Society of Automotive Engineers Baja Competition

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Rear End Sub-system Team

Joey Barta, Lars Jensen, Seth DeLuca

Department of Mechanical Engineering, Northern Arizona University, Flagstaff, AZ 86011

NAU Northern Arizona University Mechanical Engineering

SAE International

Abstract

The Baja Collegiate Design competition is an event hosted every year by the Society of Automotive Engineers (SAE) to develop a four-wheel drive vehicle that meets the robust requirements of the competition. The Rear suspension team is tasked with the design of the suspension in the rear of the vehicle. The decision to have a trailing link suspension came from rigorous research and planning. A trailing link usually consists of three main members, the trailing arm and two camber links. The team successful designed a robust and durable suspension capable of supporting the vehicle over rough terrain while maximizing output from the rear powertrain.

Requirements

- Decrease overall vehicle weight
  - Rear Suspension subassembly under 75 lbs including wheels, tires, and CVs
- Increase rearward axle path
  - Rear wheels move backwards at least 1" when the suspension is compressed
- Increase linkage radii
  - Camber links ≈ 18" (pivot to pivot) to decrease the change in camber angle
- Decrease CV axle angle
  - Maximum 20° of angle change to increase the lifespan of the purchased CV axles during the competition
- Vehicle width
  - Maximum track width under 64" to meet SAE Baja competition requirements and pass inspection
- Increase ground clearance
  - Minimum ground clearance = 8" when the shocks are fully compressed to minimize damage to the car's undercarriage
- Decrease camber link angle
  - Angle 15° from centered to prevent binding issues
- Increase camber gain
  - Design suspension geometry for ≈ 0.25" longer lower camber links

Methods

The design process started be researching successful suspension systems from previous SAE Baja competitions and deciding which platform to move forward with. The final decision is a trailing arm suspension system with two rear camber links and plunging CV axles. The geometry was created in coordination with the frame team and validated using Lotus SHARK software. The SHARK software allowed for quick dimension changes until the desired travel, camber angles, and toe angles were achieved. The structure of the trailing arm was designed in SolidWorks software with the use of FEA analysis to validate the final design.

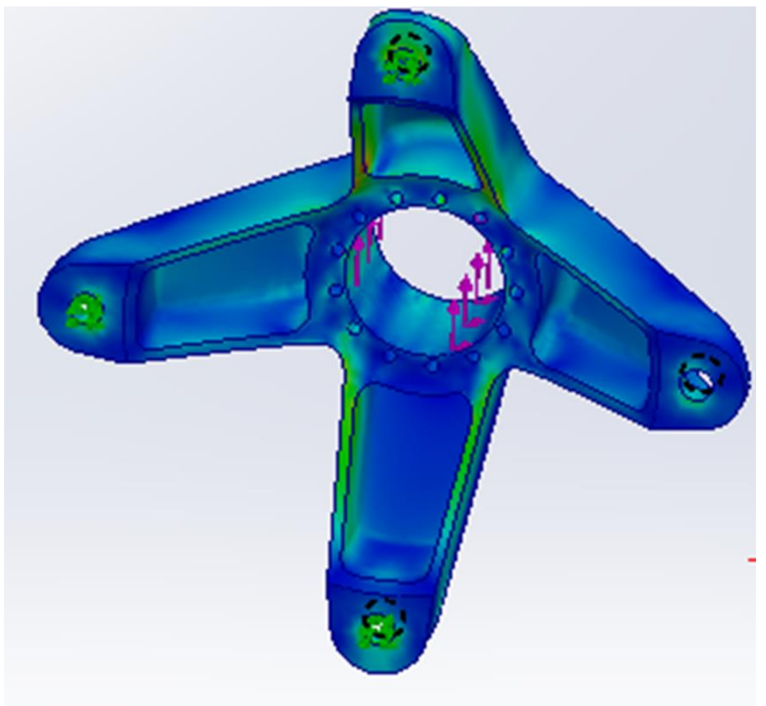

Figure 1: Hub FEA

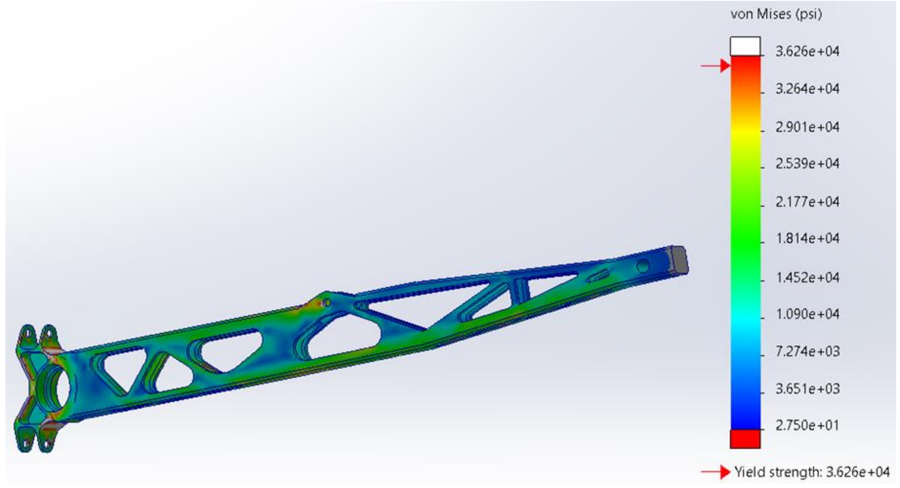

Figure 2: Trailing Arm FEA

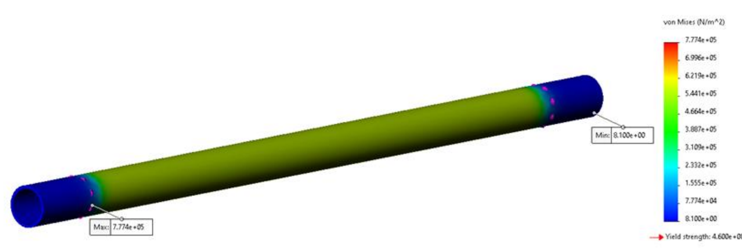

Figure 3: Camber Link FEA

Results

The final trailing arm is a mixture of 0.125" and 0.25" laser cut A36 steel plate welded together at all seams. The front of the trailing arm contains a milled steel insert for the rod end to screw into. The knuckle is milled from 4140 steel to fit the CV axle assembly and camber link rod ends. The finished knuckle is welded to the boxed trailing arm using a 3D printed jig to ensure the correct geometry is achieved. The shock is directly mounted to the trailing arm with 0.375" hardware. The upper camber links are constructed out of carbon fiber tubing and 6061 aluminum inserts fastened by epoxy during final production. The bottom camber links are made from 4130 1" outer diameter, 0.035" wall thickness tubing welded to steel inserts at both ends to attach the rod ends. The entire suspension system is attached to the frame with 0.125" A36 steel tabs.

Figure 4: Final Assembly

Figure 5: Final Subassembly

Conclusion

The rear suspension design is crucial to the performance of the vehicle as is its implementation. The rear-end team utilized Lotus SHARK software to analyze various suspension designs and then SOLIDWORKS modelling to test compatibility of components that satisfied the proven geometry. Following this, a design capable of withstanding the most extreme forces the vehicle could experience during competition was developed and revised to minimize weight. Working alongside the drivetrain and frame sub teams, the team developed a design that simultaneously increased travel and developed a smoother radius of suspension travel by increasing distance between pivot points of the trailing arm and camber links.

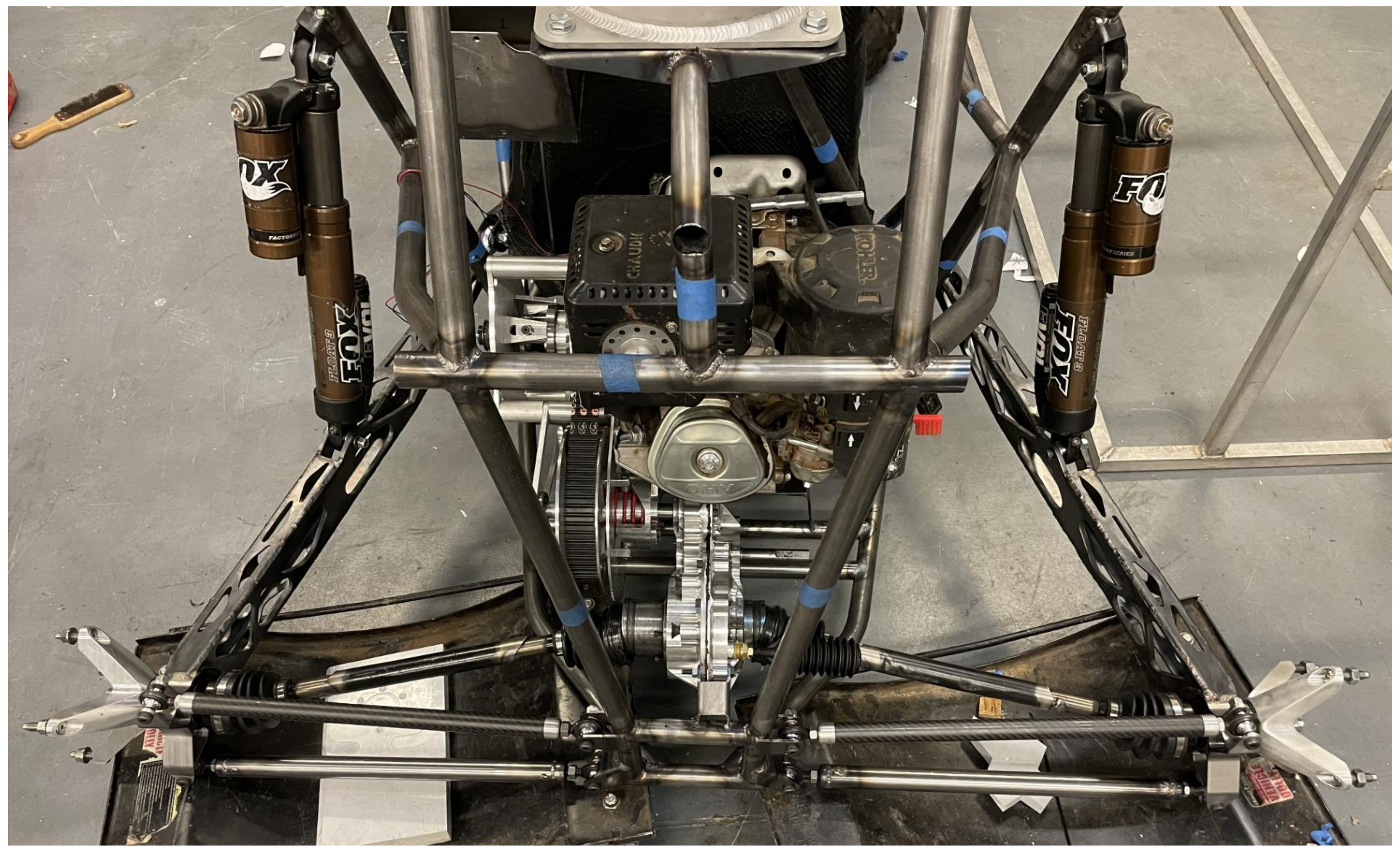

Figure 6: Manufactured Assembly

References

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