SAE Baja - Front Suspension Team

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SAE Mini Baja

Common Denominator
- Engine Size
- Max Track Width

Dynamics Events
- Maneuverability
  - Tight turn course
- Acceleration
- Breaking
- Rock Climb
  - Wheel travel
- Endurance
  - 4 hour
  - Variable terrain
Front Suspension and Steering

Objectives:

Front Suspension

1. Design robust suspension components
2. Simplify suspension design
3. Maintain proper wheel geometry throughout travel
4. Reduce weight

Steering

1. Curb-To-Curb Turn Radius of 10 ft
2. Lock-to-Lock Steering Wheel Rotation of 360°
3. Improve geometry to reduce bump steer
4. Reduce understeer
A-Arm Geometry

Design Goals

• Simple geometry
• 10" ride height
• Threaded ball joints
• Jig and cope manufacturing process

Design Challenges

• Coping at ball joint attachment

Front of Vehicle

Upper A-Arm

Top View

Lower A-Arm

Front View
A-Arm Material Selection

**Lower A-Arm**
*Material: 4130 Chromoly*
- good weldability

*Dimensions: 1”OD x 0.065” Wall tubing*
- bushing selection
- tapped ends for ball joints

*Weight: 1.86 lbs/A-Arm (0.6576 lbs/ft)*

**Upper A-Arm**
*Material: 4130 Chromoly*
- favorable strength:weight ratio
- good weldability

*Dimensions: 1”OD x 0.065” Wall tubing*
- tapped ends for ball joints
- capable of 2.5G load

*Weight: 2.81 lbs/A-Arm (0.6576 lbs/ft)*
Manufacturing

- A-Arms
  - Jigs
    - Upper and lower A-arm jigs to hold mounting points in correct locations
  - Hand coped tubing
  - 100% student welded
  - Ball joint sleeves
    - Turned, threaded, and back drilled by students
  - Mounting Tabs
    - Water Jet Part
    - Fitted for each arm

- Steering Mechanism
  - Rack Extensions
    - Machined equal lengthed extension pieces by students
    - Drilled and tapped by students
  - Clevis Head
    - Turned down to length and tapped by students
  - Tie Rods
    - Turned down to length, drilled and tapped by students
Suspension Geometry

Caster (~9°)

- A large positive caster angle will cause the steering to feel heavy at low speeds yet makes the vehicle stable at high speeds.

- A small positive caster angle makes the vehicle steer easily at low speeds at the forfeit of high speed stability.
Suspension Geometry

Camber (adjustable)

- Adjustable via threaded 90° ball joints.

- Negative camber will cause the vehicle to be more stable at speed as well as increase cornering ability compared to 0°.

Source: www.bestcoiloverguide.com
Suspension Geometry

Toe (adjustable)

- Adjustable via steering links

- Toe-in causes high speed stability and initial understeer in a corner.

- Toe-out causes high speed instability and initial oversteer in a corner.

Source: www.superstreetonline.com
Spindle Fork

- 1018 Steel Spindle Fork
  - CNC Machined

- 1018 Steel Spindle Shaft
  - Designed to fit Polaris 525 front wheel bearings

- Tapered Ball-Joint Mounts
Spindle Assembly

- Bolt on caliper mount
- Polaris Outlaw 525 Hub
- Adjustable tie rod mounting
Steering Angle

- Steep enough steering angle to achieve 10 foot curb-to-curb turn radius.

- Using the equation below to solve for average steering angle.

\[
cot(\delta) = R_1 \times L
\]

\[\delta = 37^\circ\]

- Ackerman Angles (From Model)

\[\delta_i = 41.1^\circ\]

\[\delta_o = 33.2^\circ\]
Rack and Pinion Set-Up

Positives:
• Cost effective
• Lightweight
• Manufactured for Mini-baja
• 315° lock-to-lock
• Achieves Curb-To-Curb Turn Radius Objective
• Throw Length: 4.50"

Negatives:
• Overall rack length
Steering Model
Steering Design