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Attenuating Just Enough Impact

Kelsey Fontenot

2.671 Measurement and Instrumentation



Massachusetts
Institute of
Technology

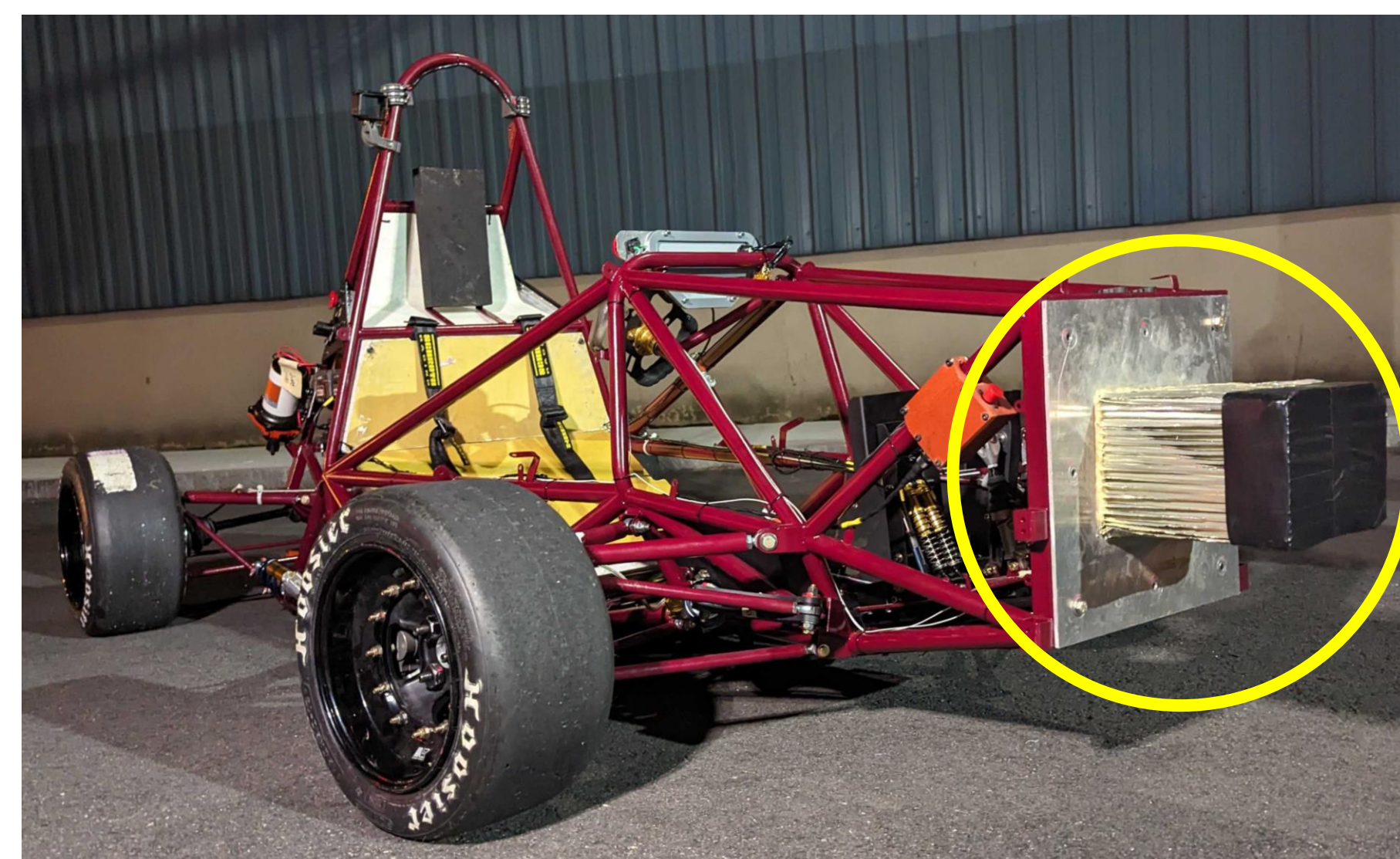
Abstract

Aluminum honeycomb impact attenuators are frontal crash mitigation structures on automobiles, such as racing vehicles in the Formula Society of Automotive Engineers (FSAE) competition. Understanding its mechanical properties will allow FSAE teams to make more informed sizing decisions. 12 honeycomb samples of varying areas were compression tested using an Instron machine. The total energy absorbed, the average force, and the peak force by each sample were plotted against their area. A proportional fit was found to be statistically significant for all parameters. As the area of honeycomb doubled, each parameter also doubled. The fits for these parameters were used to create a 3D visualization, which found the total energy absorbed to be the most important parameter when choosing an area for an FSAE impact attenuator.

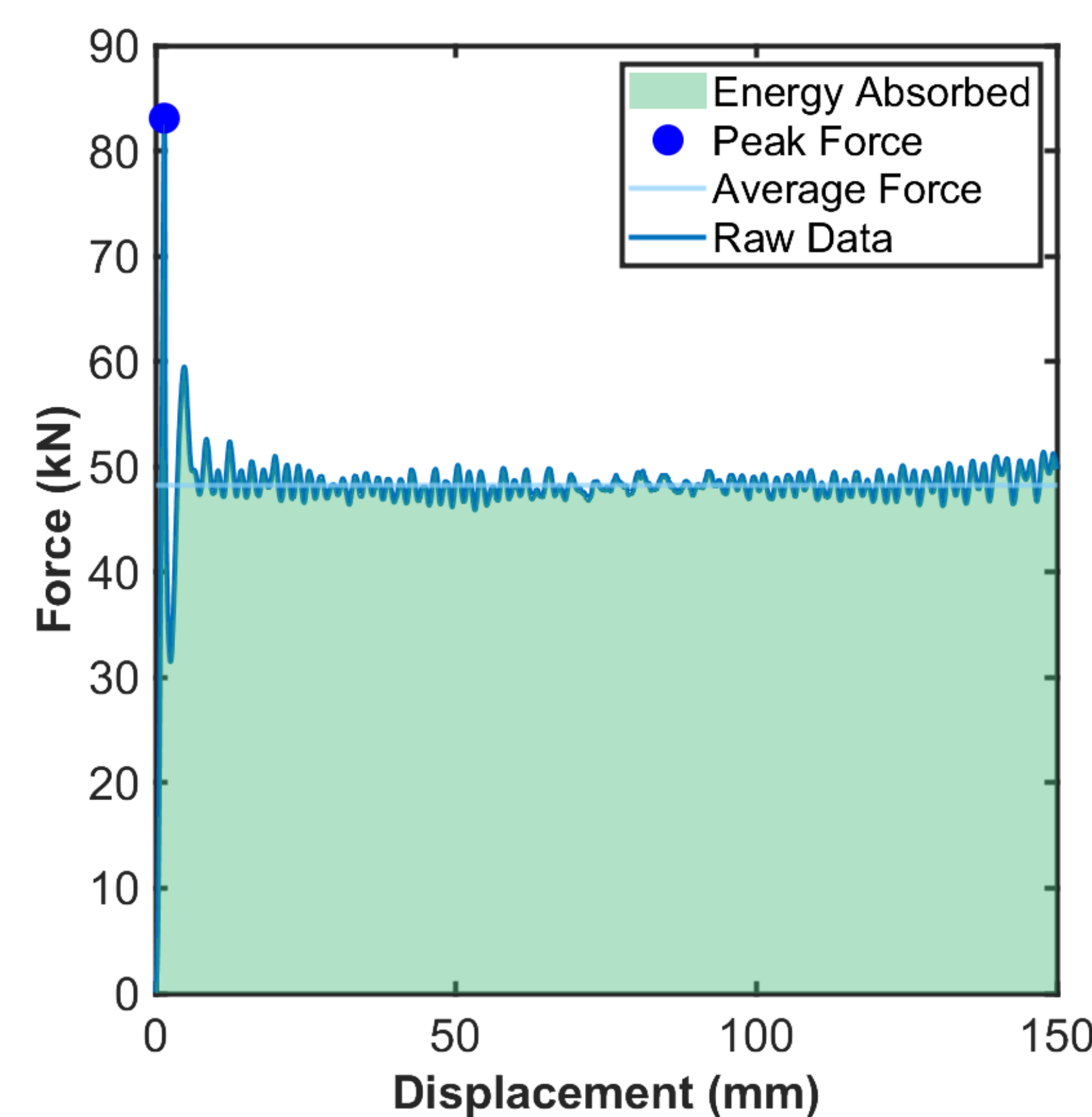
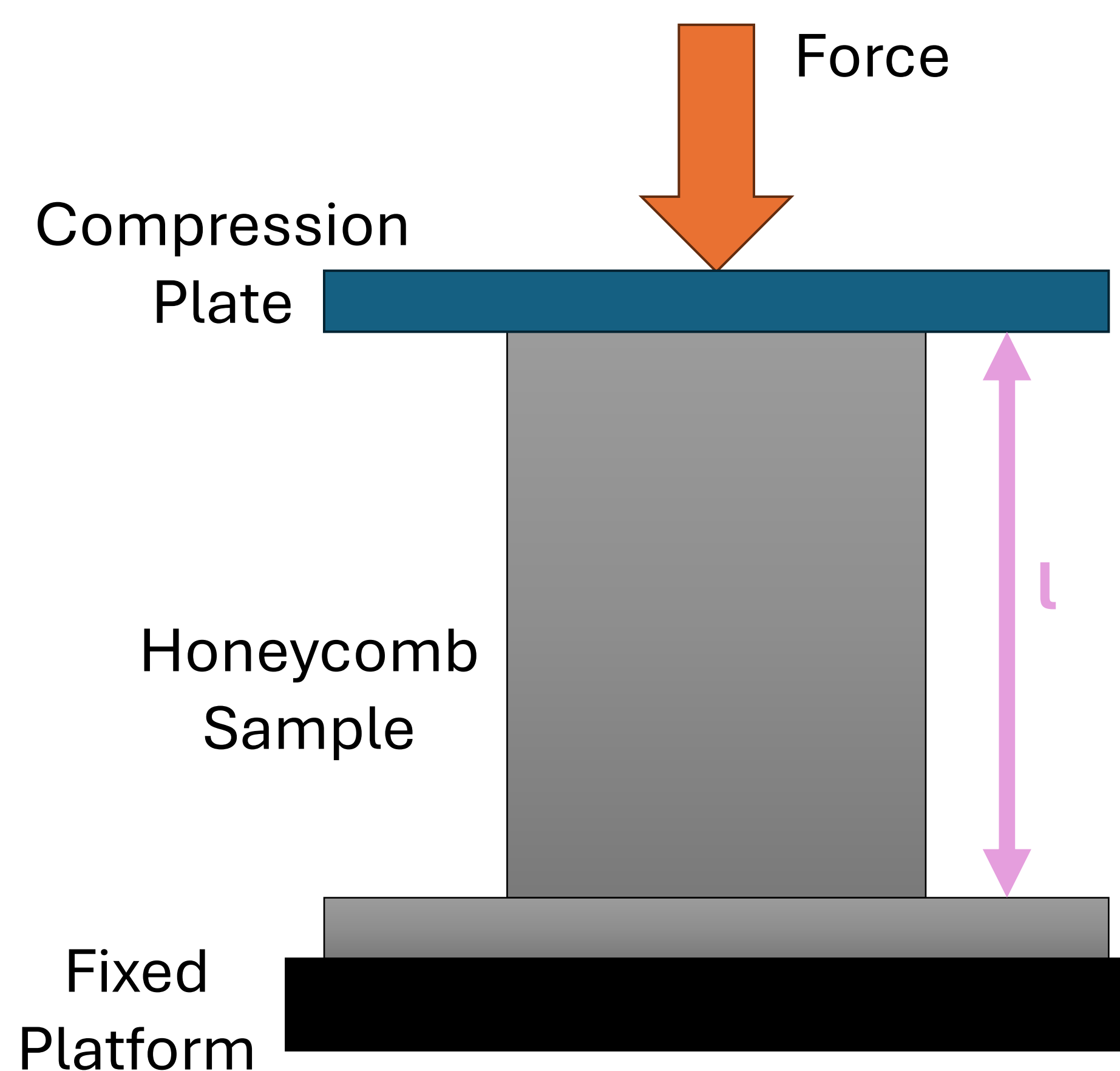
Background

An FSAE impact attenuator must:

- Absorb at least 7350 J.
- Withstand a peak force under 40 g (120 kN) and an average force under 20 g (60 kN).
- Have a minimum height of 100 mm, minimum width of 200 mm, and minimum length of 200 mm. [2]



Instron Setup & Data



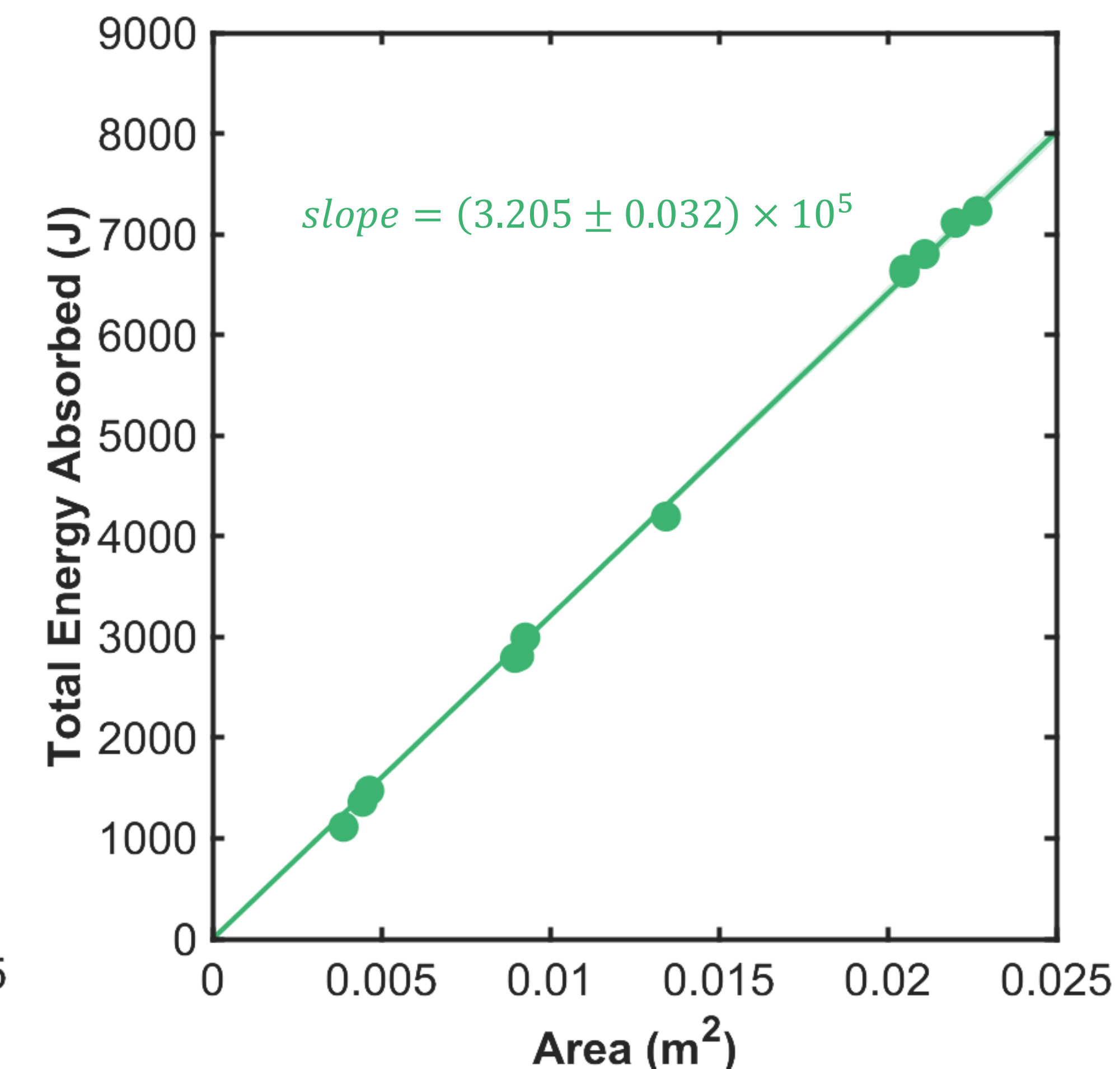
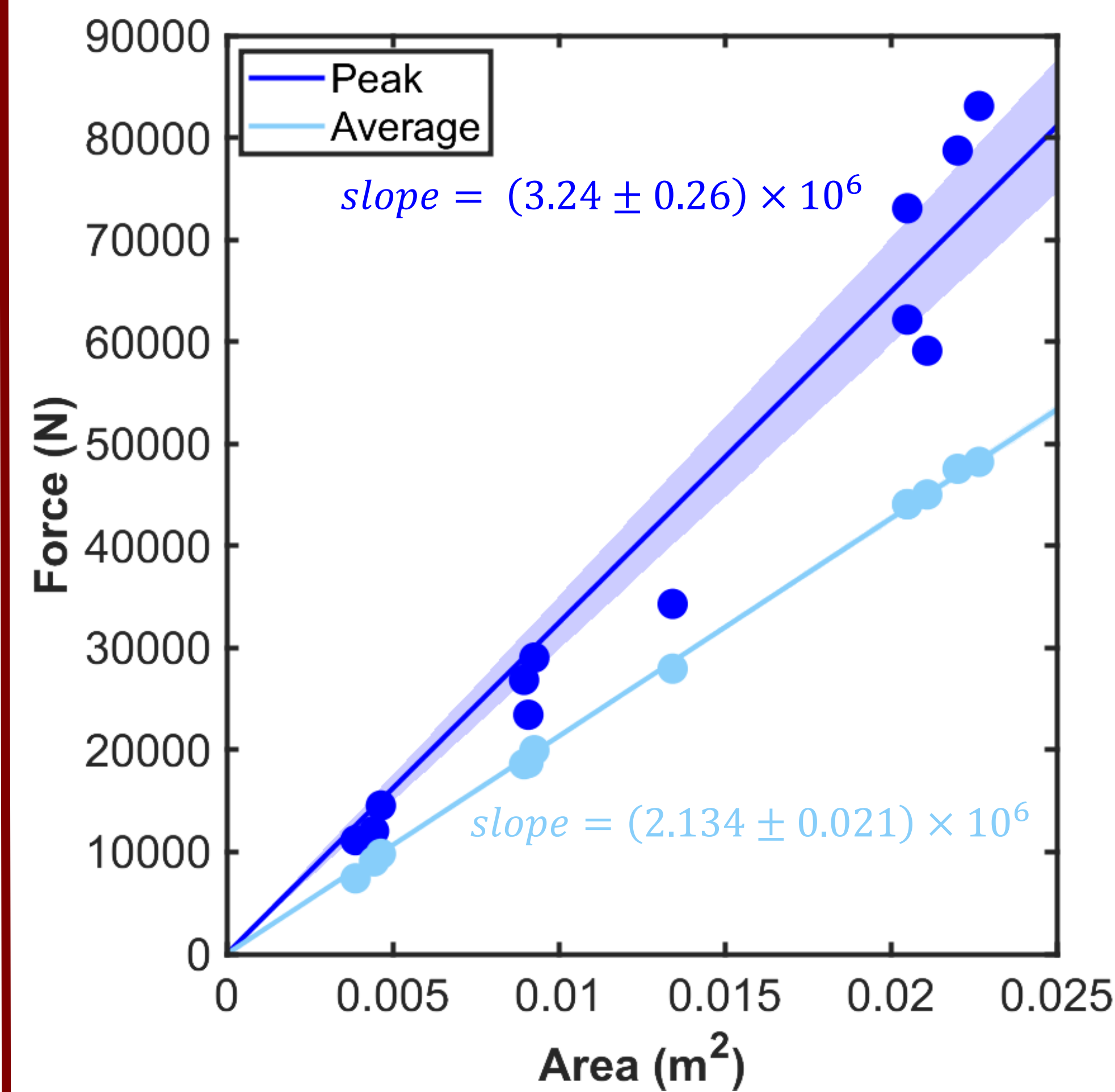
Acknowledgements

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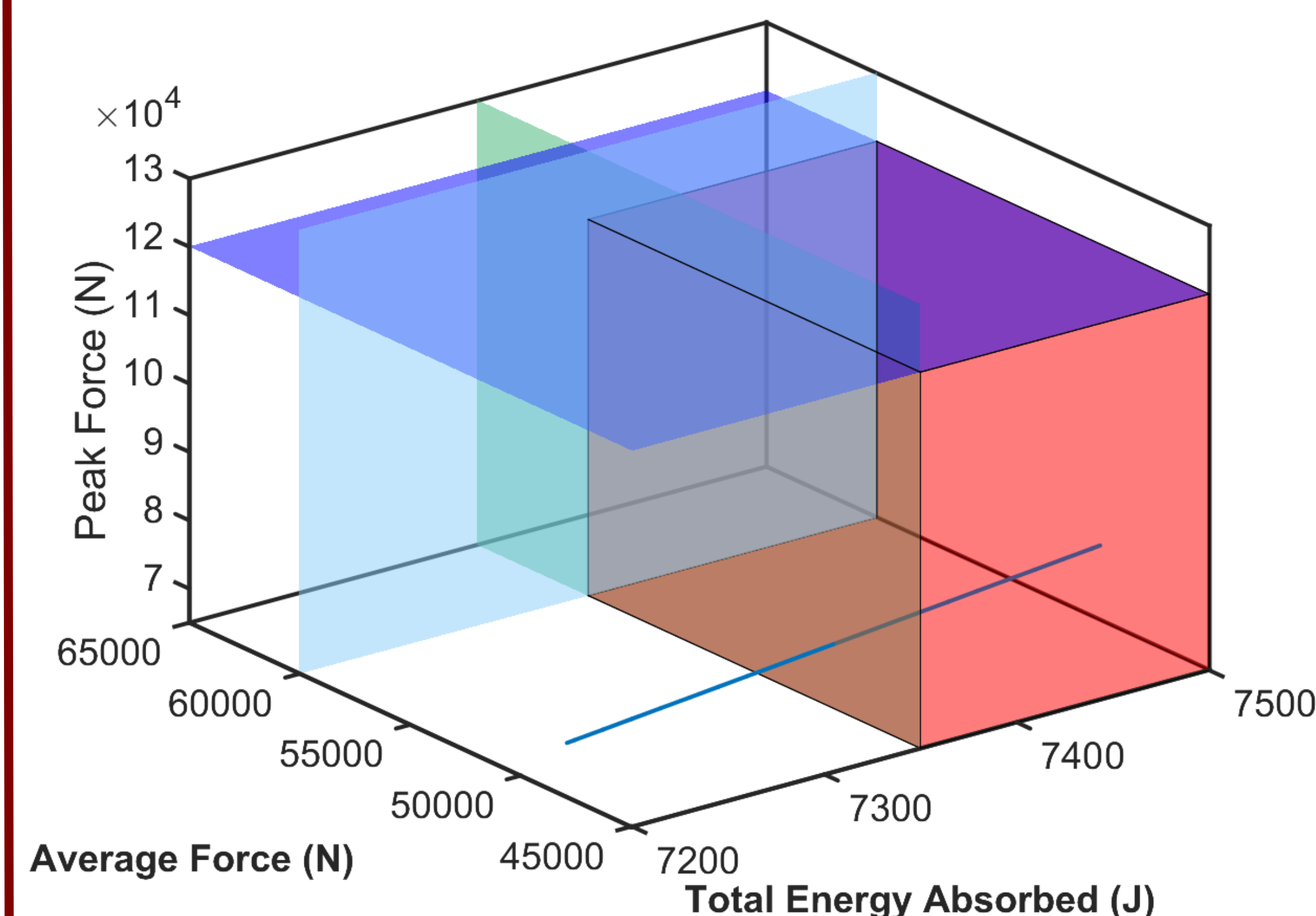
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- [2] Formula SAE Rules 2025. Formula SAE. (2024, August 8). <https://www.fsaeonline.com/cdsweb/gen/DownloadDocument.aspx?DocumentID=349fa543-c65d-467f-ac12-730949d0dc85>. (Accessed 9/14/24)

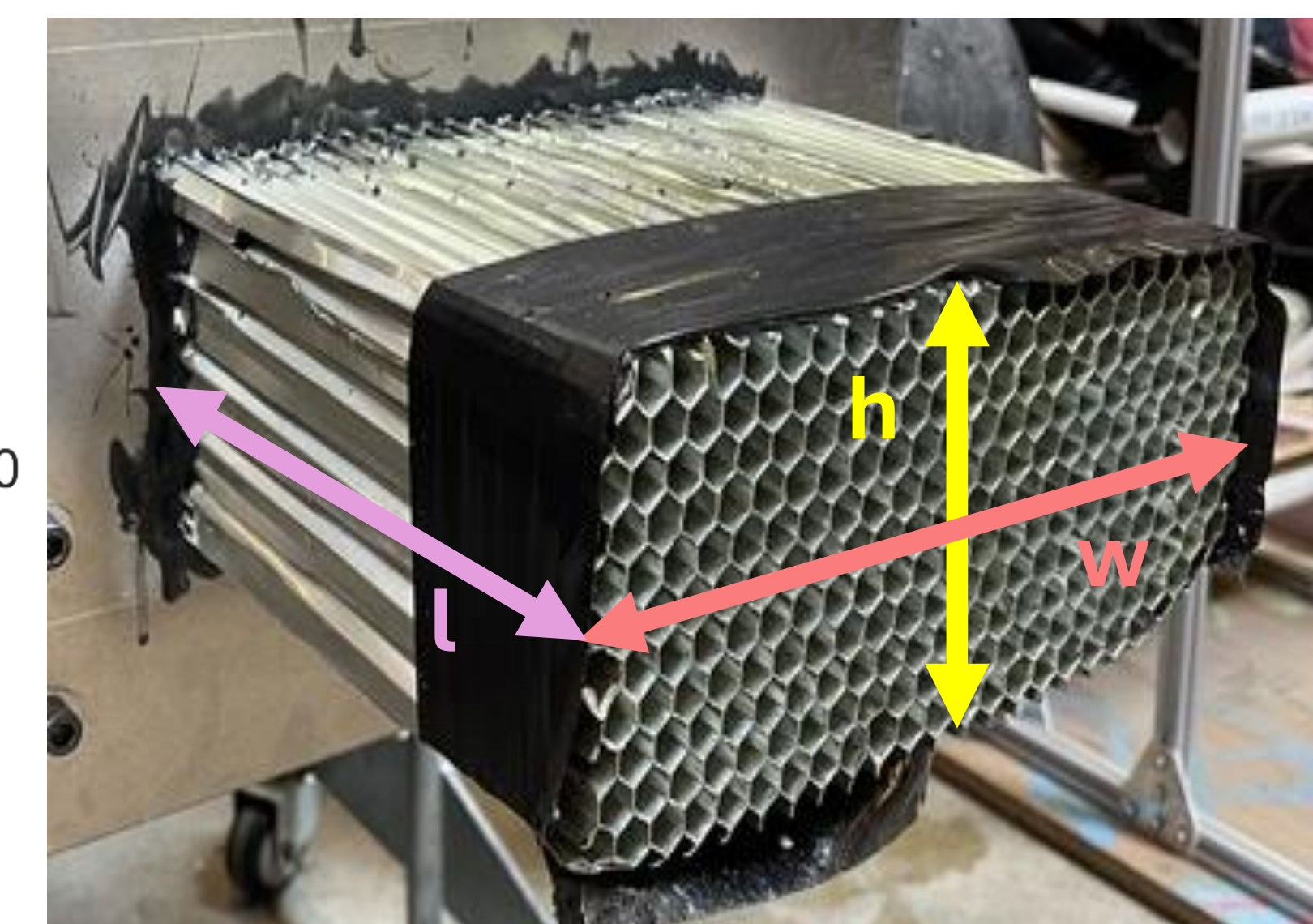
Force & Energy Models



Optimizing Area for FSAE



The minimum area that can pass FSAE requirements is $0.02316 \pm 0.00023 \text{ m}^2$ with height 108 mm and width 215, absorbing 7443 J and withstanding a peak force of 75.59 kN and average force of 49.54 kN.



Conclusions

- The total energy absorbed, peak force, and average force increase proportionally with area of the honeycomb. As area doubles, so does each parameter.
- When deciding the area of honeycomb for an FSAE impact attenuator, the total energy absorbed is the most important parameter.
- The smallest area an FSAE impact attenuator can be is $0.02316 \pm 0.00023 \text{ m}^2$ with height 108 mm and width 215 mm. It can absorb 7443 J and withstand a peak force of 75.59 kN and an average force of 49.54 kN.

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