College of Engineering
Department of Mechanical & Industrial Engineering

College of Engineering
School of Electrical Engineering & Computer Science

To Predict ▶ To Design ▶ To Perform

ME, ECE Capstone Design Programs

Team #14: Thermal Protection System Tensile Testing

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Objective Statement

Update the mechanical and electrical components of a custom NASA portable tensile tester, while maintaining the functionality of the original device.

Background

NASA currently uses a portable tensile tester, that was designed 40 years ago, to test foam isolation, used for thermal protection on flight hardware. The parts are hard to find and expensive which make repairs and maintenance difficult.

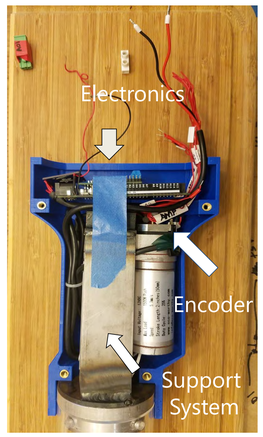
Engineering Specifications

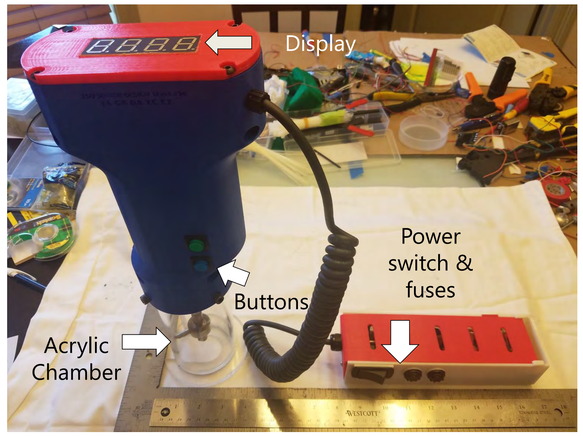
- Maximum tensile force: 250 lbf
- Linear piston velocity range: 2-4 in/min
- Display force reading within +/- 2.5%
- 30 min duration of tests
- Portability: Mass of device < 10 lbm

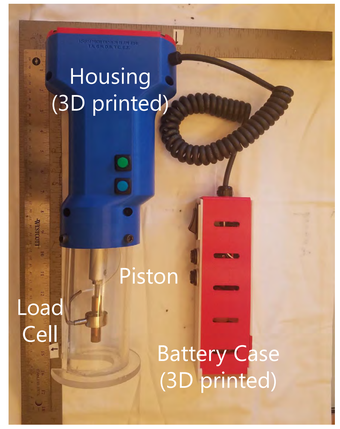
Safety

- Motor driver and fuses protect motor from overcurrent and low voltage conditions.
- At loads >250 lbs: device shuts off

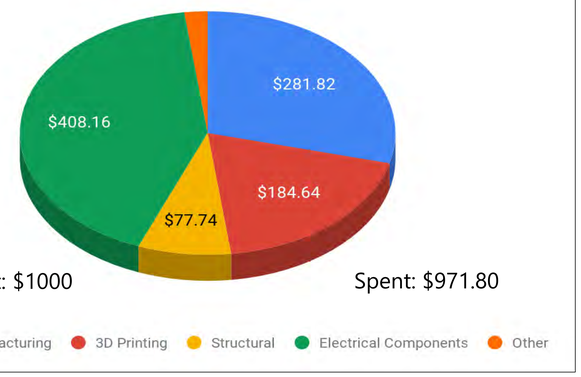
Prototype Development



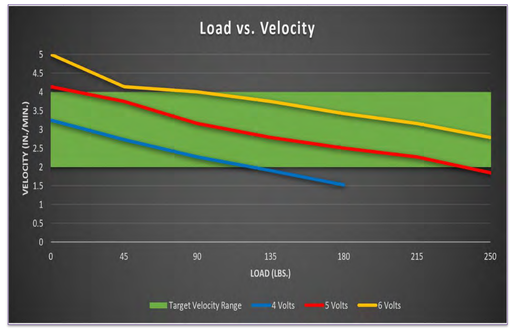


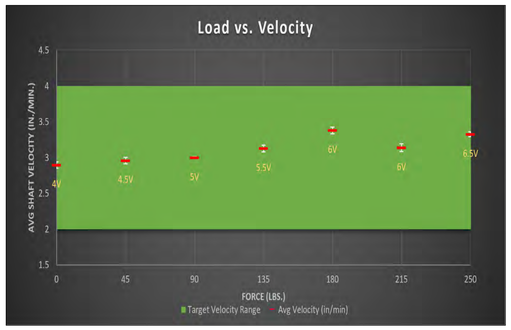


Budget



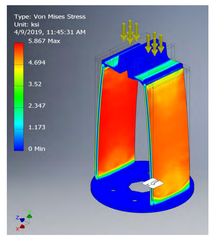
Testing & Validation



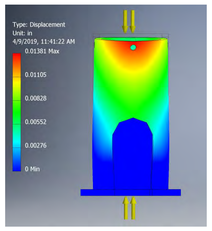


- *Top graph*: shows what voltages produce the target velocity at each load
- Linear piston velocity range: 2-4 in/min (Green region in images on left)
- Loads ranging from 0-250 lbf were pulled at voltages ranging: 4-6 volts.
- *Bottom graph*: shows the repeatability of the test (5 trials at each load)

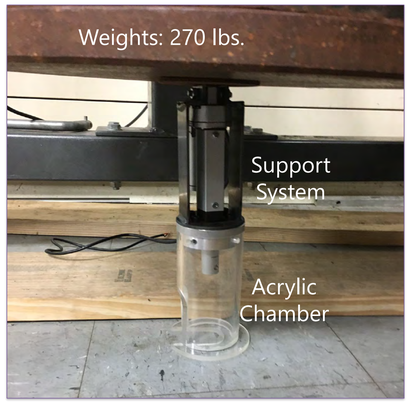
Load Analysis



Finite element analysis of support system



Finite element analysis of acrylic chamber



Support structure under 270 lbf

The FEA models (*images on the left*) show expected stresses on the main support structures, while the *image above* shows the structure holding maximum load +20 lbf.

Conclusion

A velocity of 3 in/min was maintained, for loads ranging from 0-250 lbs, by producing target voltages at each load. The structural integrity of the device was proved as it can withstand 270 lbm. The device remains portable as it weighs less than 10 lbm and is less than 15 inches tall.

Future Improvements

More efficient methods of manufacturing and tighter tolerances would reduce alignment issues. Using a single board computer such as raspberry pi , would allow for a more effective proportional integral derivative (PID) DC-motor controller.

CONCEPT GENERATION SEPT-OCT → CONCEPT ANALYSIS OCT-NOV → CONCEPT SELECTION DEC-JAN → COMPONENT ACQUISITION JAN-FEB → MANUFACTURING & TESTING FEB-APR → FINAL PRESENTATION MAY