

Grand Canyon Alternative Motor Project

University of Utah

Advisors:

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Thrust Plate Team

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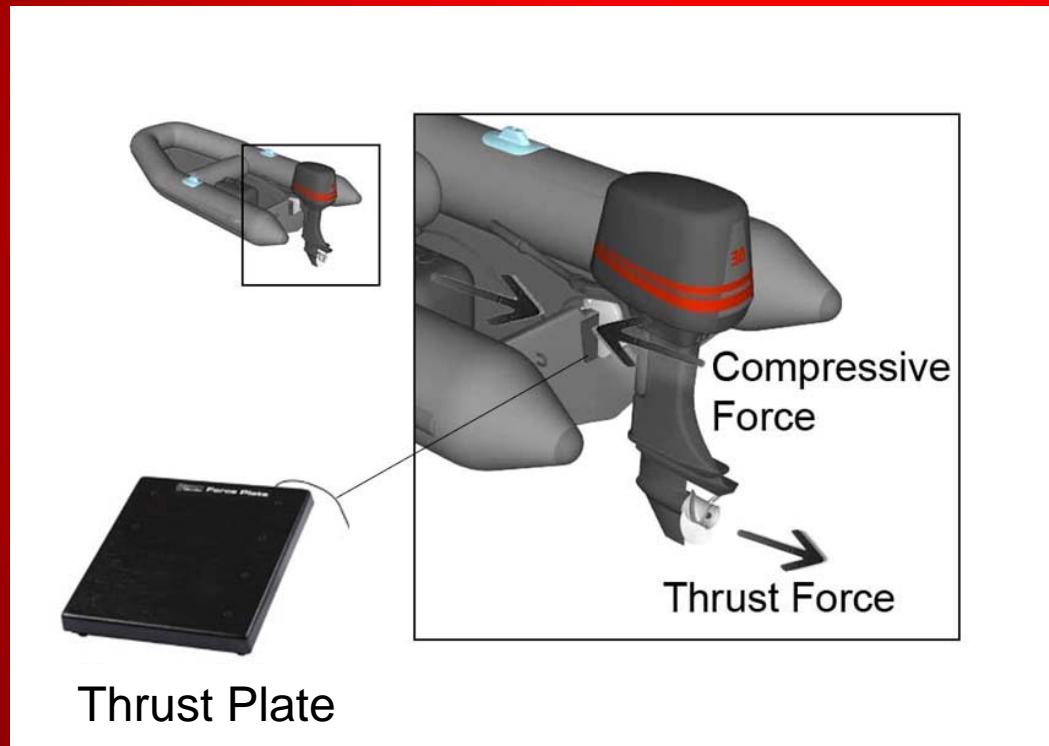
Tony Heaton

Darin Peterson



Thrust Plate Approach

- Measure the motor power via Velocity Probe and Thrust Plate



Flow Probe measures water velocity

$$\text{Power} = \text{Thrust Force} \times \text{Velocity}$$



Problem Statement

- Last year's team had no way for knowing the power of the motor
- Commercial force plates are too bulky and overpriced to effectively test our motor
- River environment causes hazards for measuring equipment



Planning the Thrust Plate

Requirements

- Waterproof
- Abrasion/overload resistant
- Precise and accurate
- Measures net force applied
- < 2 in. thick



Planning

- Four Spring elements (one in each corner) from aluminum alloy
- Full Wheatstone bridge across all four spring elements
- Motor force causes 1% of max strain

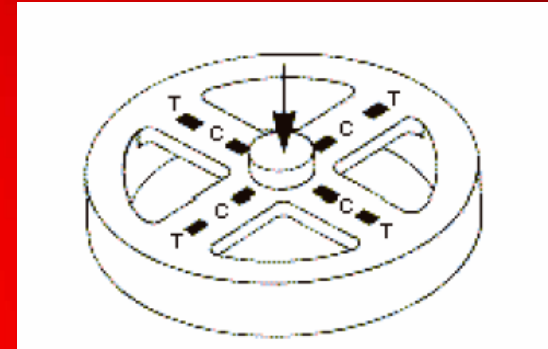


<http://photography.nationalgeographic.com/staticfiles/NGS/Shared/StaticFiles/Photography/Images/POD/p/pontoon-rafting-arizona-1048932-xl.jpg>

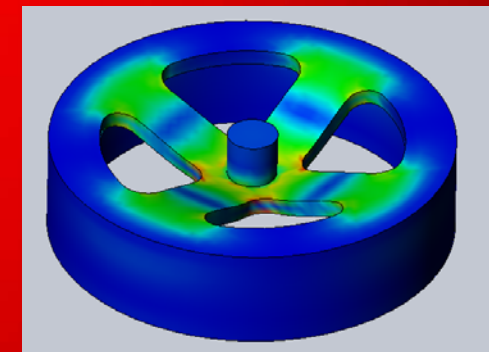


Designing the Spring Element

- Deflects with force applied to thrust plate
- Wheel design allows thin profile and relatively easy manufacturing
- Strain gages measure zones of tension and compression
- Tested using FEA analysis

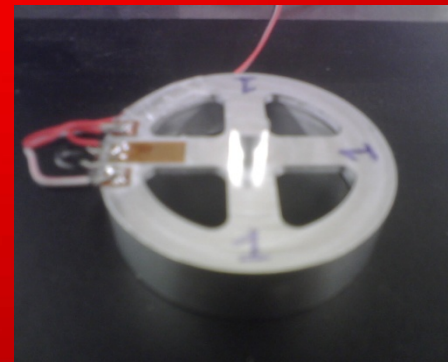


<http://www.measurementsgroup.com>



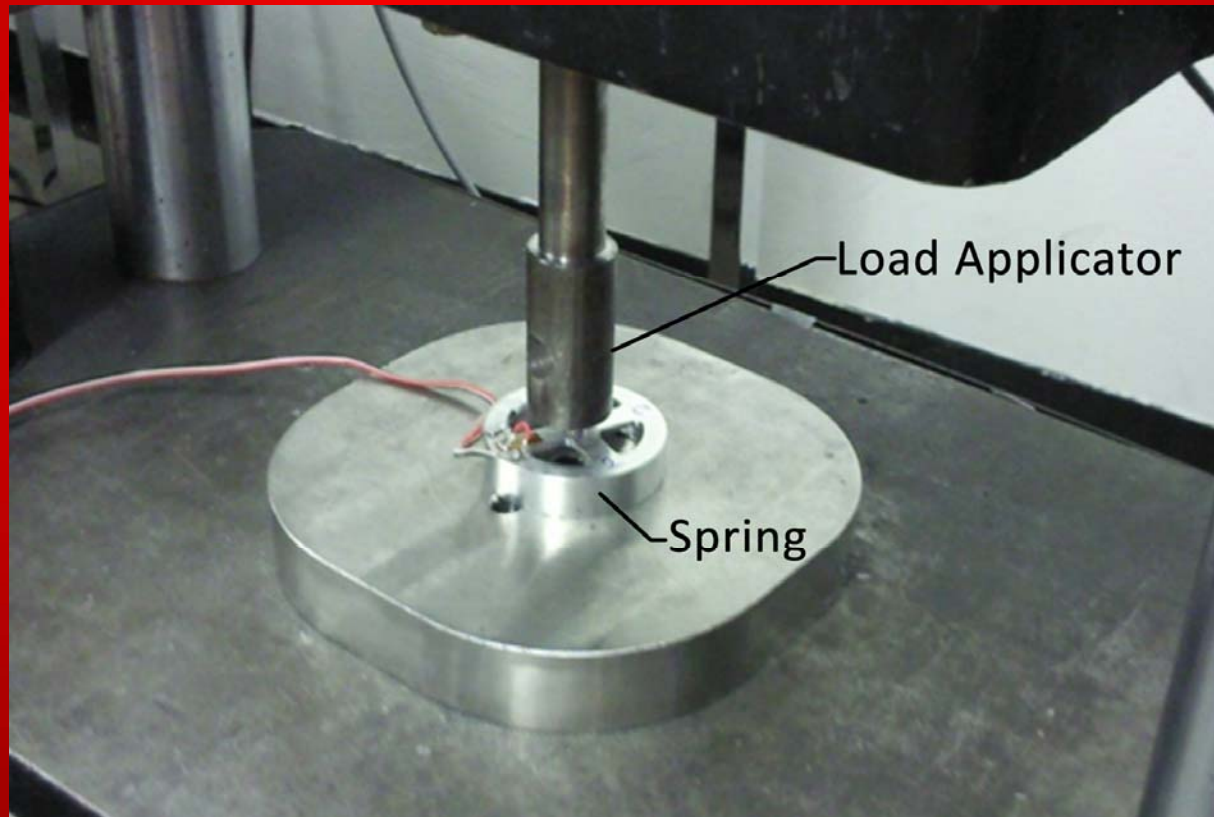
Prototyping the Spring

- Manufactured with 7073 aluminum alloy
- Three produced to test repeatability
- Quarter Wheatstone bridge
- One gauge per spring



Testing of the spring

- Spring element placed in load applicator and load cell setup



Test 1 - Precision

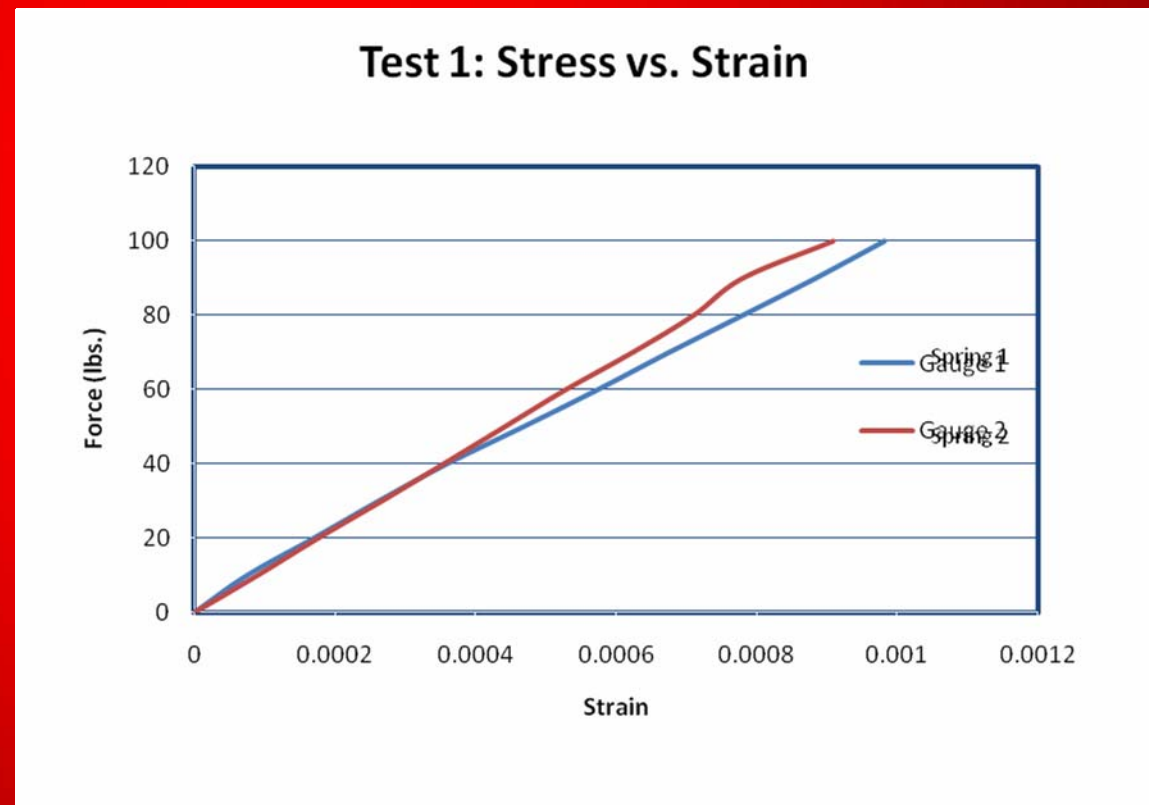
Method: Apply increasing load and measure strain

Test:

- Force vs. Strain
- Precision of Springs

Results:

- Linear relationship
- Deviation = 5%



Test 2 – Yield Strength

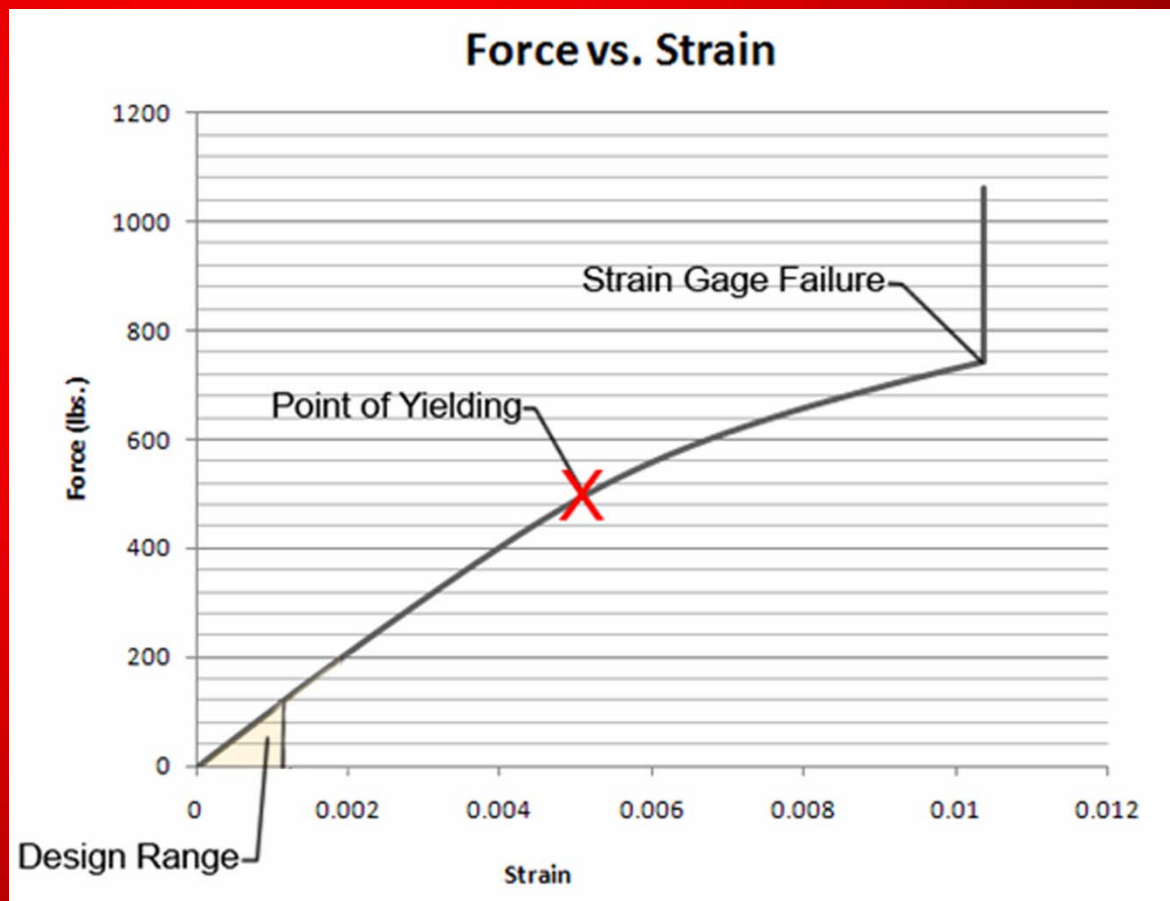
Method: Apply increasing load until spring element yields

Test:

- Force vs. Strain
- Yield Strength

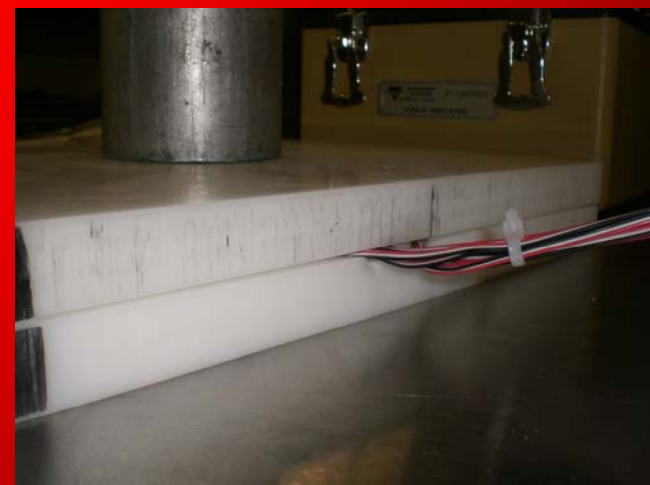
Results:

- Elastic in design range
- Factor of Safety = 5

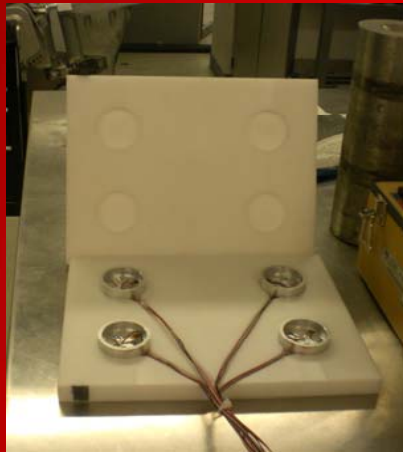


Housing Construction

- Plates provide mechanical stop by touching when deflection is too great
- Uniform application of force on gauges across the plates
- Fits all components without pinching wires or gages



Thrust Plate Prototype



- Four spring elements
- Two strain gages per spring (one in tension one in compression)
- Compression gages applied to bottom of springs
- Temperature compensation
- Half Wheatstone bridge



Prototype Testing



Test

- Standing on plate
- Applying weights to the sides and corners of the plate

Results

- Strain varies slightly when force is applied to sides
- Manufacturing caused one spring to be inconsistent



Looking Ahead

- Downsize thrust plate to fit within size constraints
- Adjust springs so that load is 1% of max strain
- Waterproof with wax and plasti-dip
- Purchase flow probe
- Full Wheatstone bridge
- Dynamometer testing



Dynamometer Testing

- Hook up drive shaft of motor to dynamometer as a measure of performance
- Compare our motor to current Honda and Tohatsu motors
- Take measurements at quarter, half, and full throttle



Conclusions

- Spring Elements work well
- Thrust plate prototype works
- Project is on track to be ready in time
- Future improvements include downsizing and tweaking parts to increase precision

