IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁘ Impact Factor 8.021 ⁘ Peer-reviewed / Refereed journal ⁘ Vol. 11, Issue 5, May 2023

DOI: 10.17148/IJIREEICE.2023.11512

DESIGN AND DEVELOPMENT OF SUSPENSION SYSTEM OF ELECTRIC VEHICLE

Abhijit Kanade[1], Somesh Bhalerao[2], Mithilesh Bibwe[3], Ganesh borale[4], Prof.Ganesh Kondhalkar[5]

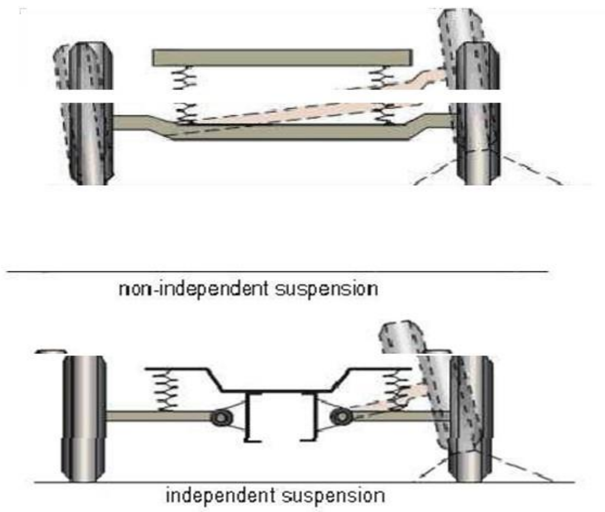
Student, of Mechanical Engineering, Anantrao Pawar College of Engineering & Research Pune Maharashtra, India[1-4]

Assistant Professor, Department of Mechanical Engineering, Anantrao Pawar College of Engineering & Research Pune, Maharashtra, India[5]

Abstract:With the technological progress in every part of the world of physics, there are advancements in automobile industry too which are pacing towards the zenith of perfection each day. The automobiles consist of many sections and one of those sections is a suspension system. This project is based on Double-Wishbone (DWB) suspension system which belongs to the independent type of suspension systems. The role of suspension system is to maximize the contact surface between the car and the road which enhances the steering stability and handling of the vehicle by evenly distributing the weight of vehicle on the tires. The end goal of using a good suspension system is to provide comfort to its. Suspension system is an important component in automotive systems. The system's role is to decrease vibrations and road shocks because the vehicle moves on surfaces. The work describes the methodology of double wishbone suspension method of analysis and design. Layout of Shock absorber and spring were considered. CATIA did the modeling of components and assembly.

I. INTRODUCTION

In recent years, the price of oil has rising day by day. Also, air pollution of earth is also increasing. for that As a result, development of the electric vehicle has become important. Our department is developing six sitter electric vehicle model. In this project we are managing to look for suspension of vehicle .right importance of suspension system is maintain the contact between the tire and chassis with absorbing the shock for the smooth ride. Suspension system prevent car form shock when it passes on the bad road contains the potholes and debris. Suspension system comprises shock absorbers, springs, and linkages which join its brakes and a vehicle. Important functions of the system are two:



 This work is licensed under a Creative Commons Attribution 4.0 International License

DOI: 10.17148/IJIREEICE.2023.11512

II. LITERATURE SURVEY

In In this paper the dynamic analysis of an electric vehicle (EV) has been researched. Ev car has to give similar performance.by cae software the solution for incresae of spring rate of front and rear suspension .used of stabilizer bar increase roll rate and increases the performance suspension. The vehicle suspension system was built using (MBD) software, motion solve. Using the model, the dynamic properties of a target vehicle with ic engine and an ev with motor and batteries. The kinematic of the suspension system was also carried out to evaluate their kinematic performance.in this paper focuses on the acceleration, roll angle and other characteristic of the vehicle. By using optimization software, Altair models of the front and rear suspension were assembled. Then the optimization of dynamic properties of the electric vehicle suspension system was carried out.

In this in this study paper the various types of suspension system are tested to choose for which type of suspension we should choose on our vehicle type based.and also disscussed. the This project focuses on the design, development, evaluation, and analysis of an adjustable vehicle suspension system. This system is aimed to improve vehicle performance on all terrain conditions from rough to flat surfaces. The proposed design is accomplished through the modification of a double-triangulated four-bar linkage suspension. The modifications allow the upper links of the suspension system to change vertical position on-the-fly, to meet operator preference. The position change alters suspension geometry and therefore the performance characteristics of the vehicle; specifically the anti-squat which impacts vehicle sag and therefore traction. Thus, traction is directly controlled through adjustments to the suspension system. Through video motion analysis of a prototype vehicle before and after the proposed design modifications, we rigorously evaluated the effect of the adjustable suspension system. Future applications of this design are expected to improve the performance characteristics of vehicles of all sizes, ranging from mobile robots to automobiles. In addition to scalability, the advantage of our design is the on-the- fly adaptability, which enables adjustments in suspension performance for the terrain or obstacle being traversed.

This study paper,main focus on relaible material for manufacture leaf spring is steel & composite material.use of composite material will increase strength and and it is also higher corroive resistance, We know that the spring plays very essential part of every automobile for suspension point of view. Leaf spring is the main type of suspension system which is used in many light and heavy vehicles. Leaf spring used in many vehicles due to having some main characteristics which are Uniformly load distribution.Lower cost ,Rough used,Easier in Isolation and Tightly attached with working frame Today every automobile company has been working on increasing the efficiency with reducing the weight without having any load carrying capacity. In this paper we would like to review some previous research work performed on the leaf spring by previous researchers for increasing the working condition and capacity with load reduction. The paper based on material composition, experimental testing and load (Steady, Dynamic) study etc. Key words: Leaf Spring, Material Compositions.

In this paper they suggest that the Leaf spring suspension can use in heavy vehicle.to absorbs shock loads in automobile. They also discussed the incoming day the steel leaf can be replaced by the composite leaf spring. And also write about different type of leaf springs.Several studies have investigated the performance of wishbone suspensions and their potential advantages over other types of suspension systems. For example, a study by Kim et al. (2016) compared the ride comfort and handling stability of a wishbone suspension system to that of a MacPherson strut suspension system. The results showed that the wishbone suspension provided superior handling stability and reduced body roll compared to the MacPherson strut suspension.Another study by Meziane et al. (2019) examined the influence of different design parameters on the performance of a wishbone suspension system. The researchers investigated the effects of the length and orientation of the upper and lower wishbones, as well as the position of the shock absorber. The study found that optimizing these design parameters could significantly improve the performance of the suspension system in terms of ride comfort and handling.

III.METHODOLOGY

The methodology for designing and analyzing a wishbone suspension system can vary depending on the specific application and design requirements. However, a general methodology could include the following steps:

1) Determine the design requirements and constraints, including the vehicle weight,intended use, and packaging constraints.
2) Develop the suspension geometry, including the length and orientation of the upper and lower wishbones, the position of the steering axis, and the position of the shock absorber.
3) Determine the suspension kinematics, including the wheel travel, camber and caster angles, and bump steer.
4) Calculate the suspension forces and moments, including the spring and damperforces, the lateral and longitudinal forces, and the torque at the hub.

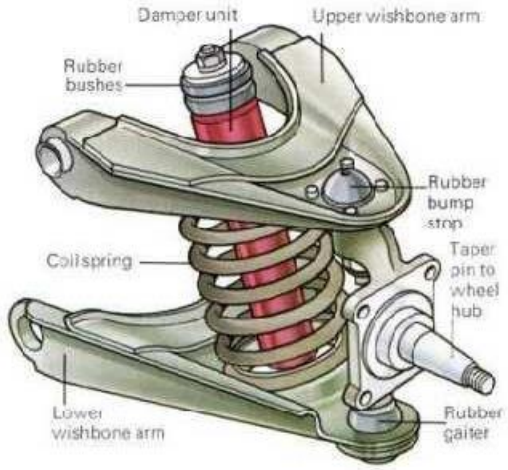
DOI: 10.17148/IJIREEICE.2023.11512

5) Choose appropriate suspension components, including the wishbone arms, shock absorbers, springs, and bushings.
6) Analyze the suspension system using computer simulation tools to assess its performance and identify any potential issues.
7) Optimize the suspension system based on the simulation results and adjust the design parameters as necessary.

Suspension system:
A motor vehicle have many components and processes,suspension system is also one of them. Suspension system is consist of tire springs, shock absorbers and linkages that's connects vehicle tochassis & wheels and allows relative motion between this two. Good suspension criteria is, vehicle should have good road holding, handling smooth ride Quality. The vehicle suspension maintain the forces & traction between wheels and road. The suspension system protects big cargo or glass, luggage from damage and wear, because of safe ride .the rear suspension and front suspension are may be different & depend on vehicle type. Suspension system have many types, like beam axle, dual beam suspension, double wish bone suspension, Macpherson strut suspension, leaf spring suspension. Thesuspension system components are links, springs, shock absorbers, camber, caster etc. good suspension design to perform *better*.

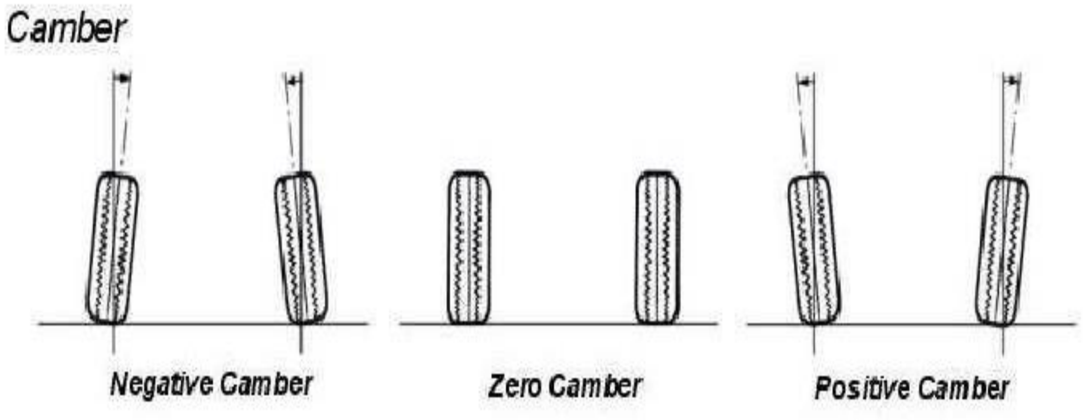
Purpose of suspension system:
- To absorb shocks and vibrations caused due to road irregularities. To transmit vehicle load to the wheels.
- To preserve the stability of vehicles while in motion.
- It maintain good contact of tyres with the road.
- To provide cushioning a drive comfort to the passengers.
- Its allow good cornering without high body role.
- To prevent excessive body squat or body drive.

ANALYSIS OF DOUBLE WISHBONE:
"The double-wishbone consists of Upper and Lower arms, Spring, Damper and wheel hub as shown in figure3. Arms have length utilizing spring and a shock absorber".



International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
ISO 3297:2007 Certified ⁒ Impact Factor 8.021 ⁒ Peer-reviewed / Refereed journal ⁒ Vol. 11, Issue 5, May 2023
DOI: 10.17148/IJIREEICE.2023.11512

oundaries of the Design:



IV. DESIGN CALCULATION

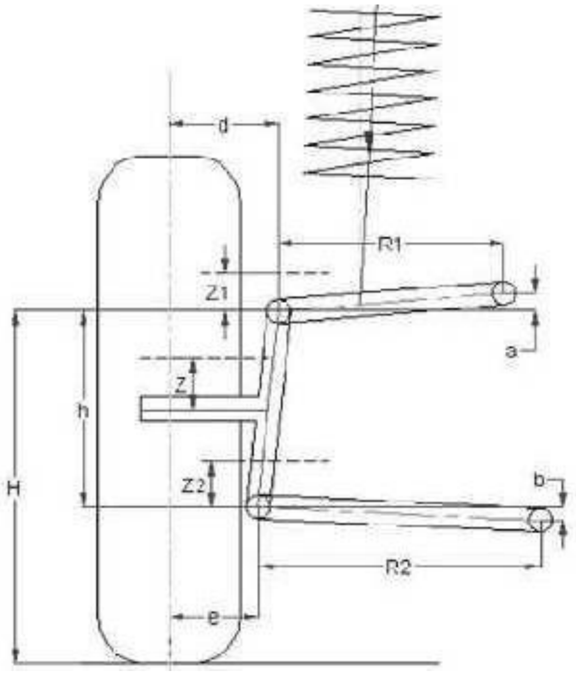


Figure 5 shows a wish bone structure's geometry. “Numerous parameters are asfollows: d-offset of upper arms,e-offset of lower arms,
H-Clearance of ground from ball joint,

h-distance between upper and lower ball joints,Z-Wheel center lift,
Z_1-Liftof upper arm,

R1-Length of upper arm,R_2-Length of lower arm,
a-Upper ball joint distance from with board,b-Lower ball joint distance from board,
Y_1-Displacement of upper ball joint,Y_2Displacement of lower ball joint,

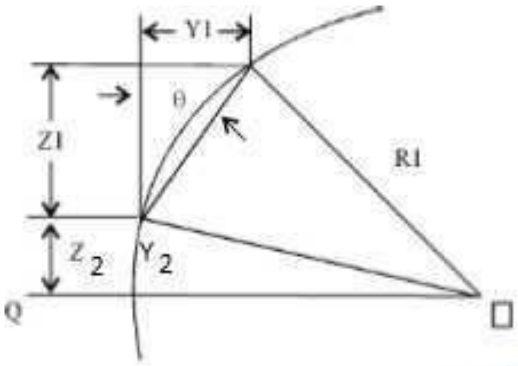
Z_1-Upper arm lift,Z_2-Lower arm lift.
For negative camber Angle R1>R2.

DOI: 10.17148/IJIREEICE.2023.11512

The desire bone structure measurements used for purposeof designing are as follows:
d = 97.5 mm, e = 92.5 mm, H = 439.4 mm, h = 279.4 mm Z = 50.8mm
Control arm length was calculated as:

$$Y_1 = \frac{Z_1^{\,2}}{R_1} + \frac{Z_1}{R_1} a$$

$$Y_2 = \frac{Z_2^{\,2}}{R_2} + \frac{Z_2}{R_2} a$$



$$Z_2 = Z\text{-}e\,\Theta = 50.8\text{-}92.5[\frac{2*\pi}{180}] = 54 \text{ mm}$$

$$Y_2 = Z_2 \operatorname{Tan} \Theta = \text{-}1.88\text{mm}$$

Z_1=50mm

Y_1= -1.74mm

In the equations Above we have: R2= 316 mm, R1= 200 mmWeight is around 1000kg and security factor 3.
Taking into account uniform mass distribution on both Rear and Front sides, massper wheel will be around 250 kg.

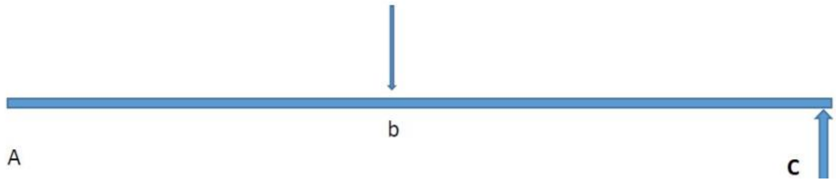


Figure 7 displays load supply for spring.

A is the point, b is spring location, c is center of wheel. Point of attachment from chassis end wishbone is of dual.
Force from the ground on wheel = (Mass per wheel * 9.81) N

= (250kg * 9.81) N = 2452.5 N

Distance of response force out of hinge stage is 408.5mm. Spring attachment tipfrom hinge stage is in 250.5mm. By taking time

2452.5 *408.5 = Spring Force * 158Spring Force = 6340.80 N
the best spring compression needs to be approx. 90 mm.
Desired Spring Stiffness=Dynamic Spring Force / Spring Deflection.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁑ Impact Factor 8.021 ⁑ Peer-reviewed / Refereed journal ⁑ Vol. 11, Issue 5, May 2023

DOI: 10.17148/IJIREEICE.2023.11512

= 16330.3/ 90 mm

= 181.5 N /mm

Taking spring indicator (C) as 8,Wahl's factor would be:

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C} = 1.184$$

Shear force acting on spring(τ) = K PC/πD^2 Hence Wire diameter (D) is 15.18mm = 20mmMean coil dimeter is C*d = 160mm

Number of active coils (δ) = 8P D^{2}N/GD^4 = 3

N is number of coils where D is diameter of the spring, De is coil pitch And G.Assuming that the spring has square and ground ends

Nt = N+2 =5coils

Solid length of spring = Nt*d = 140 mmTotal axial gap = (Nt– 1)*1 = 4

Free length = Solid length + Gap +δ = 236 mm"

V. CONCLUSION & FUTURE WORK

Conclusion:

You'll discover in this work layout of spring to get a double wish bone suspension structure has been examined. In order to generate pressure evaluation, simulations were ran springs and it had been utilized to determine pressure concentration space and find maximum pressure values compared with the results gained from fashion analysis. Values were interior design limits, so design. However, their energy consumption is yet comparable to that of internal combustion engine vehicles while conventional approaches can hardly achieve further significant amount of energy saving. This work is to inspire range of system-level energy saving research providing comprehensive survey on propulsion power, energy-efficient routes, nonpropulsion power, vehicle batteries, energy harvesting, power grids for electric vehicles.

Based on this research background, this paper deals with the design and the developments of a virtual prototype of an electric vehicle. This work is focused on the design of a mathematical model representing the engineering relevant aspects of an electric vehicle of class L7. In order to be able to carry out an analysis that takes into account the different forces acting on the system, a standard dynamic model with three degrees of freedom referred to as the half-car model is implemented. This mechanical model is further extended including also the longitudinal displacement of the vehicle in order to simulate appropriate driving cycles. The computer simulations are performed in MatlabSimulink environment, using the Simscape library. A proportional-integrative control is used for the system motion, which allows the vehicle to follow the standard WLTP class 1 driving cycle. The electric system of the vehicle is also modeled in Matlab-Simulink environment in order to determine the energy consumption. The proposed dynamic model allows for effectively performing the virtual prototyping of the electric vehicle of interest.

REFERENCES

[1] Pranav Upadhyay,Mrinal Deep,Aryan diwedi,Ashutosh agarwal,Pikesh bansal,Pradeepsharma, "Design and analysis of double wishbone suspension system",
[2] Pulkit solamki,Dr. Ajay kumar kaviti , "Study and review on the analyses of leaf spring",
[3] Priyanka kothari,Amit patel, "A review paper on design and analysis of leaf spring",
[4] Sadjyot biswal,Arvind prashant,Dr . R uday kumar,Shobhit deva,Aman gupta, "Designof a suspension system and determining suspension parameters of a medium downforces small formula type car" ,
[5] Hsin-Tsun Hsu , Christopher Coker, Hubert Huang. "Optimization of an Electric Vehicle Suspension System Using CAE", 2010,world electric vehical genral.
[6] Mohammad aadil sheikh. "Design of electric golf cart with batteries & solar panel for 6 seat capacity" ,2019, International Research Journal of Engineering and Technology(IRJET),(page no 2114 -2118)
[7] Michael Gifford,Tanner Landis,Cody woods, "Design and manufacturing of an adaptive suspension system", 2015
[8] Viganesh bs, Sufiyan ahmed,chandan v,Prashant kumar shrivastava, "Double wish bone suspension system ; a reaserach", International Conference on Mechanical and Energy Technologies (ICMET 2019).
[9] Pranav Upadhyay,Mrinal Deep,Aryan diwedi,Ashutosh agarwal,Pikesh bansal,Pradeepsharma, "Design and analysis of double wishbone suspension system", 2020