Scooter Solutions

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Abstract

Scooter Solutions is a composite structured chassis designed to be connected to a two-wheeled small engine vehicle for the purpose of transporting cargo and passengers. Manufactured using woven carbon fiber/epoxy panels with an XPS foam core and Aluminum 6063-T5 framing, the structure must be light for user practicality and reducing engine wear while maintaining adequate strength for the passenger load and debris deflection while exposed to the natural environment.

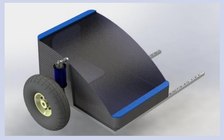
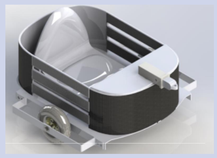
This product is unique due to its carbon fiber reinforced foam sandwich panels with a two-part epoxy matrix allowing for a lighter, more durable side car than its contemporaries. The lightweighting is achieved via novel carbon composite construction in substitution of the steel and thick fiberglass used by competitors in this market.

Meet The Team

Design Concerns

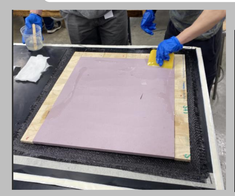
Design Concerns Categories	Design Concerns	Assessment Definition:	Assessment: Requirement	Design 1	Design 2
Physical	Leisure adjustment	Uses: (Pet, Person, Cargo)	Holds Pet	Holds Pet, Cargo	Holds pet, Cargo
Physical	Lightweight	Weight of Sidecar/ Trailer(lb)	120lb	26.05	94.1
Structural	Able to withstand rocks, bugs, rough roads, and other terrain on multiple occasions for rider or cargo protection	Limited Damage on impact of debris (lb/f)	Withstand debris impact and rock impact	Izod and Charpy impact Test	Izod and Charpy impact Test
Structural	Adequate strength	Failure load applied to Sidecar/Trailer (lb)	200lbs	3-point test	3-point test
Environmental	Will not degrade due to UV exposure	Be able to be in the sun for long periods of time.	90% Retention	Little/no degradation physically or to material properties from UV radiation	Little/no degradation physically or to material properties from UV radiation
Human Engineering	Accessibility to Storage	Space allowed to hold Objects (L)	50L	213.94951 L	154 L
Life Cycle	Easy maintenance	Ability to maintain the same lifecycle as a Scooter (Years)	10 Years	Equal stress fatigue and impact strength as Scooter. Service checks every 250 miles	Equal stress fatigue and impact strength as Scooter. Service checks every 250 miles
Life Cycle	Easy to service	Time to disassemble and assemble main components (Sidecar/Trailer Connection) (min)	Minimum	Might require tools to disassemble.	Easier to detach and roll of quicker.
Cost	Affordable price	Cost plus profit margin of 25% ($)	$2,000	Price for this design is Lower	Higher price

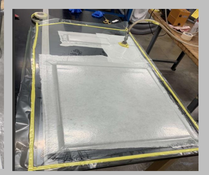
Design Alternatives

#1	#2
	

Manufacturing

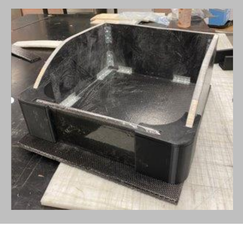
Wet Hand Lay-Up





This was performed to make the main body of the sidecar. Utilized XPS foam and wooden inserts in some areas to allow for modular assembly

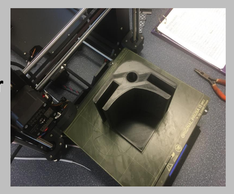
Scale Model



A Scale model was fabricated to practice implementing all manufacturing methods.

3D Printed Parts

3-D printed parts were fabricated using carbon reinforcement for front corner bracket supports and ease of assembly



Assembly

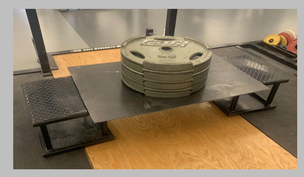
All panels were assembled with epoxy adhesive and mechanical fasteners.

Frame

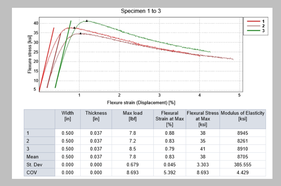
The frame was constructed with aluminum bar stock and a steel connecting plate. They were assembled together with adhesive and mechanical fasteners

A steel rib was welded for support. The wheel and axle were attached to the steel plate through bolted pillow bearings.

Qualification Testing

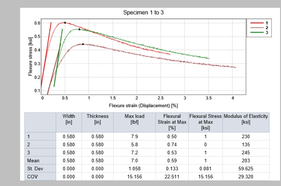


Four tests were conducted to assess the quality of the parts produced. These tests were: the three-point bend flexural test with a large flat lay-up panel, three-point bend flexural test on smaller rectangular strip specimens exposed to different environments such as UV and water exposure, impact tests utilizing a free fall fixture with weights, and an impact test using rocks. Both three-point bend tests resulted in adequate strength with the large panel withstanding upwards of 900 lbf and the UV exposed samples maintaining over 90% of their original mechanical properties. The free fall impact test caused some damage with an energy of around 34 ft-lb on impact (far exceeding which the impact force any typical debris would inflict on the side car). A more realistic rock impact test was conducted, and it showed no visible damage to the panel used.



	Width [in]	Thickness [in]	Max load [lbf]	Flexural Strain at Max [%]	Flexural Stress at Max [psi]	Modulus of Elasticity [ksi]
1	0.500	0.037	7.8	0.88	38	8945
2	0.500	0.037	7.2	0.83	35	8261
3	0.500	0.037	8.5	0.79	41	8919
Mean	0.500	0.037	7.8	0.83	38	8705
St. Dev	0.000	0.000	0.679	0.045	3.303	385.555
COV	0.000	0.000	8.693	5.392	8.693	4.429

Control Flex Test Data



	Width [in]	Thickness [in]	Max load [lbf]	Flexural Strain at Max [%]	Flexural Stress at Max [psi]	Modulus of Elasticity [ksi]
1	0.580	0.580	7.9	0.58	1	230
2	0.580	0.580	5.8	0.74	0	135
3	0.580	0.580	7.2	0.53	1	245
Mean	0.580	0.580	7.0	0.59	1	203
St. Dev	0.000	0.000	1.956	0.133	0.681	59.625
COV	0.000	0.000	15.156	22.511	15.156	29.328

UV Flex Test Data

Final Design

Final assembly was performed with mechanical fasteners and 2-part epoxy adhesive

Conclusions

The final sidecar design is constructed utilizing both a carbon fiber body and an aluminum frame for weight reduction which is mounted to the sidecar via a steel plate. Great option for trips with more to carry or a pet to transport on a small engine scooter.