

Design Of Formula Sae Suspension

Design Of Formula Sae Suspension Decoding the Design of Formula SAE Suspension A Deep Dive So youre building a Formula SAE car and staring blankly at the suspension system a critical component that directly impacts handling speed and overall performance Dont worry youre not alone Designing a highperforming 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 lets establish a solid foundation The Formula SAE suspension systems 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 Aarms wishbones connected to the upright hub carrier It offers excellent adjustability for camber caster and toe allowing for finetuning of handling characteristics Think of it as offering precise control over the wheels movement Visual Imagine two curved arms each connecting to the chassis at one point and the upright at another They create a wishbone shape Pros Excellent adjustability good handling 2 Cons Complex design more parts can be heavier 2 PushrodPullrod 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 sidebyside diagrams of a double wishbone and a pushrod suspension system clearly labeling key components like wishbones uprights pushrods dampers etc Howto 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 $k = \frac{\text{Weight}}{\text{Deflection}} = \frac{250 \text{ kg} \cdot 9.81 \text{ ms}^{-2}}{0.05 \text{ m}} = 49050 \text{ Nm}$ 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

Formula SAE Suspension DesignDesign and Integration of a Formula SAE Suspension SystemDesign and Analysis of Formula SAE Car Suspension MembersDesign of Formula SAE SuspensionDesign and Development of Formula SAE Front Suspension SystemFormula SAE Car Suspension Design and AnalysisDesign and Development of a Suspension System for a Formula SAE Racing CarIntroduction to Formula SAE Suspension and Frame DesignDesign and Developmnt of Formula SAE Rear Suspension SystemPerformance Modification of a Rear Suspension for a Formula SAE Style Race CarHandling-driven Design of Formula SAE SuspensionFormula SAE and Its Systems Engineering ApproachDesign of Suspension, Brake and Wheel System for Formula SAESuspension Design and Whole-vehicle Dynamic Development of a Formula SAE Racing CarThe Optimization of a Formula SAE Vehicle's Suspension KinematicsFormula SAE Frame and Suspension DesignThe Design of an Innovative Automotive Suspension for Formula SAE Racing ApplicationsThe design of a rear suspension for the 1995 Formula SAE competitionOptimum Suspension Geometry for a Formula SAE CarPhelan 2005 Formula SAE suspension team report Gabriel de Paula Eduardo Patrick Drum Evan Drew Flickinger Badih A. Jawad Choon Yin Loke William Carroll Edmund F. Gaffney (III.) Azhar Alias Scott Michael Froebe (University of Manitoba student) Prout Lisa Jean Muhamad Imran Ishak Geoff R. Pearson William Thomas Harvey (S.B.) Ryan Paul Chase Jared Michael Darius John Moloney Matt Dellemann

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System for a Formula SAE Racing Car Introduction to Formula SAE Suspension and Frame Design Design and Development of Formula SAE Rear Suspension System Performance Modification of a Rear Suspension for a Formula SAE Style Race Car Handling-driven Design of Formula SAE Suspension Formula SAE and Its Systems Engineering Approach Design of Suspension, Brake and Wheel System for Formula SAE Suspension Design and Whole-vehicle Dynamic Development of a Formula SAE Racing Car The Optimization of a Formula SAE Vehicle's Suspension Kinematics Formula SAE Frame and Suspension Design The Design of an Innovative Automotive Suspension for Formula SAE Racing Applications The design of a rear suspension for the 1995 Formula SAE competition Optimum Suspension Geometry for a Formula SAE Car Phelan 2005 Formula SAE suspension team report *Gabriel de Paula Eduardo Patrick Drum Evan Drew Flickinger Badih A. Jawad Choon Yin Loke William Carroll Edmund F. Gaffney (III.) Azhar Alias Scott Michael Froebe (University of Manitoba student) Prout Lisa Jean Muhamad Imran Ishak Geoff R. Pearson William Thomas Harvey (S.B.) Ryan Paul Chase Jared Michael Darius John Moloney Matt Dellemann*

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 thesis covers the design of a suspension system for a formula sae racecar with particular emphasis given to demonstration of proper roll rates for optimum handling this study will first overview the formula sae event as well as relevant parameters relating to suspension design it will then overview pacejka tire modeling before examining and selecting a tire for the vehicle physical suspension parameters will then be determined and programmed into a wireframe to generate a suspension architecture handling balance of the vehicle will be evaluated for a sweep of roll couple distributions and ride and roll rates will be set for desired handling finally the suspension will be simulated against the previous suspension design to evaluate the effectiveness of the proposed changes

the suspension geometry is the foundation of a performance vehicle s design because it dictates the overall packaging constraints and the connection between the chassis and the tires this thesis details the design process used to produce the suspension geometry for mit motorsports 2018 formula sae car and the justification for each design decision made a thorough iteration process was used to prevent compromises that could significantly detract from specific component performance in order to meet suspension kinematic requirements using this process the kinematic performance of the suspension was maximized by minimizing the roll center s movement and designing the tire camber change characteristics to achieve 0 of outer wheel camber while at the car s maximum lateral acceleration

this thesis details an analytical approach to an innovative suspension system design for implementation to the formula sae collegiate competition it focuses specifically on design relating to geometry mathematical modeling energy element relationships and computer analysis and simulation to visualize system behavior the bond graph approach is utilized for a

quarter car model to facilitate understanding of the analytical process then applied to a comparative analysis between two transverse half car models the second half car model contains an additional transverse linkage with a third damper and is compared against the baseline of the first half car model without the additional linkage the transverse third damper is an innovative design said to improve straight line tire contact during single sided disturbance help mitigate the adverse effects of squat and dive while not inhibiting the function of the anti roll bar in cornering capability additional work is done investigating an optimization of suspension geometry through mathematical modeling in matlab of a four bar linkage system this code helps visualize the complex motion of the upright and calculates the wheel camber rate and variation to compare against tire data analysis to match maximum tire performance characteristics with camber angle

this paper will explore the features that optimize suspension performance for a formula sae racecar focusing on suspension geometry employing research and designs from previous year s cars the suspension will be designed using the iterative design process to help with this process multiple programs and methods will be used when the design is finalized it will be built and installed on the 2019 viking motorsport s formula sae car

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