SAE Baja Suspension System

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SAE INTERNATIONAL

Project Description

Competition background:

Society of Automotive Engineers (SAE) Baja is a collegiate level competition that simulates real world engineering design and manufacturing challenges. Students are tasked to design and build an off-road vehicle that will survive the severe punishment of rough terrain.

Scope:

Design and fabricate a suspension system to compete in the SAE Baja competition. The SAE Baja car will require a suspension system adequate for continued use during multiple competition events. The suspension system shall meet the requirements set by the 2024 competition rule book and metrics decided from user needs testing.

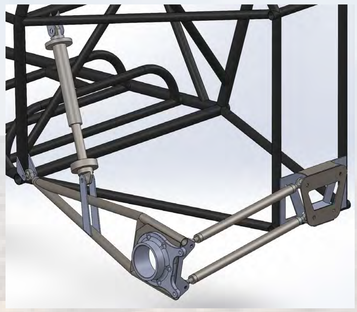
Design Metrics

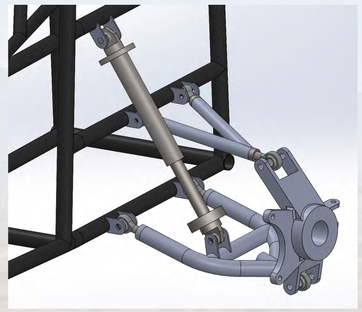
Front Suspension		
Metric	**Desired**	**Achieved**
Track Width (in.)	57	57.5
Static Camber (deg)	-3	-0.75
Camber Change (deg) (Compression, Extension)	-8, 2	-9.6, 3.7
Castor (deg)	6	6.3
Ground Clearance (in.)	12.5	12.6
Wheel Travel (in.)	14	13.7

Rear Suspension		
Metric	**Desired**	**Achieved**
Track Width (in.)	56	55.9
Static Camber (deg)	-2	-2.9
Camber Change (deg) (Compression, Extension)	-6, -1	-9.4, -2
Static Toe (deg)	1	2.3
Toe Change (deg) (Compression, Extension)	0.5, -1	0,0-.2
Ground Clearance (in.)	12.5	13
Wheel Travel (in.)	14	15

Design

The front suspension features a double A-arm design, enabling increased camber throughout the travel to maximize tire contact during corners. The rear suspension uses a 3-link system, which adjusts the toe angle of the rear wheels to aid in turn initiation while braking and maintain straight-line stability during acceleration.





Materials:

Tubing is 4130-steel chosen for its higher yield strength compared to mild steel. The universal joints are made from 52100 chrome plated steel. Hardware used is grade 8 fine thread bolts and locknuts.

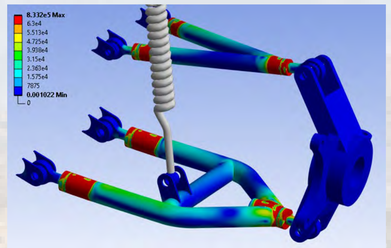
Fabrication:

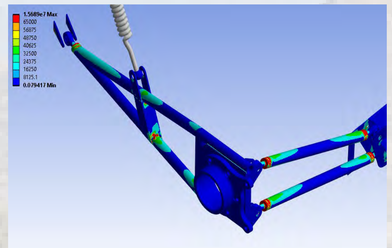
Team members manufactured and assembled the suspension components in the senior design lab on campus. Mounting brackets were cut using a CNC plasma table and finish-sanded for precision. The 4130 tubing was cut with a horizontal band saw and hand-notched using paper templates. All parts were TIG welded using ER80S-D2 filler material for maximum joint strength and fatigue life.

Computer Modeling

Structural FEA:

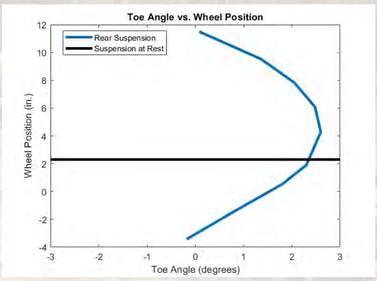
Stress analysis was conducted using Ansys Static Structural software to evaluate the structural integrity of our design under anticipated competition load scenarios. The yield strength of the 4130-steel used for our components is 63,000 psi. Load values were estimated based on past competition data and anecdotal evidence.

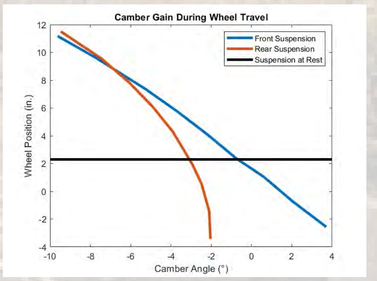




Motion Studies:

Motion studies were conducted in SolidWorks to verify proper suspension geometry and ensure no interference between components or with the chassis. Below are figures showing the camber and toe angles as a function of wheel position, with the wheel position of 0 representing the bottom of the frame.





Conclusion

The design, fabrication, and testing of the SAE Baja suspension system successfully met the requirements for competition. The front and rear suspension systems were optimized to improve handling and durability under challenging conditions. Stress analysis and motion studies verified the structural integrity and proper functionality of the design. Through careful material selection and precise fabrication, the team achieved suspension performance metrics that align closely with the project goals.