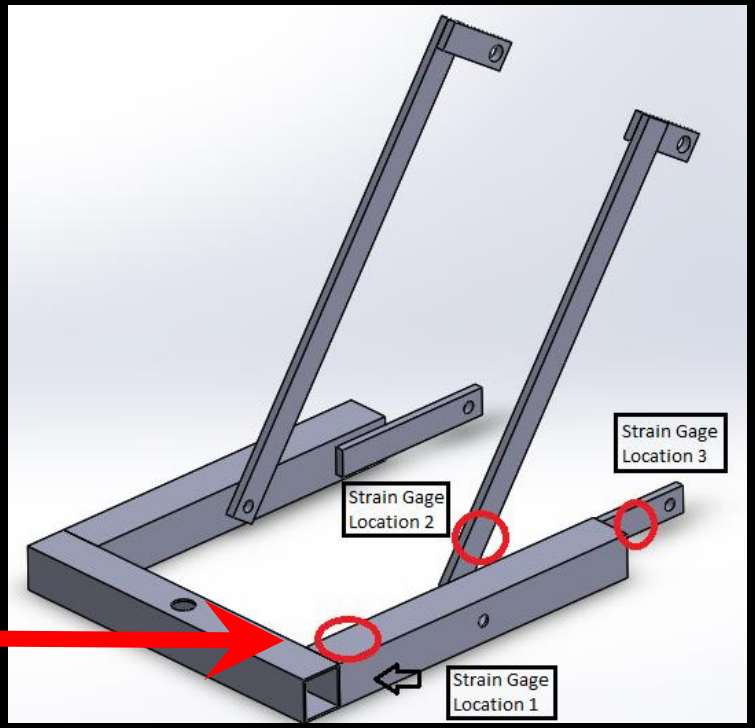
- Dropping suspended weights onto trailer
- We found that 6 inches was the optimal height
- This test simulates a “worst case” scenario that the hitch would see

Impact Testing Results

Below is a sample of the impact testing data



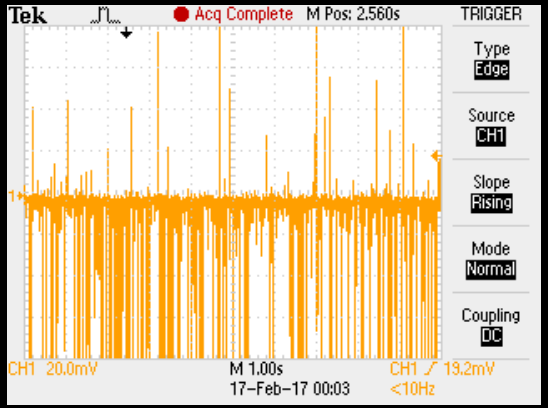
Sample strain data from strain gage



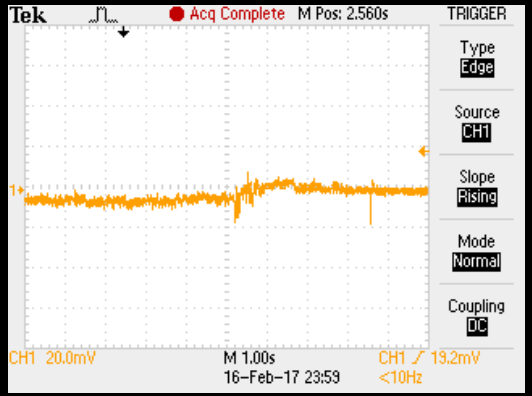
Simulated Field Testing

- We discovered that when the bike was running it was interfering with the data
- For this reason we had to push the bike over the bump so we would get good data

motor on



motor off

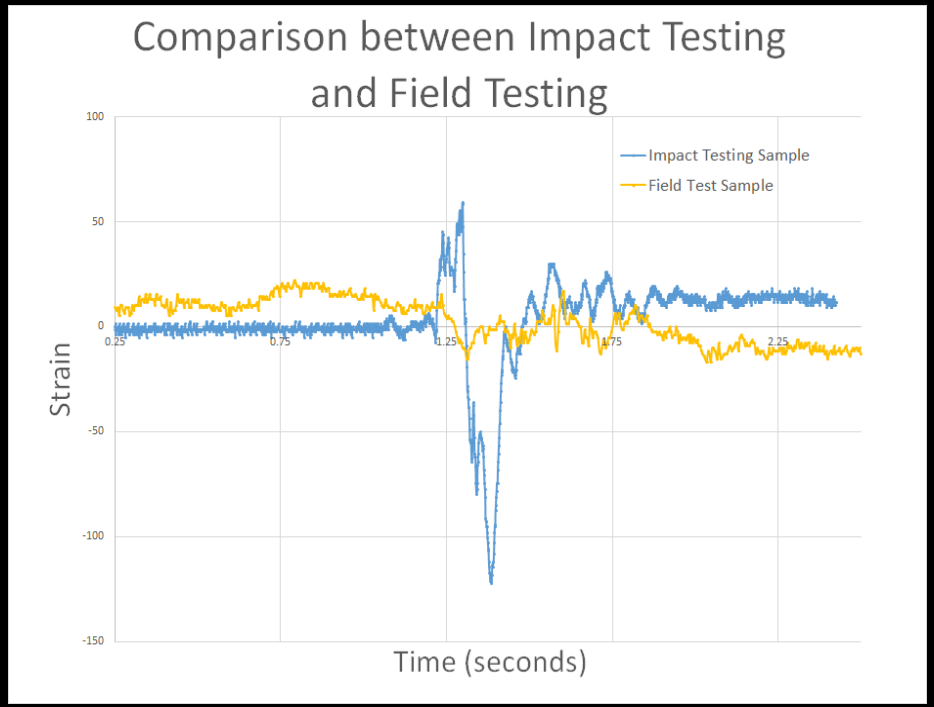


Simulated Field Testing

- Our goal for this test was to gather strain data which represented normal operating conditions.
- This was done by recording the strain which occurred when the trailer ran over a bump
- The procedure consisted of running the trailer over a 2 inch block of wood at an approximate speed of 5 mph

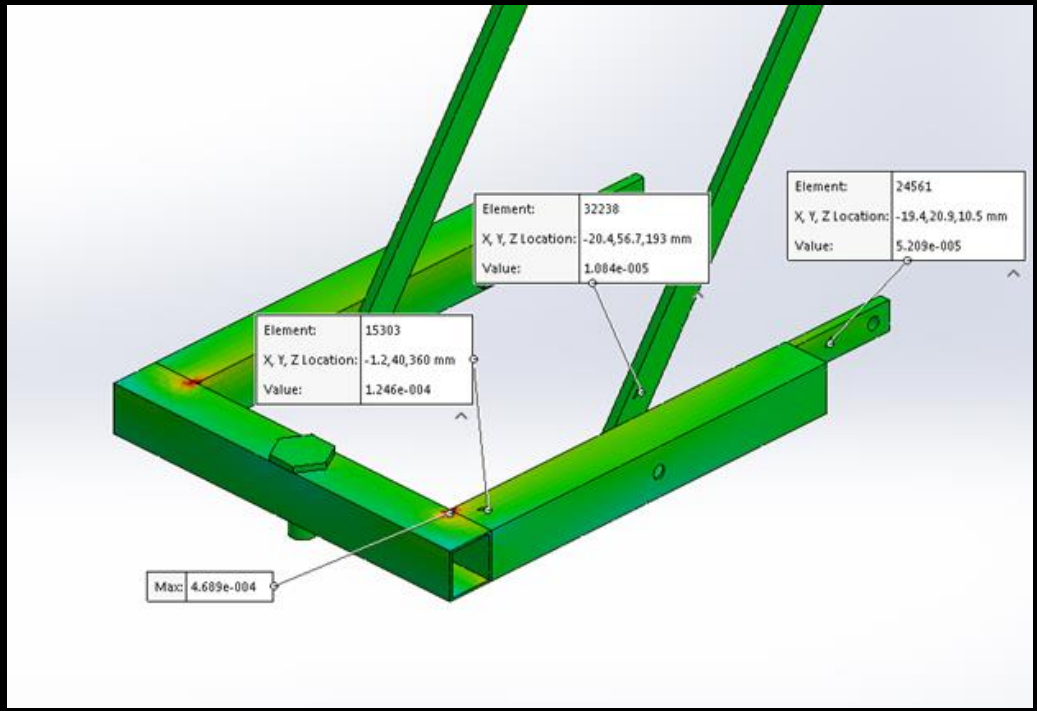
Field Testing vs. Impact Testing

- Field testing produced very small strain values compared to impact testing.
- Impact testing simulated a worst-case scenario, so we chose to use this data instead of field testing data.



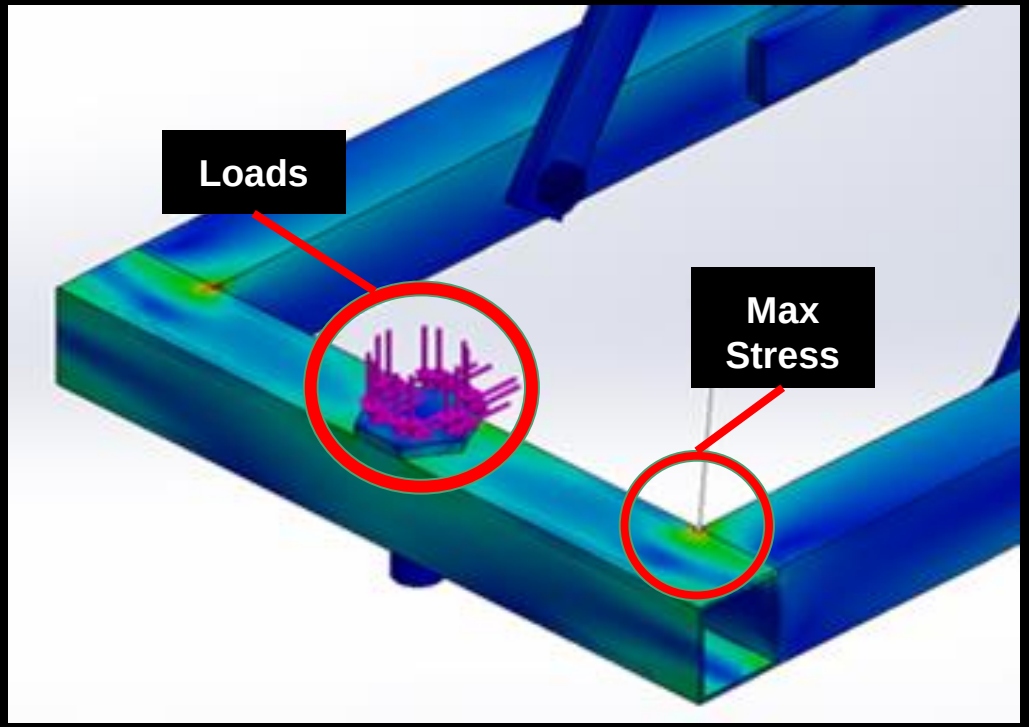
SolidWorks Analysis

- SolidWorks finite element model created.
- Loads found by matching each strain gage to impact strain data.
- This allowed us to solve for loads.

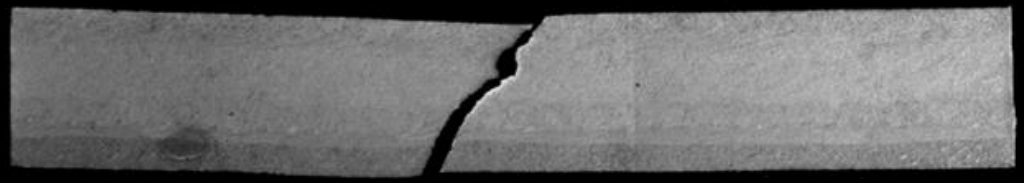


SolidWorks Analysis

- Loads were used and simulation was run.
- The point of maximum stress was found.

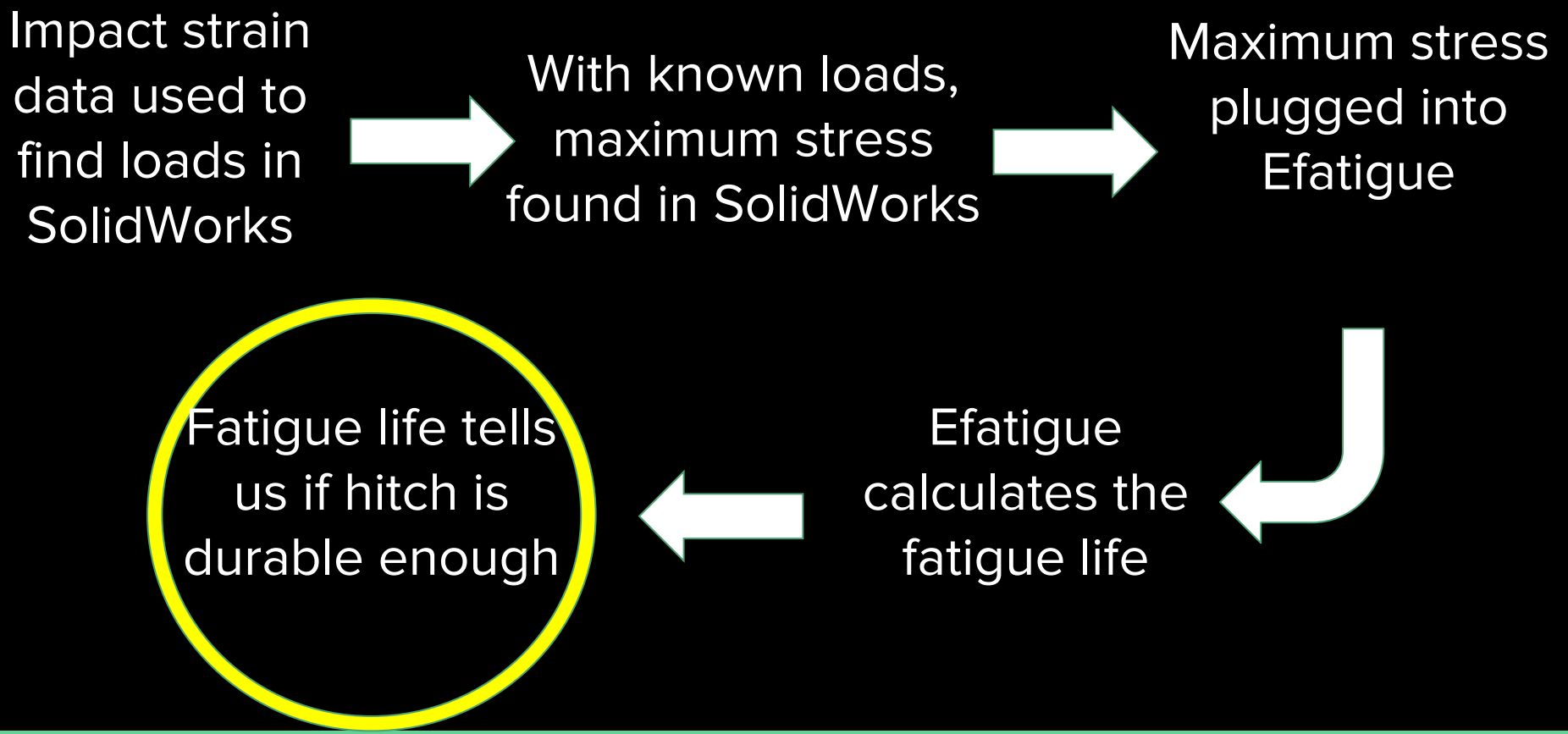


Fatigue Analysis



- What is Fatigue?
  - Fatigue occurs when a part is loaded repeatedly over a period of time.
  - It eventually causes a part to break if enough time passes.
  - With fatigue analysis, we can calculate how long a part will last with known stresses.

Fatigue Analysis



Fatigue Analysis Results

- Our hitch will last forever.

- Our hitch design can safely be built and used in developing countries.

Conclusion

- We have proven that our hitch design is sufficient for real-world use.

- Our design is safe for even the worst-case conditions.

Future Work

- We hope to distribute our designs for field testing in Burkina Faso.

- Our next step is to create a trailer design that is optimized for use with our hitch.

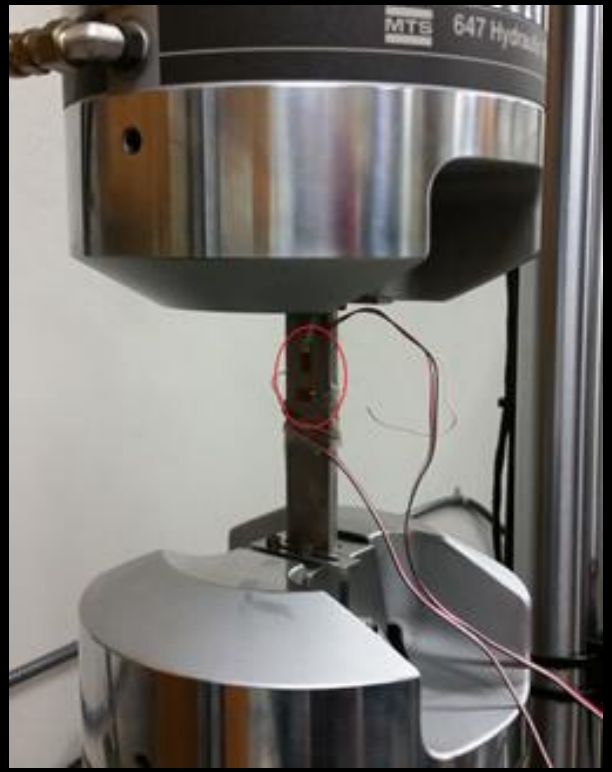
Acknowledgements

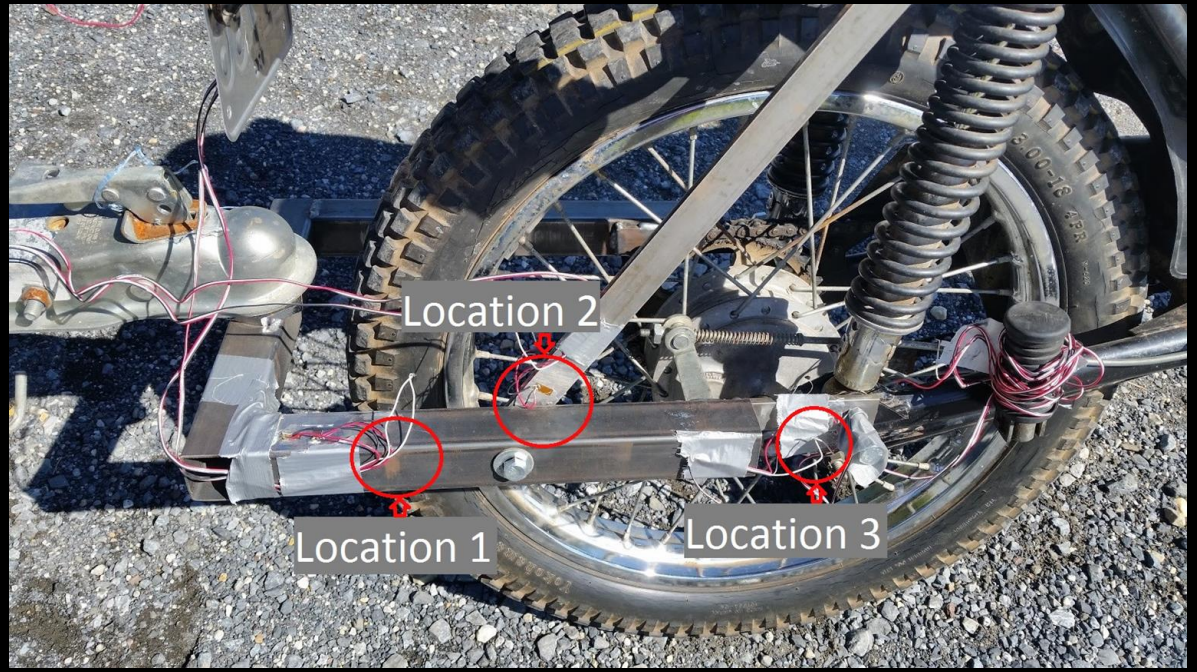
- Thanks to all who have helped with this project:
  - Dr. Van Dyke
  - Dr. Pratt
  - Paul Meyers
  - John Meyer

Questions?

Tensile Testing

- Tensile testing was performed to check the calibration of our strain gages.
- Strain calculated from strain gages was compared to hand calculations and results matched.




Location 2
Location 1
Location 3