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Review of Design and Analysis of Double Wishbone Suspension

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ABSTRACT

A combination of technological advancements and new manufacturing methods has helped to bring about these improvements, which have resulted in better products for customers. Mechatronic technologies have led to technological advancements in a number of automotive areas, resulting in increased performance output. The safety of both the vehicle and its occupants is ensured by a suspension system that provides stability and comfort during movement. To drive a car without the use of a suspension system would have been nearly impossible because the steering would have been subjected to all of the vehicle's shocks and vibrations. It is the primary objective of this study to discuss how to design and analyze a double wishbone suspension system for a vehicle.

Keywords:Dependent Suspension, Independent Suspension, Double Wishbones, spring and Damper System

1.Introduction:

Citroen, a French car manufacturer, pioneered the double wishbone in 1934 and used it on the Rosalie model. A double wishbone suspension system is sometimes known as a double arm suspension system. This suspension has two upper and lower chassis mounts, as well as a knuckle joint on the other end. A wishbone is divided into two categories: independent suspension system and dependent suspension system. A double wishbone suspension system is classified as independent suspension because both sides, right and left, are not connected to each other and are independent from one another. In an independent suspension system, a torsion bar, anti roll bar, or sway bar is used to reduce rolling movement when one side of the suspension is down and the other side is level.

Parts of Double Wishbone Suspension System

Control arms: A double wishbone is made up of two wishbones: the lower wishbone and the upper wishbone, which are also known as control arms. These control arms are connected to the car body on one end and the wheel on the other, allowing the wheel to move up and down.

Coil spring: A coil spring is a helical spring that is compressed in a strut to provide support for the damper of the suspension. The stiffness or softness of this spring varies depending on the vehicle type..

Steering knuckle joint: The steering knuckle joint is an important component of the steering system since it controls the vehicle's turning movement. It is divided into two parts, the lower control arm or lower wishbone on the bottom side and the upper assembly on the upper side.

Strut assembly: It is the most important portion of the suspension since it combines a damper and a coil spring with the appropriate bushing to form a complete strut assembly..

Shock absorber: Shock absorber, also known as a damper, is a component of the strut assembly that is used to dampen the vehicle's motion. This shock absorber is available in a variety of styles and lengths.

Bushes: To limit direct metal contact, resulting in less wear and tear, as well as to reduce noise, even at high dampening levels

Upper strut mount: The location where the strut's upper end is attached to the vehicle's frame to provide a fix point for the strut is known as the upper strut mount

Sway bar: In the event of an uneven road surface, this bar controls rolling or swaying motion on only one side of the road, which is either faced by left suspension or right suspension.

Steering linkage: Because Macpherson strut suspension is typically utilized for front wheels, this element serves to guide the vehicle. This setup is popular in drifting automobiles because it enhances turning radius when compared to other suspension setups

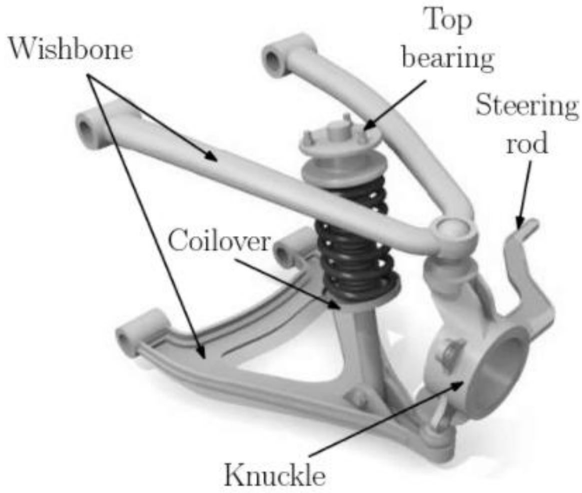

Figure 1: Double Wishbone System

2.LiteratureReview

In this section, research publications that are linked to the current work are discussed in detail. This section contains a selection of recently published papers.

Mahmoud Omar et al. [1]Simscape'sSimscape library was used to depict and compare the active performance to that of the passive. For this comparison, we used the Sims cape package for both experimental and numerical analysis. To make the validation process as straightforward as feasible, both systems are built with a single degree of freedom. During the design and construction of the rig, economic concerns were taken into account. The rig is made up of two similar platforms that are two suspensions can be tested at the same time because they are positioned side by side. Sprout and unsprung mass sensors have been installed on each platform.

TianMi et al. [2] Using the Lagrange Equation, a five-degree-of-freedom (DoF) model is built to analyse an electric car's shimmy issue. The gyroscopic moment and tyre nonlinearity are taken into consideration while constructing tire-road constraint equations, and this is done with the nonslip assumption. When using the linearized model, stability charts are created, and a numerical simulation is also created so that the results of the two methods may be verified against one another. Results demonstrate that bifurcation happens at particular vehicle forward speeds, according to the findings. Wheel shimmy is influenced by suspension structural characteristics such as the caster angle. Furthermore, the provided model allows for the investigation of any system parameters, as demonstrated by the investigation of the influence of dampings on shimmy.

Carlos Arana et al. [3] in testing, the Series Active Variable Geometry Suspension (SAVGS) has shown that it may improve ride quality and traction. The SAVGS concept introduces significant nonlinearities by introducing rotational nonlinearities in the mechanical link linking the chassis and the spring-damper unit. Traditional linearization processes employed in multi-body software packages are capable of dealing with this setup; however, they yield linear models that have a limited range of application.

Jan Dizo et al. [4]The vibration analysis of the coach's wheel that had been damaged by the wheel-flat had been the primary focus of the study. For the analyses, multibody software is used to determine how suspension settings affect the resulting changes in acceleration output signals. It is broken into two halves. The first section is concerned with the problem of the damaged wheel's genesis and consequence while rail vehicles are operating on rails in real-world situations. Also integrated is an instrumentation system for detecting forces and accelerations created by rail vehicles as they go along a given track section. The second portion is concerned with the evaluation of selected quantifiable parameters of a rail vehicle with a flat tyre, which have been derived by computer simulations of the vehicle. Coil spring stiffness of the main and secondary suspensions was modified to determine the findings based on signal accelerations at the designated location during passenger car driving on a straight track.

Anirban et al. [5] had been one of the most difficult tasks for engineers to accomplish. In order to keep the vehicle's body from being jarred by the road, suspension systems must minimise or eliminate the road excitations. In this study, an attempt is made to implement an ISO 2631-1: 1997 compliant passive suspension system utilising an optimization approach known as the Genetic algorithm. The spring stiffness, damping coefficient, sprung mass, unsprung mass, and tyre stiffness can all be adjusted to provide a more comfortable ride. A four-DOF system is employed to mimic the ride comfort of the quarter car and driver's seat using SIMULINK.

A.A. Koshurina et al.[6] an Arctic rescue vehicle (URV) had been chosen as the focus of the investigation. The NNSTU named for R.E. Alekseev is currently developing this rescue vehicle. The URV is unique in that it is the first vehicle of its sort to utilise an operated equalising beam suspension. The article discusses the various equalisation beam designs and analyses them. The rotary-screw vehicle motion is taken into account when developing calculation systems and simulation models. Using Autodesk Inventor 2015's standard tools, the models and strength calculations were completed. The stress-strain states of various equalising beam configurations are discussed in this article. After conducting comparative analyses of previously studied designs, researchers have come to believe that the equalisation beam embodiment can be used in the development of an air rescue vehicle with the proper modifications.

PanosBrezas et al. [7]Optimal control of semi-active vehicle suspensions had been stated as a challenge. Specific objectives include developing an algorithm capable of simultaneously optimising riding and handling characteristics in an experimental setting. Road disturbances (stochastic) and driver inputs are described as exogenous disturbances that affect the vehicle's ride and handling in a time-domain optimal control technique (treated as deterministic quasi-static disturbances). For the finite-horizon scenario, the stochastic Hamilton–Jacobi–Bellman equation is used to create a control algorithm. On a test car navigating a rough roundabout, the approach's advantages are put to the test.

Werner Scheele et al. [8] random excitation by the unevenness of the road. Models of vertical vibrations in vehicles and road unevenness in guideways are necessary for dynamical analysis. Vehicle suspension fundamental dynamics may already be approximated by a quarter automobile with the separation of body motion and wheel motion. Shock absorber and tyre spring deterioration and poor maintenance make two of the five design characteristics of this suspension style inherently unpredictable. Ride comfort, driving safety, and suspension travel are all factors to consider when evaluating a vehicle's performance. A conflict or Pareto-optimal problem arises when all five design characteristics are taken into consideration. These parameters' uncertainties are projected into a criteria space in support of a Pareto-optimal problem decision in this paper. The robust suspension design is supported by simulations that include uncertainty. Controlled suspension parameters are demonstrated to be unreliable due to the driver's unpredictability.

M. Soleymani et al. [9] for a better ride and travel suspension in diverse traffic situations, this article looks at a design for an adaptable active suspension system. Fuzzy controllers for the front and rear suspensions of a full-vehicle model with eight degrees of freedom were developed for this purpose. A multi-objective Pareto-optimal approach is used to modify the fuzzy controller parameters for varied traffic circumstances in a driving pattern.

VladimírGoga et al. [10]It had been stated that the purpose of the vehicle suspension was to ensure a safe and comfortable ride, regardless of the road surface. There are frequently conflicts between these needs. We're here to show you what's possible when you combine a virtual environment with evolutionary computation to optimise a design problem. Matlab/Simulink was used to generate the mathematical half-car model. evolutionary computation was used to improve the damping and stiffness coefficients of the passive suspension. Original and optimised suspension parameters were simulated and compared.

SamantSaurabh et al.[11] A formula student race car's front twin A-arm pushrod suspension system had been depicted in great detail. We'll take a look at the most common types of suspension systems. SolidWorks is used to create the CAD models of suspension system components, and ANSYS Workbench is used to do the finite element analysis of the components. The developed suspension system is subjected to both kinematic and dynamic analysis. Vibration and roll-steer analyses are also included in the suspension system's design results. Spring design is explained in detail. This article focuses on the design and analysis of a race car's suspension system.

KameshJagtap et al. [12] Large travel and Ride Quality make it an On-Road Commercial Vehicle, and it must also contend with varied ground conditions such as mud, ice, rocks and rough tracks in order to be considered an On-Road Commercial Vehicle with all-terrain competence. Consequently, it must be able to withstand numerous undulations. When designing commercial vehicle suspension systems, they take into account typical road conditions. An ATV's suspension system must take varied terrain conditions into account. A review of ATV suspension systems is provided in this study.

Sameer Verma et al. [13] has been a widely used and highly effective suspension system style. It has a single control arm and a strut. These components often come from the suspension system's strut assembly. In most cars, the front suspension is handled by a Macpherson suspension system. Instead of being wrapped around the strut, a coil spring can be positioned on the control arm. The shock absorber connects the knuckle to the frame on this sort of vehicle. There are several applications for this sort of suspension strut. High-performance automobiles still use the Macpherson strut setup.

Reena Mishra et al. [14] Research on the front wishbone has increased significantly in recent years, and this page lists and emphasizes the most relevant research to the design, analysis, and optimization of the system. In order to reduce unsprang mass, increase durability, and decrease cost, current research is concentrating on strategies for selecting materials, impact loads, material deformation, stress, and weight reduction for ATV vehicles. The goal of the research presented here is to provide the reader with an overview of the current state of knowledge on the front wishbone suspension system.

Dongchen Qin et al. [15] has been one of the most important components in automobiles, with the potential to have an impact on things like steering steadiness and ride comfort. ADAMS/VIEW is used to create the multi-body dynamics model of the MPV front suspension and to simulate the placement parameters of the front wheel. Front suspension sensitivity analysis and design optimization are carried out to increase kinematics performance and steering stability. The findings can serve as a reference point for the development of the MPV.

Jihui Liang et al. [16] it had previously been employed as a symbol the suspension system regulates and controls the relative motion of the wheel and the automobile body in order to lessen the impact and shock of the road surface on the transmission of force and torque. Kinematic characteristics of the suspension refer to parameters such as kingpin inclination angle, camber angle, caster angle, and others when the vehicle body and wheels move vertically in respect to one another. The ride quality, handling precision, and overall comfort of a car are directly influenced by the design and performance characteristics of the suspension.

P. Nagarjuna et al. [17]it had been represented that a car's suspension system is critical to the vehicle's stability. Luxury is another key component of the suspension system for passenger cars that has been realised to some extent. Lots of work has been done on this front, and an independent suspension system has now been developed. An independent suspension system relies heavily on the control arm. Due to factors such as increased weight and expense, forging is typically the only option for this type of component. Sheet metal control arms, which have numerous advantages over forged metal, are the focus of this study. Curves derived from PRO-workspace E's have been used to model the component. In order to analyse the model, a STEP file is created from it and imported into 'Unigraphics. Structures P.E. solver is used to examine the model under various load circumstances. The model's stress and stiffness are examined using the analysis results to validate the design's success.

Mohammad Iman et al. [18] had been used to represent for active cars that are typically equipped with high-tech electronic components, simulation accuracy has improved dramatically thanks to recent advances in dynamic vehicle simulation multidimensional expression. Increasing the design of the safety car has come up as a topic of discussion recently. As a result, a great deal of work has gone into improving vehicle stability, particularly in turns. Car suspension systems' camber angles need to be fine-tuned, and this is a critical step. In addition to vehicle stability, optimal control camber angle has an impact on the adhesion of the wheels on the road, decreasing rubber abrasion and accelerating and decelerating the vehicle. Because the camber angle has an effect on vehicle stability, an automobile suspension system mechanism with adjustable camber angle is described in this study, and it is shown that the system may be applied and is also shown to be economically priced. Thus, this study introduces a passive double wishbone suspension with variable camber. Then an adjustable camber mechanism is built in Visual Nastran to test the system's kinematics and see how well it performs.

Arvin Niro et al. [19} NASA's rovers have allowed us to explore the farthest reaches of our solar system, which had been a major component of NASA's curiosity. Modern technology allows us to see and measure if life exists outside our solar system. It is our goal in this project to create a suspension system that can be used on the Rover Eric Caldwell and Lee Do built last semester in the Kapi'olani Community College Robotics Lab. The mecanum driving system and wireless technology on this rover make it incredibly agile. However, the rover's nimbleness causes it to vibrate uncontrollably. The mecanum wheels' vibrations were reduced and dampened using a double-wishbone suspension system with a spring and damper system. A suspension system might be created and optimised using SolidWorks' finite element analysis to determine the overall system's design for this specific rover.

Dr. Naser LAJQI et al. [20] employed in building a suspension system for 4x4 terrain vehicles' research approaches have been represented. Literature studies, computer-aided design (CAD) techniques, numerical analytical methods, mathematical modelling and simulation, mechanical system optimization, and results comparison, analysis, and assessment are among the most common research approaches. In the end, the terrain vehicle's planned suspension system was successfully derived from a double-wishbone control arm. Multi-objective Genetic Algorithms are used to optimise passive suspension parameters, while the Hooke-Jeeves non-linear programming method is used to optimise active damping force parameters. Based on a thorough investigation, it is concluded that active systems are better suited to the task. There are no camber angles, and the proposed suspension design effectively absorbs vibrations induced by road noise.

3.Conclusion

In the end, we'll find that the model's structural analysis is explored in two distinct methods. Loading and modal analysis are two different types of analysis. Deformation, fatigue life, and safety factors are all considered in the structural analysis of the double wishbone system suspension system and the Shock Absorber. The lower and connecting arm of the double wishbone suspension system is used in the modal analysis to determine the natural frequencies. The overall deformation of the components as a function of the vibrating frequency and crucial sites is calculated.

References

[1] Mahmoud Omar, M.M. El-kassaby, WalidAbdelghaffar, " A universal suspension test rig for electrohydraulic active and passive automotive suspension system", Alexandria Engineering Journal (2017)

[2]TianMi, Gabor Stepan, Denes Takacs, Nan Chena, NingZhanga," Model Establishment and Parameter Analysis on Shimmy of Electric Vehicle with Independent Suspensions", Procedia IUTAM 22 (2017) 259 – 266.

[3] Carlos Arana, Simos A. Evangelou, Daniele Dini," Series Active Variable Geometry Suspension application to comfort enhancement", Control Engineering Practice 59 (2017) 111–126.

[4] Jan Dizo, StasysSteisunas, MiroslavBlatnicky, "Vibration analysis of a coach with the wheel-flat due to suspension parameters changes", Procedia Engineering 192 (2017) 107-112.

[5]Anirban. C. Mitra, Gourav. J. Desai, Saaish. R. Patwardhan, Parag H. Shirke, Waseem M. H. Kurne, Nilotpal Banerjee," Optimization Of Passive Vehicle Suspension System By Genetic Algorithm", Procedia Engineering 144 (2016) 1158 – 1166.

[6] A.A. Koshurina, M.S. Krasheninnikov, R.A. Dorofeev,"Strength Calculation and Analysis of Equalizer Beam Embodiments for the Operated Equalizing Beam Suspension of the Universal Rotor-Screw Rescue Vehicle for the Arctic", Procedia Engineering 150 (2016) 1263 – 1269.

[7]PanosBrezas, Malcolm C. Smith, Will Hoult," A clipped-optimal control algorithm for semi-active vehicle suspensions: Theory and experimental evaluation", Automatica 53 (2015) 188–194.

[8] Werner Scheele, Igor Iroz," Uncertainties in road vehicle suspensions", Procedia IUTAM 13 (2015) 151 – 159.

[9] M. Soleymani, M. Montazeri-Gh, R. Amiryan, "Adaptive fuzzy controller for vehicle active suspension system based on traffic conditions", ScientiaIranica B (2012) 19 (3), 443–453.

[10]VladimírGoga, Marian Klúcik," Optimization of vehicle suspension parameters with the use of evolutionary computation", Procedia Engineering 48 (2012) 174 – 179.

[11]SamantSaurabh Y., Santosh Kumar, Kaushal Kamal Jain, Sudhanshu Kumar Behera," Design of Suspension System for Formula Student Race Car", Procedia Engineering 144 (2016) 1138 – 1149.

[12]KameshJagtap, YogeshRathod, AnmayShedge, MitaliGramopadhye, Prof. VivekDiware," Suspension System For An All-Terrain Vehicle: A Review", International Journal of Engineering Research and General Science Volume 4, Issue 3, May-June, 2016.

[13] Prof. Sameer Verma, Parvez Raza, “Theoretical Analysis of Macpherson Suspension System", IJSART - Volume 2 Issue 3 –MARCH 2016.

[14]Reena Mishra, AnandBaghel," Design, Analysis and Optimization of front suspension wishbone of BAJA 2016 of Allterrain vehicle- A Review", IJRMMAE, Vol. 2 Iss.3, pp. 40-52, 28th Feb 2017.

[15]Dongchen Qin, Junjie Yang, Qiang Zhu, Peng Du, "Simulation and Optimization of MPV Suspension System Based on ADAMS", 11th World Congress on Structural and Multidisciplinary Optimisation 07th -12th, June 2015, Sydney Australia.

[16]Jihui Liang, Lili Xin," Simulation analysis and optimization design of front suspension based on ADAMS", MECHANIKA. 2012 Volume 18(3): 337-340.

[17] P. Nagarjuna, k. Devaki Devi, "Design And Optimization Of Sheet Metal Control Arm For Independent Suspension System", International Journal of Engineering Research and Applications, Vol. 2, Issue5, September- October 2012, pp.535-539.

[18] Mohammad ImanMokhlespourEsfahani, MasoudMosayebi, "Optimization of Double Wishbone Suspension System with Variable Camber Angle by Hydraulic Mechanism", World Academy of Science, Engineering and Technology 61 2010.

[19] Arvin Niro, "Design and Development of A Suspension System Used in Rough terrain Vehicle Control For Vibration Suppression in Planetary Exploration".

[20]Asoc. Prof. Dr. Naser LAJQI, Asoc. Prof. Dr. Azem KYÇYKU, Ass. Prof. Dr. Shpetim LAJQI, "Design Process for The Suspension System of The Terrain Vehicle With Four Wheel Drive", ScientificProceedings Xiv International Congress "MachinesTechnologies. Materials." `k2017 - Summer Session