Raider Racing SAE-BAJA 12-13

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Abstract

Baja is an off-road vehicle collegiate competition. This year the BAJA team has a redesigned frame, drivetrain, and suspension systems. The BAJA vehicle is using a hydrostatic transmission donated by Poclain Hydraulics. A 10hp engine running at constant speed will drive a variable displacement pump outputting flow to a hydraulic motor. The frame is setup for a side-mounted engine yielding a high degree of maneuverability in terms of the hydraulic drivetrain orientation and positioning. The BAJA's suspension redesigned the entire front suspension with an emphasis on reducing weight, and improving the reliability and handling. The suspension has chosen a double A-Arm to minimize weight.

Introduction

The Society of Automotive Engineers (SAE) Baja series is an intercollegiate off-road competition in which over 300 teams participate. Each team must use a stock 10 horsepower Briggs & Stratton engine for their vehicle. Students must function as a team to not only design, build, test, promote, and race a vehicle within the limits of the rules, but to also generate financial support for their project and manage their educational priorities. A vehicle's rank is based on grading criteria from both dynamic and static events. The dynamic driving events are acceleration, towing, rock crawl and endurance. The static events are design evaluation, cost report, prototype cost, and presentation. In order to compete, SAE requires passing an in depth technical inspection.

2011-2012 MSOE Baja vehicle at competition

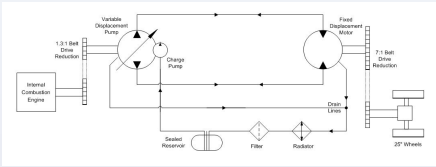
Design Requirements

- Reduce vehicle weight
- Comply with SAE Baja rules
- Top speed of 30 MPH
- Peak torque of 450 ft-lb_F
- Survive a load equivalent to a 3 to 4 foot drop without failure
- Low center of gravity, 50/50 weight distribution

Sub-Teams

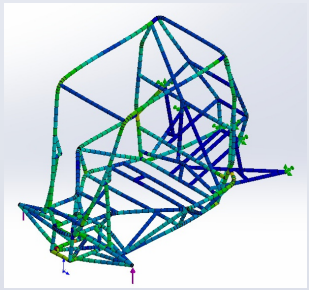
Drivetrain

The design objectives were reduce weight, develop a favorable gear reduction, ensure component performance and compliance, and design/tune the controller system. The hydrostatic transmission includes Poclain PM-10 variable displacement axial piston pump; Poclain PMV-2 constant displacement axial piston motor; SmartDrive Easy Plus controller; and various sensors and hosing. The hydrostatic transmission has a high power density thus achieving a maximum velocity of 30 MPH and peak torque of 535 ft-lb_F. The vehicle will have significant advantage in towing and rock crawl events, however the weight of the hydraulics will make the vehicle have an average performance in the speed events.



The Baja vehicle hydrostatic transmission circuit

Frame



Finite Element Analysis loading and constraint method through ANSYS

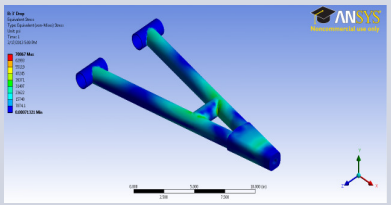
The focuses of the frame are reducing the weight, center of gravity, keeping the driver safe, and keeping Baja vehicle compact and maneuverable. The frame was redesigned to allow for a side mounted engine, a compact drive train system and modified suspension system. The frame utilized ANSYS for stress analysis (Picture on the left) and optimized the frame for weight reductions by using secondary members at lower stress areas. The side mounted engine accomplishes several goals: high degree of maneuverability for component location, center of gravity is centrally located and closer t on the ground for a better performance in turns and better stability thus resisting rolling over.

Specifications:

- Constructed of 1026 tubular steel. Primary members: 1.25 in. dia. and 0.065 in. wall thickness. Secondary members: 1.00 in. dia. and 0.065 in. wall thickness.
- Side mounted engine for improved center of gravity.
- Bare frame weight = 100 pounds.
- Incorporate previous year's rear suspension.

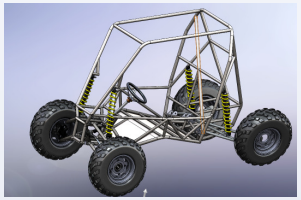
Suspension

The goal for suspension is to minimalize weight while still maintaining a durable, reliable and inexpensive design. A double A-arm suspension was utilized for the specific events of the Baja competition. The double A-arm suspension offers more options for mounting the shock while decreasing complications with the tire-rod. The front suspension is designed to survive a three foot drop, as well as meet the design goals of: 10-14 inches of travel at the wheel, and a turning radius of 7-14 feet. The Figure to the right is an analysis done in ANSYS to determine the stresses in the A-arm from a 3 foot drop.



ANSYS analysis of equivalent stress from a 3 foot drop on the Vehicle's A-arm

Final Vehicle Performance



3d Model of the Baja Vehicle using SolidWorks

Top Speed: 29.85 MPH
Peak Torque: 534.75 ft-lb_F
0-100 Feet: 4.117 Seconds
0-150 Feet: 5.374 Seconds
0-15 MPH: 1.465 Seconds
0-Top Speed: 5.91Seconds
Overall Gear Ratio Range: 9:1 – 50:1

Sponsors

The Baja team acknowledges the contributions from its top sponsors. Our Thanks to Poclain Hydraulics for their generous donation of components and microprocessor for the hydrostatic transmission. Gates for their donation of gear and pulley system, and hydraulic transmission lines. Signicast and Mykonos for a generous monetary donation.