Abstract
The goal of this experiment was to examine the energy absorption properties of origami-inspired and standard honeycomb structures varying the materials and wall thickness. The results indicate that origami-inspired structures perform best at energy absorption at a higher wall thickness with a rigid material. The results also indicated that standard honeycomb structures perform better with lower wall thickness, but still with a rigid material. In vehicles with structures of a sufficiently high wall thickness with a rigid material, origami-inspired honeycomb structures could be used instead of current structures in order to better protect the passengers.

Background
Previous studies have investigated the energy absorption of origami-inspired structures. Origami-inspired honeycomb structures have been examined on their own [1], as well as in a sandwich structure [2]. A common theme of these studies is that origami-inspired structures seem to have better energy absorption than their standard honeycomb counterparts. Energy absorption is a structural property that acts as a measure of how much impact from a load a structure can take before it reaches densification [3]. This is typically calculated from a force-displacement curve, as shown in the figure below:

Before Testing

TPU Structures

ABS Structures

Results

The first structures were printed from TPU, a flexible material, which was thought to potentially be better at demonstrating the unique properties of origami-inspired structures. While it did demonstrate interesting recovery properties, the origami-inspired structure did not perform better at energy absorption until the highest wall thickness. Overall, standard honeycomb structures performed better when made of TPU. A sample of the force-displacement curves are shown below:

Displacement vs. Force at 2mm Wall Thickness (TPU)

Displacement vs. Force at 2mm Wall Thickness (ABS)

Conclusion
It was determined that origami-inspired structures are best suited for energy absorption at higher wall thicknesses with ABS. Additionally, the folding and recovery properties of the origami-inspired structures were much better demonstrated with TPU. This research has applications wherever honeycomb structures are used. In vehicles with a sufficiently high wall thickness, these origami-inspired honeycomb structures could be used in place of current ones to better protect passengers and delicate payloads, especially in aerospace vehicles where these structures are commonly used.

References

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