High-Speed Tensile Tester

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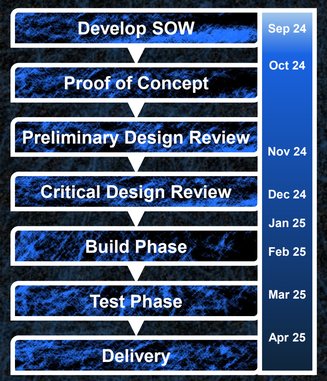
What is the High-Speed Tensile Tester?

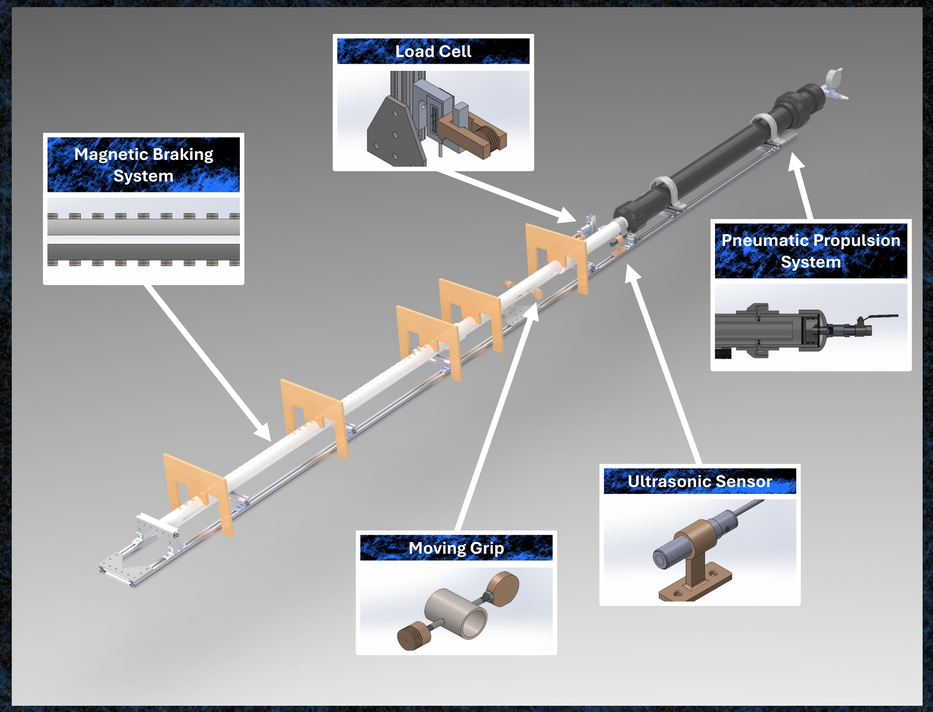
Autoliv designs airbags that open at high speeds to protect passengers. Regular tensile testing instrumentation exists to test fabric and threads at low speeds, but little numerical data is known about the **stress & strain performance of airbag threads** in high speed and high stress environments. This project aims to collect data to better understand the performance of airbag thread put under high load at speeds of up to **100 m/s (224 mph).**

Timeline

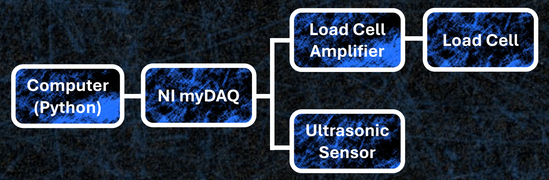


Major Subsystems

The high-speed tensile tester uses a **pneumatic propulsion system** with a quick-release piston valve to pull the thread sample at high speeds. A moving **gripping mechanism** holds and rapidly pulls one end of the thread sample. Stress data is recorded using a **strain gauge load cell** with strain data collected by an **ultrasonic sensor**. Collected data is fed into a **NI myDAQ** which interfaces with a **python script** for data analysis. The fast-moving thread grip is slowed by a **magnetic braking system** after the thread breaks.



Data Collection System

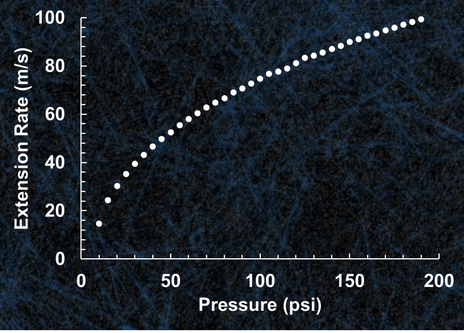


Testing and Performance

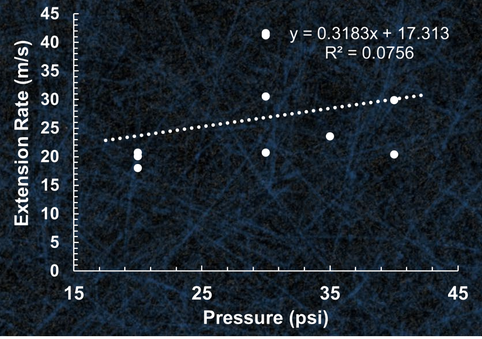
- Numerical simulations used to predict system performance.
- Low-speed tensile testing to validate pneumatic system.
- Testing at range of pressures to analyze pressure/velocity relationship.
- System review to ensure system met physical requirements.

Requirement	Target	Threshold	Predicted	Actual
Extension rate	100 m/s	50 m/s	95 m/s	25 m/s
Speed accuracy	+/- 5 m/s	+/- 10 m/s	+/- 2 m/s	+/- 10 m/s
Extension accuracy	+/- 5%	+/- 10%	+/- 0.19%	+/- 1%
Force accuracy	+/- 5%	+/- 10%	+/- 10%	+/- 3.4%
Data points	50+	30+	35	5
Elongation limit	75%	50%	100%	75%
Total cost	$5000	$7000	$5,578	$3389
Cost per cycle	$10/cycle	$15/cycle	$1.03	$9.40
Cycle time	2 min	3 min	2.42 min	3.45 min
Part sourcing	80% COTS	50% COTS	88% COTS	94% COTS
Assembly Length	12 ft	N/A	11 ft 8 in	13 ft 5 in

Analyis Results



Test Results



Looking Forward

Results: As desired, the prototype high-speed tensile tester demonstrated the viability of a pneumatic propulsion system and magnetic braking system. The design also demonstrated low-cost PVC and instrumentation were not suitable for high-speed tensile testing

Lessons Learned: Manufacturability must be considered when creating a mechanical design. Buffer time to resolve issues should always be built into project schedules.

Future Work: For more consistent high-speed testing at increased speeds, the prototype should be rebuilt with high-pressure steel piping, proper instrumentation, and a reinforced Lexan safety enclosure.

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