

Advanced Wildfire Hose Clamp

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Sponsors

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Problem Statement

Wildland firefighters need a new way to quickly stop high pressure water flow in a hose because current solutions delay or inhibit the process of attaching more hoses during extended hose lays.



Timberline Hose Clamp

Kochek Hose Clamp

Background

The current industry standard, the Timberline hose clamp, is expensive and when worn does not completely stop water flow during hose lays. Our goal was to improve firefighters' tools and therefore firefighting effectiveness.

Design Progression

Main stakeholder needs:

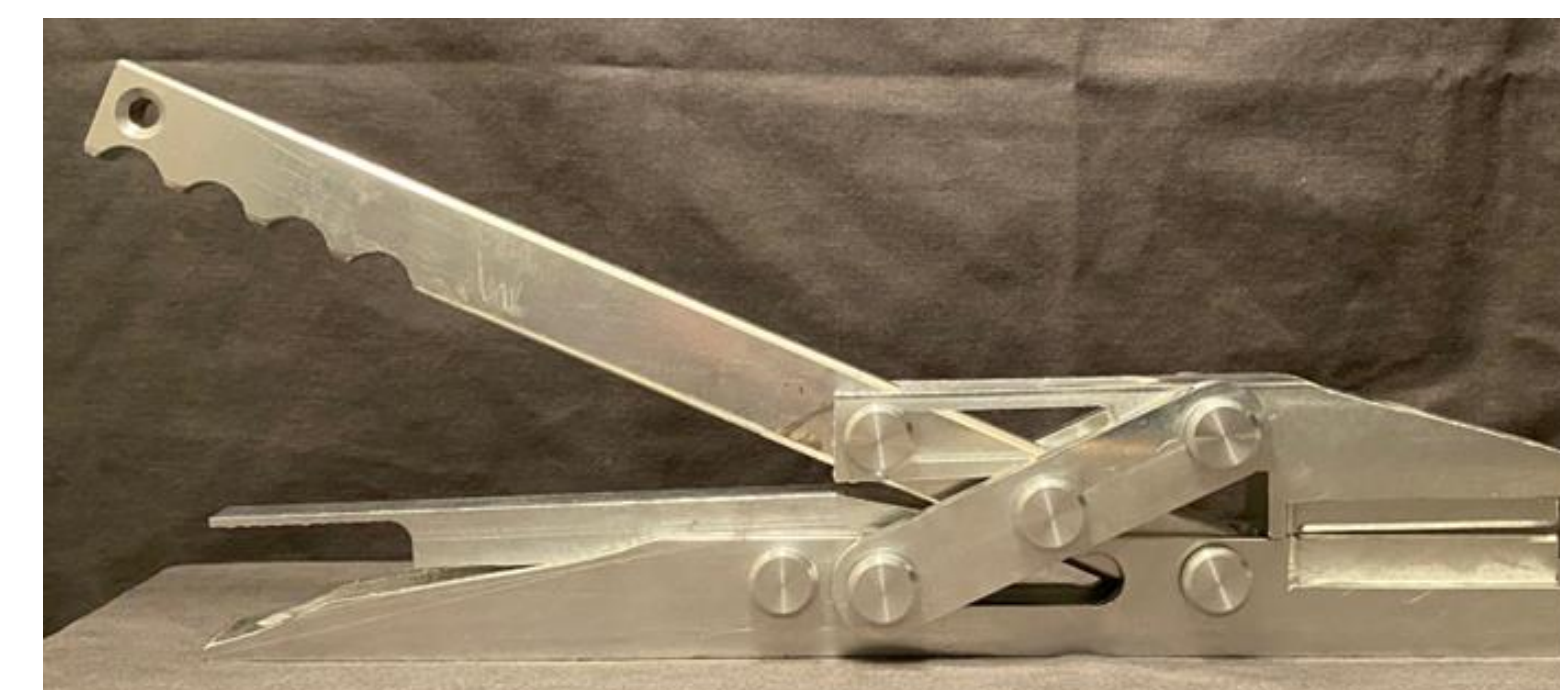
- Low cost
- Minimizing leakage
- Durable
- Lightweight design

Design choice:

- Parallel motion jaws
- Minimizes leakage
- Uniform Pressure minimizes wear
- Uses links, pins, and slots



Concept Prototype: 3D-Printer

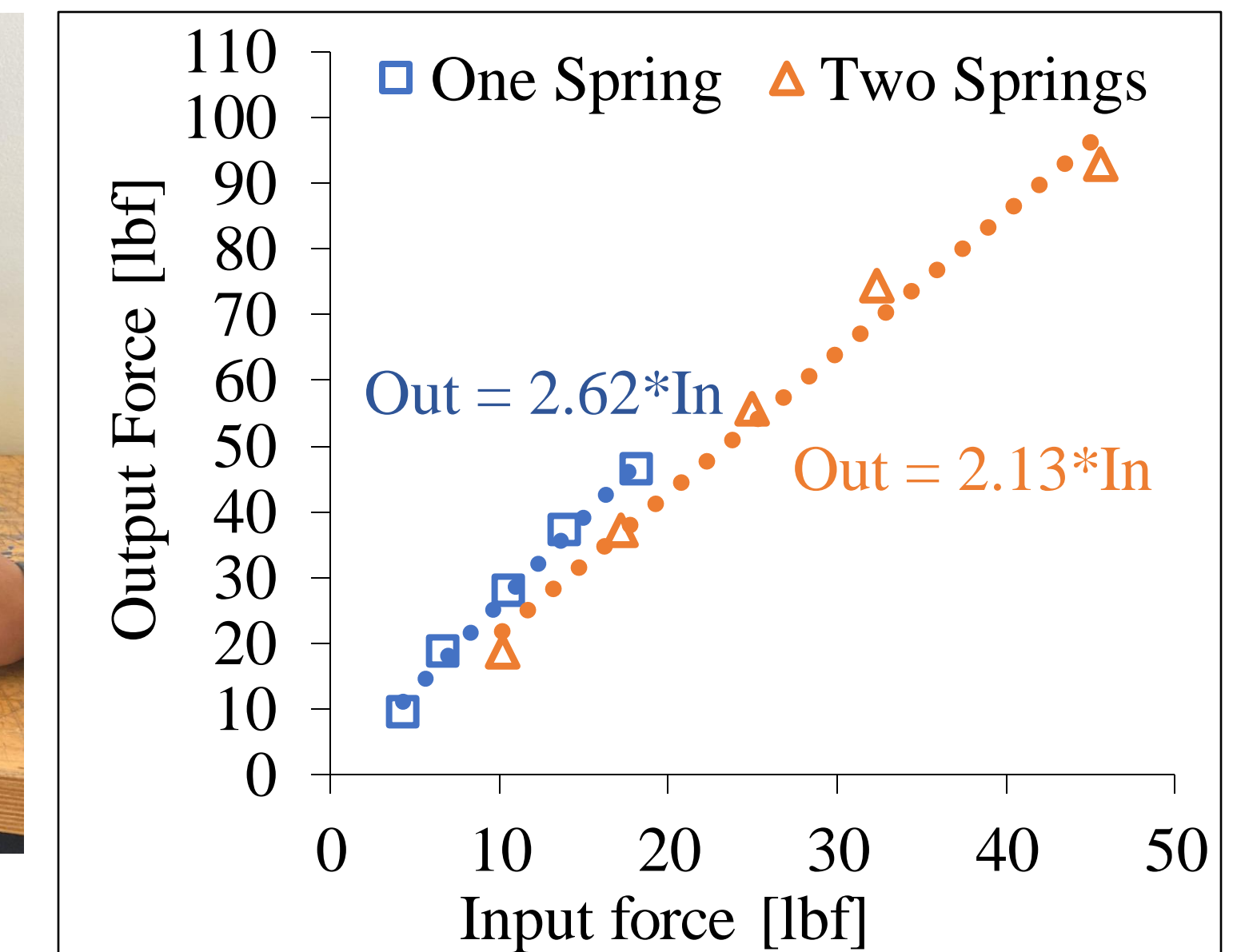


Structural Prototype: 6061 Aluminum

Testing

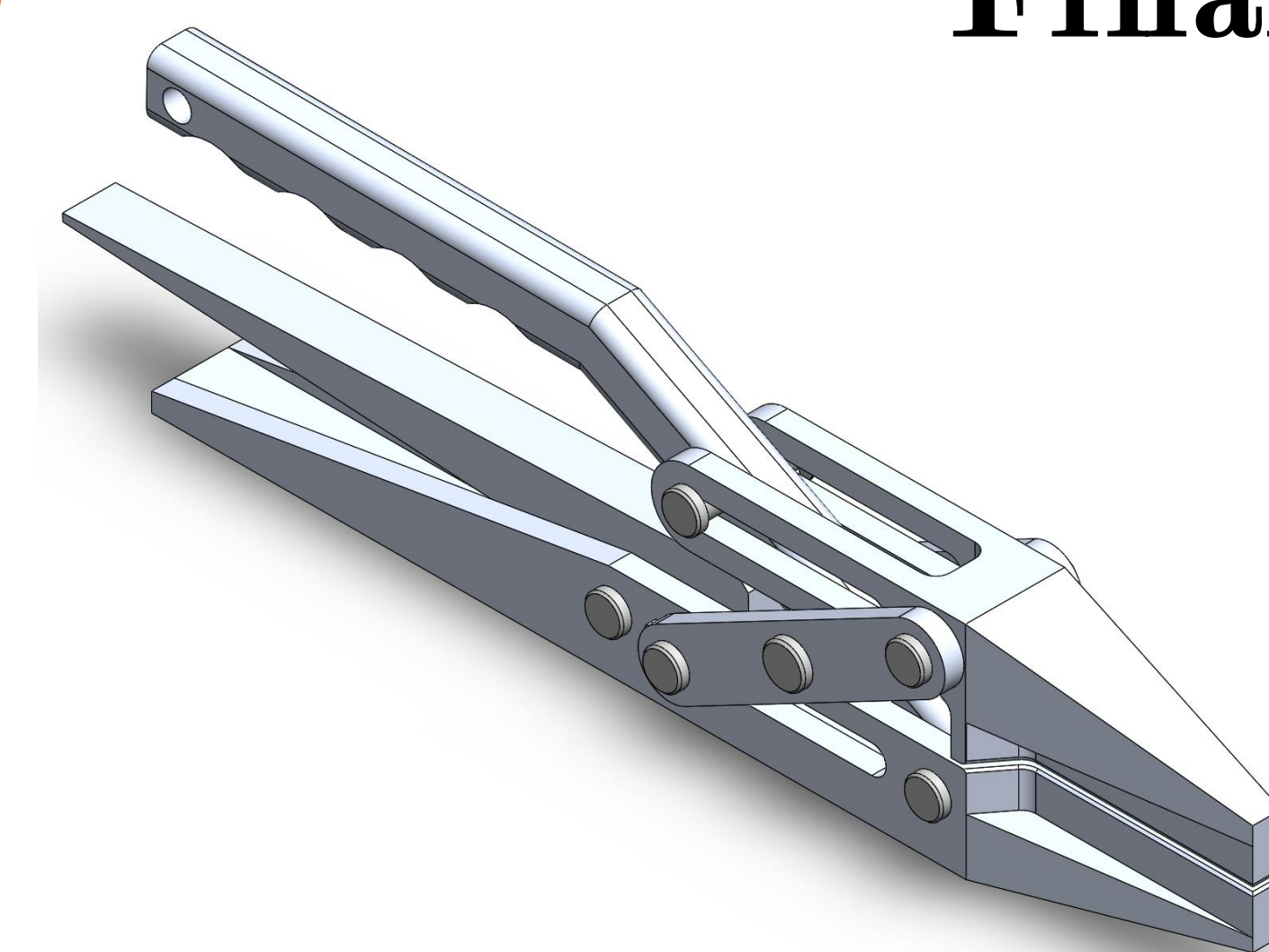


Mechanical Advantage using spring deflection

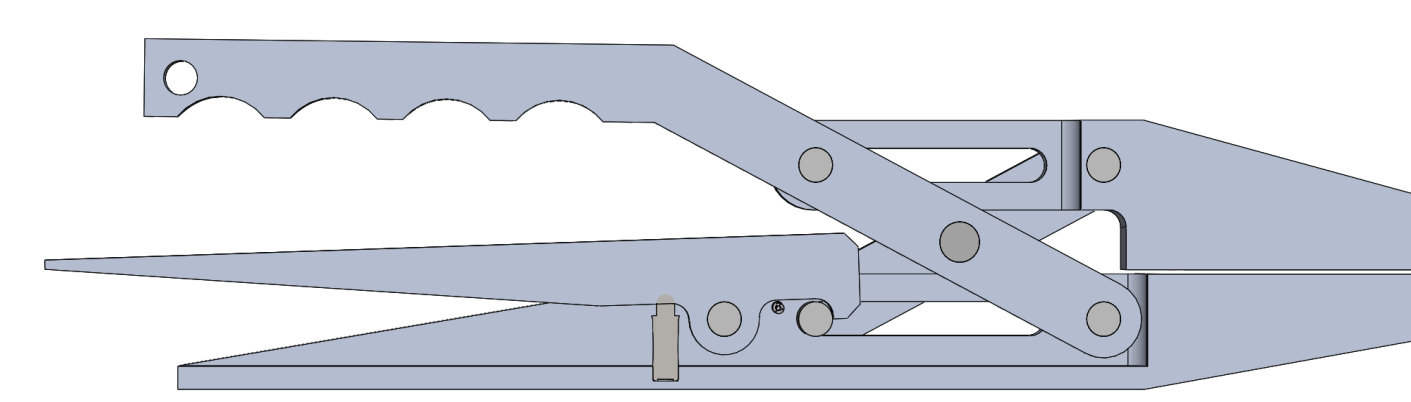


The slope of the plot is our mech. adv.

Final Design



CAD Isometric



CAD Section View



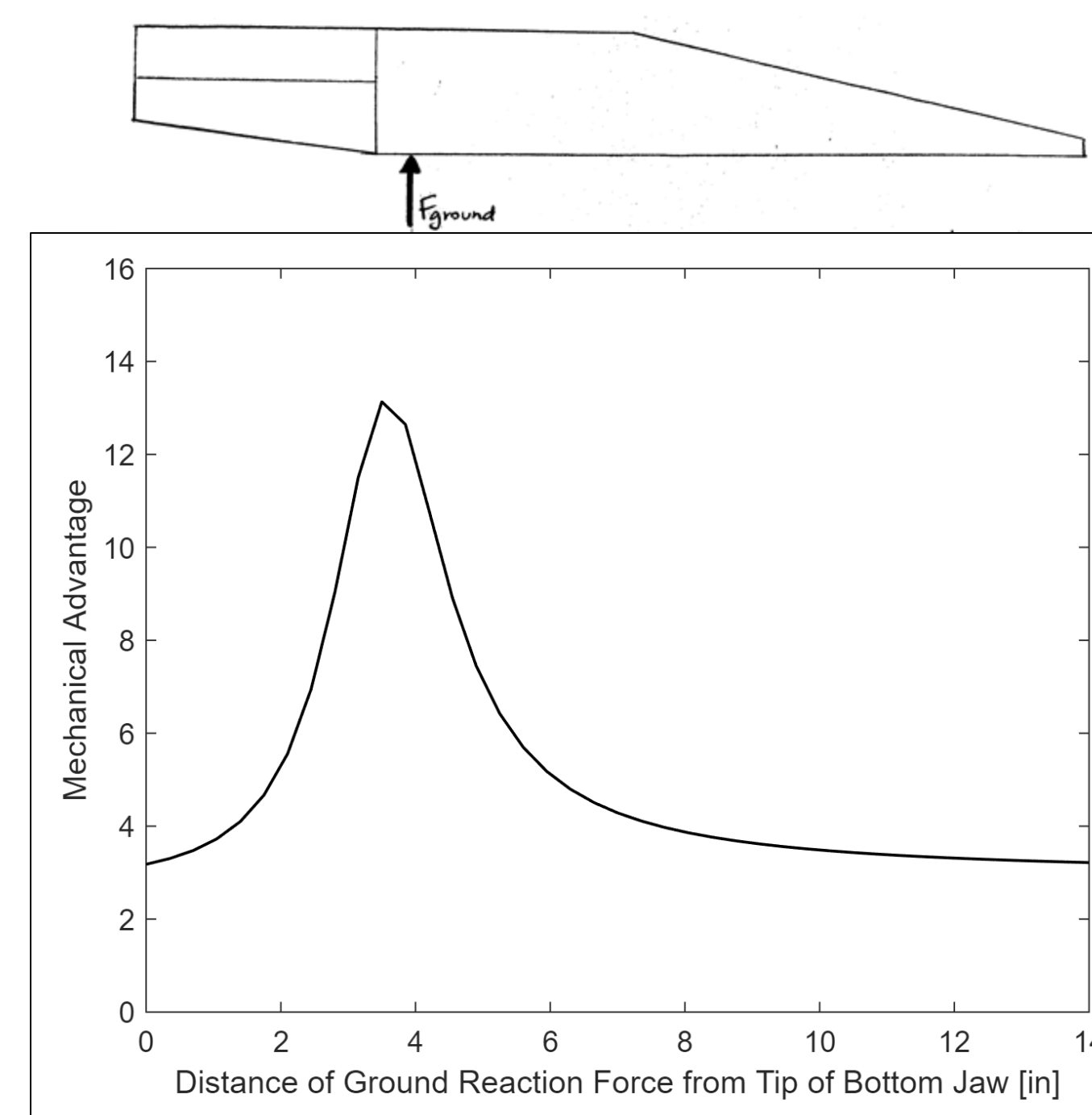
Final Prototype

- 7075-T6 Aluminum
- Features: carabiner hole, ergonomic hand grooves
- Parallel jaw mechanism: links, slots, pins
- Locking Mechanism: coiled spring pin, spring plunger, latch

Analysis

MATLAB

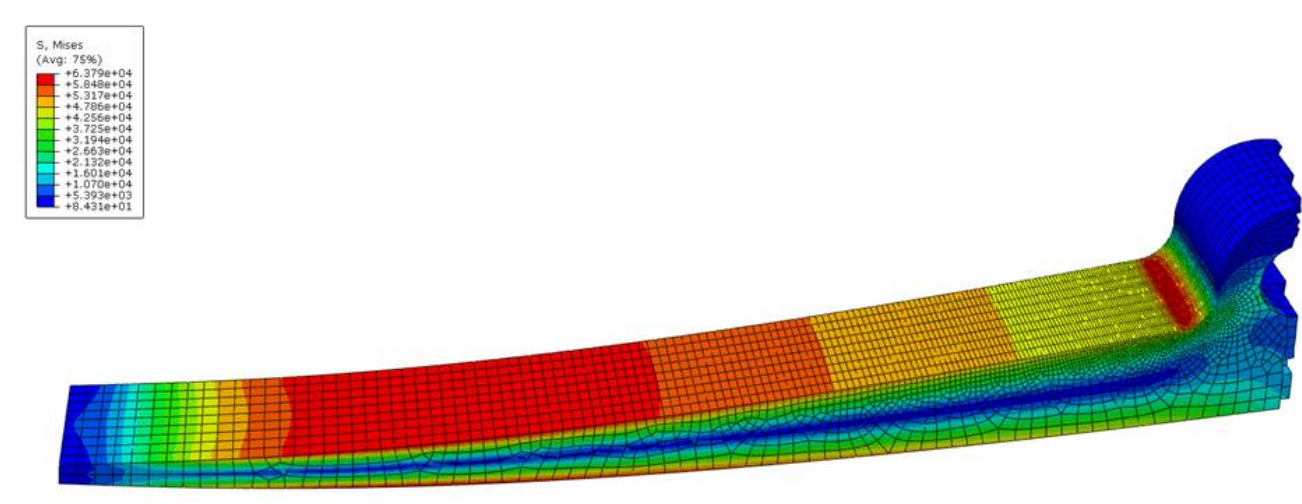
- Iterates through design variables to calculate forces and member sizes
- The geometry of the parallel motion mechanism is dependent on the jaw gap
- Mechanical advantage changes depending on where the ground reaction force is located along the length of the bottom jaw



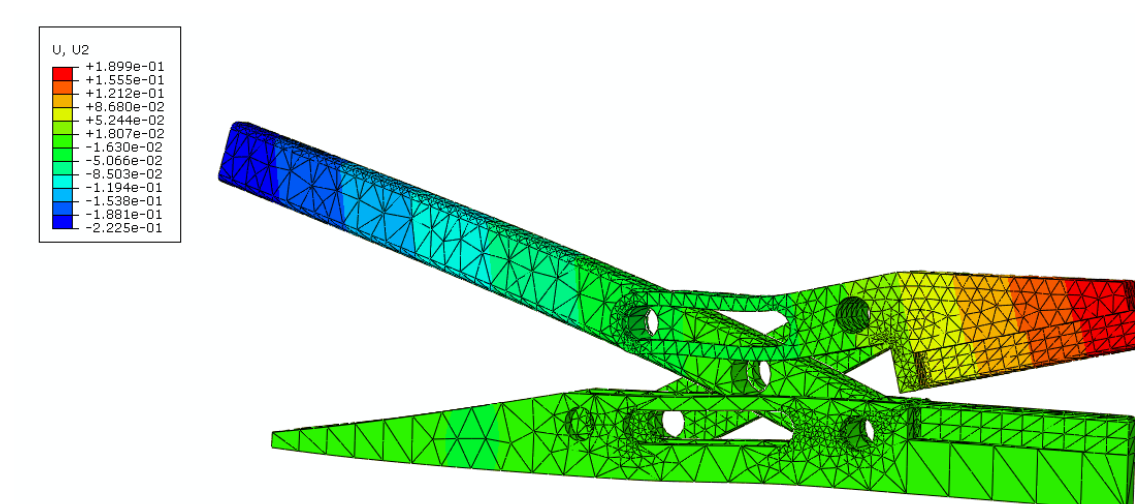
Mech. adv. varies with location of ground reaction force

FEA

Multiple FEA models in ABAQUS helped determine stress and deflection response to different loading conditions.



Latch Stress Analysis



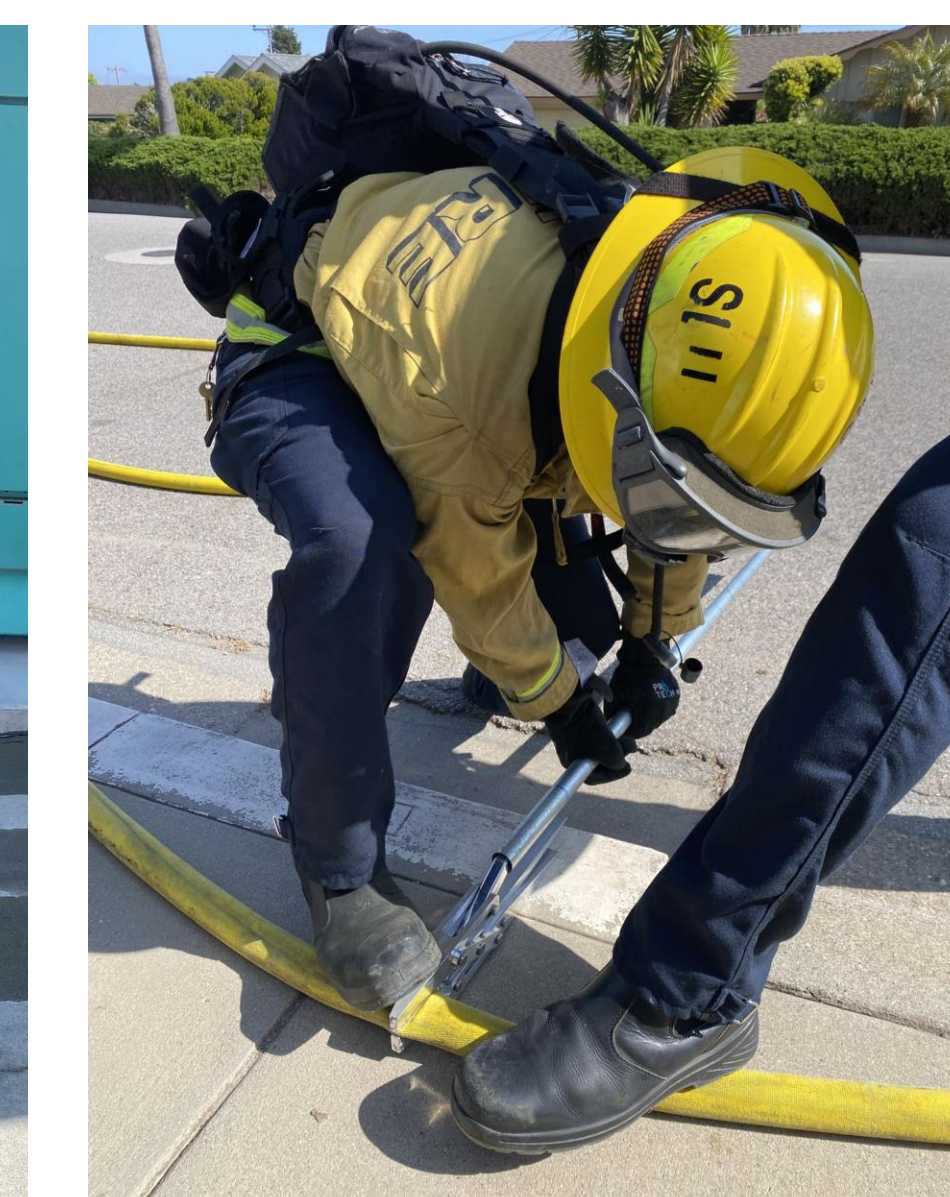
Assembly Deflection Analysis

Safety Factors of Major Components

Pins			Slots		Links			Latch	Handle
Top	Middle	Bottom	Top	Bottom	Top	Middle	Bottom		
6.04	1.03	1.08	2.75	2.75	1.60	1.39	1.60	1.02	3.53



Time to Use



Cheater Bar to increase mech. adv.



Leakage after clamping

Conclusion

Based on our testing, we found that our calculations were correct, but our clamp did not meet our engineering specifications. Our design could not perform better than the Timberline clamp mainly due to leakage, poor mechanical advantage, and large tolerance stack-up. Nevertheless, some successes include our locking mechanism and strength and stiffness as expected. If this project is continued next year, the new team should focus on more robust stakeholder research and improving the Timberline design itself.

Manufacturing

We outsourced one clamp to Elco Machine Co. in San Luis Obispo for CNC milling and manufactured a second, identical final prototype ourselves at the Mustang '60 and Aero Hangar Machine Shops on campus. We roughed out the profiles using a waterjet and vertical band saw and then refined and added features using manual mills.



Waterjetting



Milling



Milling



Final Parts