

Design Of Formula Sae Suspension

Design Of Formula Sae Suspension Decoding the Design of Formula SAE Suspension A Deep Dive So you're building a Formula SAE car and staring blankly at the suspension system a critical component that directly impacts handling speed and overall performance. Don't worry you're not alone. Designing a high-performing suspension is a complex task but breaking it down into manageable chunks makes it far less daunting. This blog post will guide you through the key aspects of Formula SAE suspension design providing practical examples and tips along the way.

Understanding the Fundamentals More Than Just Springs and Shocks

Before diving into specific designs let's establish a solid foundation. The Formula SAE suspension system's primary goal is to maintain tire contact with the track surface optimizing grip and handling. This involves managing several forces:

- Weight Transfer**: As the car accelerates, brakes, and corners, weight shifts dramatically. The suspension needs to manage this efficiently to prevent wheel lift under acceleration or loss of control under braking and cornering.
- Tire Load**: Maintaining optimal tire load ensures consistent grip. Too much load can cause excessive tire wear and reduced performance, while too little compromises grip.
- Ride Height**: The distance between the chassis and the ground is crucial. A correctly chosen ride height balances aerodynamic efficiency with ground clearance.
- Bump and Rebound**: The suspension needs to effectively absorb impacts, bumps, and control the return rebound to prevent excessive bouncing and maintain stability.

Common Formula SAE Suspension Types

A Comparison

Two main suspension types dominate Formula SAE:

- 1. Double Wishbone**: This configuration utilizes two A-arms (wishbones) connected to the upright hub carrier. It offers excellent adjustability for camber, caster, and toe, allowing for fine-tuning of handling characteristics. Think of it as offering precise control over the wheels' movement.
- 2. Pushrod/Pullrod Suspension**: This utilizes pushrods or pullrods to connect the damper/shock absorber to the chassis often indirectly. It offers a more compact design and allows for packaging advantages by placing the damper within the chassis.

Visual

Imagine two curved arms (A-arms) each connecting to the chassis at one point and the upright at another. They create a wishbone shape.

Pros

- Excellent adjustability
- Good handling

Cons

- Complex design
- More parts can be heavier

2. Pushrod/Pullrod Suspension

This utilizes pushrods or pullrods to connect the damper/shock absorber to the chassis often indirectly. It offers a more compact design and allows for packaging advantages by placing the damper within the chassis.

Visual

Picture a rod connecting the damper to a rocker assembly which then connects to the chassis. The rod either pushes (pushrod) or pulls (pullrod) the damper.

Pros

- Compact design
- Good packaging
- Potential lower unsprung mass potentially

Cons

- Requires careful design and simulation to ensure proper function and avoid binding.
- Image: Include side-by-side diagrams of a double wishbone and a pushrod suspension system, clearly labeling key components like wishbones, uprights, pushrods, dampers, etc.

How-to Key Design Considerations

Regardless of your chosen suspension type several key considerations will impact your design 1 Spring Rate Selection This determines how stiff the suspension is A stiffer spring reduces body roll but can make the ride harsh Use simulation software eg MATLABSimulink ADAMS to optimize spring rates based on your vehicles weight and intended use 2 Damper Tuning Dampers control the rebound and compression of the suspension Experiment with different damping settings to find the optimal balance between comfort and handling This is heavily iterative and often involves track testing 3 AntiRoll Bars Sway Bars These connect the left and right suspension on an axle reducing body roll during cornering The stiffness of the antiroll bar is crucial too stiff can make the car overly responsive while too soft wont adequately control body roll 4 Geometry Optimization Camber caster and toe angles significantly influence handling Properly optimizing these parameters is crucial Consider using a suspension analysis software to explore different setups 5 Material Selection Lightweight materials aluminum alloys carbon fiber are essential for reducing unsprung mass This improves handling responsiveness and reduces stress on the suspension components Practical Example Spring Rate Calculation Simplified Lets assume a simplified spring rate calculation Vehicle weight 250 kg 3 Static deflection desired 50 mm 005 m Spring rate k Weight Deflection 250 kg 981 ms 005 m 49050 Nm This is a very basic calculation In reality several other factors influence the optimal spring rate Image Include a simple diagram illustrating the concept of spring rate and static deflection Simulation and Testing Crucial Steps Designing a suspension solely on theory is a recipe for disaster Employing simulation software like ADAMS or MATLABSimulink allows you to virtually test different configurations and predict their performance before building the physical components This drastically reduces the time and cost associated with iterative design changes Physical testing on a test track or even a smaller test rig remains essential for validating simulation results and fine tuning the suspension setup Summary of Key Points Choose a suspension type based on your teams experience and resources Double Wishbone offers more adjustability PushrodPullrod offers better packaging Spring and damper selection is crucial for handling and ride quality Use simulation and testing to optimize these parameters Geometry camber caster toe greatly influences handling use software for detailed analysis Lightweight materials are vital for minimizing unsprung mass Simulation and realworld testing are crucial for achieving optimal performance FAQs 1 Q What software is best for Formula SAE suspension design A Popular choices include ADAMS MATLABSimulink and various CAD software packages with simulation capabilities The best choice depends on your teams expertise and budget 2 Q How do I determine the optimal ride height A Ride height is a balance between aerodynamic performance ground clearance and suspension travel Experimentation and simulation are key considering track conditions and vehicle dynamics 3 Q How much does suspension design influence overall vehicle performance A Its arguably the most influential aspect of handling and performance A poorly designed

suspension will severely limit your cars ability to corner effectively and maintain speed 4 Q What are some common mistakes to avoid A Neglecting simulation ignoring geometry 4 optimization using inappropriate materials and failing to adequately test the suspension 5 Q Can I use offtheshelf components A Yes but be sure to carefully assess whether they fit the specifications and requirements of your design Custommade components might offer better performance By understanding the fundamentals utilizing appropriate design tools and embracing a rigorous testing process your Formula SAE team can design a highperforming suspension system that gives your car a competitive edge Remember the key to success lies in a thorough understanding of the principles diligent simulation and meticulous ontrack testing Good luck

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in 2006 a small unavailing university auto racing team began building a racecar that would challenge the best engineering schools in the world with fewer people and resources than any of the top competitors the only way they were going to win was to push the limit go for broke and hope for more than a little luck by the time they got to the racetrack they knew in the fog of fierce competition whether you win or lose you learn the hardest lessons about engineering teamwork friendship and yourself

the suspension system of a fsae formula society of automotive engineers vehicle is a vital system with many functions that include providing vertical compliance so the wheels can follow the uneven road maintaining the wheels in the proper steer and camber attitudes to the road surface and reacting to the control forces produced by the tires acceleration braking and cornering the members that comprise the suspension are subjected to a variety of dynamic loading conditions it is imperative that they are designed properly to ensure the safety and performance of the vehicle the goal of this research is to develop a model for predicting the reaction forces in the suspension members based on the expected load scenarios the vehicle will undergo this model is compared to the current fsae vehicle system and the design process is explained the limitations of this model are explored and future methodologies and improvement techniques are discussed

this book gathers outstanding papers presented at the china sae congress 2022 featuring contributions mainly from china the biggest carmaker as well as most dynamic car market in the world the book covers a wide range of automotive related topics and the latest technical advances in the industry many of the approaches in the book help technicians to solve practical problems that affect their daily work in addition the book offers valuable

technical support to engineers researchers and postgraduate students in the field of automotive engineering

this book gathers the proceedings of the 6th international conference and exhibition on sustainable energy and advanced materials ice seam 2019 held on 16 17 october 2019 in surakarta indonesia it focuses on two relatively broad areas advanced materials and sustainable energy and a diverse range of subtopics advanced materials and related technologies liquid crystals semiconductors superconductors optics lasers sensors mesoporous materials nanomaterials smart ferrous materials amorphous materials crystalline materials biomaterials metamaterials composites polymers design analysis development manufacturing processing and testing for advanced materials sustainable energy and related technologies energy management storage conservation industrial energy efficiency energy efficient buildings energy efficient traffic systems energy distribution energy modeling hybrid and integrated energy systems fossil energy nuclear energy bioenergy biogas biomass geothermal power non fossil energies wind energy hydropower solar photovoltaic fuel cells electrification and electrical power systems and controls

this book explores the nexus between professional technical societies and engineering education by examining several societies efforts to promote and support engineering and engineering education in the areas of pre university education university education and informal education through programs and activities designed to leverage social innovation professional societies are in a unique position to support and contribute to engineering education and have dedicated substantial resources to social responsibility programs and activities that promote engineers and engineering the book is chiefly intended for engineers engineering educators staff members of professional technical societies and for the broad range of scholars whose work involves technology education and education policy

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the conference offered an international forum for discussion and exchange of knowledge on opportunities and challenges related with all facets and aspects of technological innovations applications in industry 4 0 its challenges and way ahead the objective of this

international conference was to provide a platform for policy makers academicians and researchers to share their experiences and knowledge by presentation of scientific advances made in the field of industry 4.0

author's abstract the importance of standardized courses for testing georgia southern university's formula sae fsae vehicle is emphasized in order to reproduce test results and analyze trends within data the test courses are clearly defined so that future eagle motorsports ems participants can replicate testing conditions to track progress from year to year as well as validate simulations and design models a data acquisition system daq was installed on the fsae car for the first time this paper serves as an introduction to the purpose of acquiring data an explanation of the hardware available and components chosen to implement daq on georgia southern's fsae car mathematical validation is presented to complement the data acquired from the daq and the results from testing are evaluated this data may be used to validate simulations models or evaluate changes in vehicle behavior during the tuning process

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