# Formula SAE suspension System

Alec Barrett, Caden Thatcher, Joonyup Kwon, Kibin Park
Department of Mechanical Engineering, University of Utah, UT, USA

Department of MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

## Introduction

Our project group's ultimate goal is to develop a suspension design that can be used on the Formula U Racing Club's next-generation electric vehicle. The primary requirement of our design is that it can be installed on a new chassis design that is being developed concurrently with this project. Additionally, the new suspension system must comply with the FSAE rulebook, have good durability, and have desirable suspension characteristics.

## Specifications

| Item | Value |
|---|---|
| **Front Kingpin Axis Angle** | -2.353˚ |
| **Front Scrub Radius** | 27.768 mm |
| **Front Caster Angle** | +2.923˚ |
| **Front Mechanical Trail** | 11.667 mm |
| **Rear Kingpin Axis Angle** | -2.249˚ |
| **Rear Scrub Radius** | 56.529 mm |
| **Rear Caster Angle** | +1.759˚ |
| **Rear Mechanical Trail** | 7.049 mm |
| **Front Track Width** | 1262 mm |
| **Rear Track Width** | 1392 mm |
| **Wheelbase** | 1684.47 mm |

Using OptimumKinematics, we were able to design a double-wishbone suspension system that can be used with the new chassis design. Our system retains many of the same characteristics of previous years' suspensions, with a decrease in the front scrub radius of more than 50%. This model was translated into a Solidworks assembly that was used for FEA analysis.

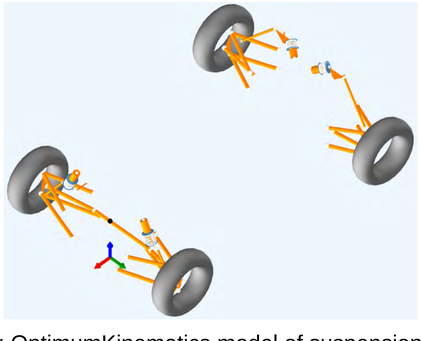

Figure 1: OptimumKinematics model of suspension system

## Analysis (front)

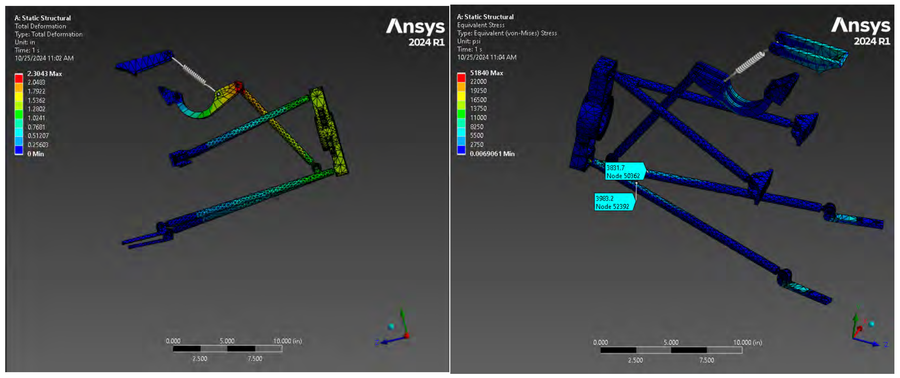


Figure 2: FEA model Displacement (left) & Stress (right)

Under 1G loading (186 lbf), the front suspension system with a 450 lbf-in spring rate experiences 0.724 inches of compression, closely matching the expected 0.728 inches based on calculations, demonstrating alignment with real-world behavior. ANSYS analysis shows a maximum stress of 3900 PSI under 1G, which scales linearly to 11,700 PSI under the 3G design constraint. Since the yield strength of 4130 Steel is 66,000 PSI, the front suspension system safely passes the 3G design requirement.

## Analysis (rear)

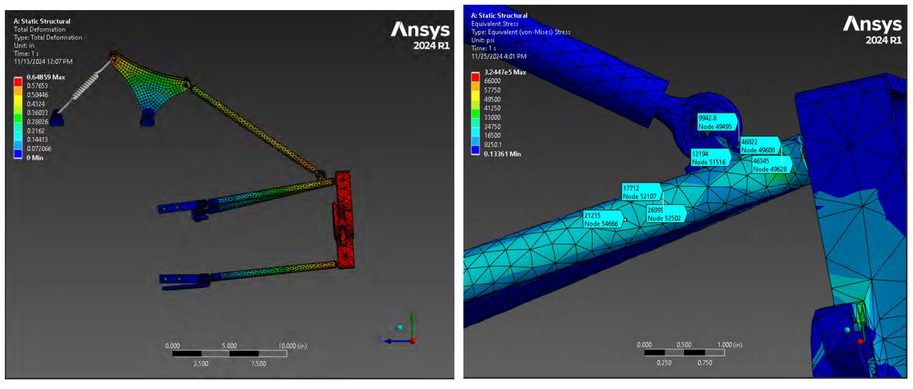


Figure 3: FEA model Displacement (left) & Stress (right)

For the rear suspension, we conducted a similar FEA test under 1G loading (265 lbf) to evaluate the performance of the A-Arms. Using a spring rate of 450 lb-in, the spring experiences 214.33 lbf in compression, corresponding to a calculated deflection of approximately 0.52 inches. The ANSYS simulation, however, shows a slightly lower deflection of 0.41 inches, indicating consistent and reliable results that align with expected real-world behavior. Under 1G loading, the maximum stress observed in the A-Arms is 15,333 PSI. Since the system behaves linearly, the stress scales to 46,000 PSI at the design constraint of 3G. Given that the yield strength of 4130 Steel is 66,000 PSI, the rear suspension system safely meets and passes the 3G design requirement.

## FEA Results

| | 1G | | 3G | |
|---|---|---|---|---|
| | **Front** | **Rear** | **Front** | **Rear** |
| **Load** | 186 lbf | 265 lbf | 558 lbf | 858 lbf |
| **Spring rate** | 450 lbf-in | 600 lbf-in | 450 lbf-in | 600 lbf-in |
| **Max Stress** | 3,900 psi | 15,333 psi | 11,700 psi | 46,000 psi |

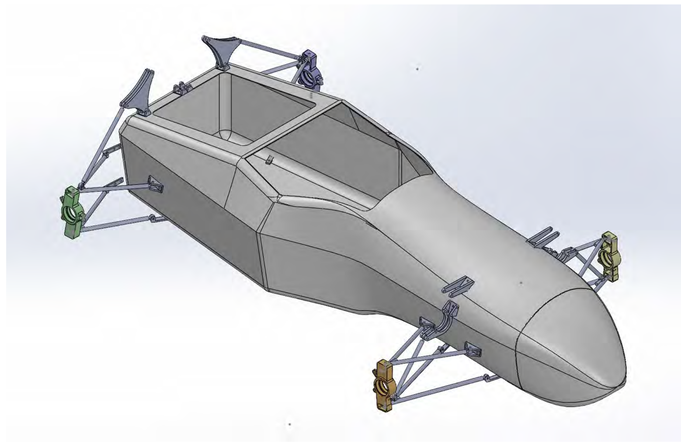

FIgure 4: whole assembly suspension with chassis

## Conclusion

The stress analysis under 1G conditions (265.15 lbf) indicates a maximum stress of 7800 PSI, well within the acceptable limits. At the 3G design load, the estimated maximum stress is 23,400 PSI, safely below the 66,000 PSI yield strength of 4130 steel, confirming the structural integrity of the A-arms. Additionally, the OptimumKinematics simulation shows promising results, with most measured suspension characteristics closely matching or improving upon the previous design. Future adjustments to address any issues will aim to minimize changes to the current configuration.