International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 07 | July - 2022 Impact Factor: 7.185 ISSN: 2582-3930

DESIGN AND ANALYSIS OF WISHBONE SUSPENSION SYSTEM

Mr. B. Phanindra Kumar[1], K. Pranadeep Reddy[2], K. Saideepak[2], P. Avinash Reddy[2]

[1]Assistant Professor, Mechanical Engineering, GNIT

[2] Student, Mechanical Engineering, GNIT

[2] Student, Mechanical Engineering, GNIT

[2] Student, Mechanical Engineering, GNIT

1 ABSTRACT

The Suspension of a road vehicle is normally planned with two targets specifically: to Isolate the vehicle body from road nonuniformity and to keep in touch of the wheels with the road. Independent suspension system can be given by an assortment of linkages between the stub hub conveying the haggle vehicle case. Most famous mixes in present day traveller vehicles are the Double wishbone suspension system. The Double wishbone designs can give vertical development near opposite comparative with the tier contact surface. The wishbone linkages course of action gives generally excellent wheel attachment and ideal wheel control. Furthermore, the Double wishbone suspension system gives a totally different scope of conceivable outcomes with respect to the use of PC frameworks which would give dynamic suspension control to suit different circumstances. The primary point of this project is to improve the thickness of the upper control arm of wishbone suspension system to stacking. The current undertaking work has made by catiaV5 for wishbone suspension utilizing. Pre-Processing steps, for example, refreshing of component type, material properties, use of load and boundary conditions.

Streamlining of the thickness of upper control arm, number of coils in spring and position of spring in an angle of wishbone suspension system is done in terms of decrease in its weight, increase absorbing and dampening shock. there by the decent expense, activity cost is diminished definitely. Thickness of the control arm is changed in various strides to advance it, so as a factor of safety for upper control arm fulfils the strength rules and the factor of safety is within the cut-off points.

Key Words: Suspension System, Double Wishbone Suspension , CatiaV5, Ansys.

2 INTRODUCTION

Suspension is an arrangement of tires, tire air, springs, shock absorbers, and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems have to take care of both handling and ride quality, which are at odds with each other. Suspension is the system that connects the vehicle's body (chassis) to its wheels and allows relative movement between the two and therefore isolates the vehicle from road shocks[1]. The suspension system consists of springs, shock absorbers (shock absorbers), linkages, levels and air which are filled into the shock-absorbing tires and provide better road grip/handling and ride quality to the occupants while driving, cornering and braking. The double-wishbone independent suspension system consists of control arms, springs, shock absorbers, and linkage mechanisms that connect a vehicle's wheel and roll cage. There are three different types of Suspension Systems are there, they are:

- Dependent suspensions.
- Semi – independent suspensions
- Independent suspensions

This type of suspension allows the wheel to travel without affecting the motion of the opposite wheel. This is a widely used suspension system in passenger cars, luxury cars and ATVs because of its advantages over dependent suspension systems. Following are the examples of independent suspension system.

- Macpherson Suspension: Used in front suspension of most of the commercial cars.
- Double Wishbone Suspension: Used in ATVs.
- Trailing Arm Suspension. Used in rear suspension of most of the commercial cars.

The double wishbone suspension is a very popular type of suspension found on midrange to high-end cars. It is an independent suspension design using two (occasionally parallel) wishbone-shaped arms to locate the wheel as shown in Fig. Each wishbone or arm has two mounting points connected to the chassis and one joint at the knuckle to accept the steering input. The shock absorber and coil spring are mounted on the wishbones to control its vertical movement. Double wishbone designs allow the engineer to carefully control the motion of the wheel throughout the suspension travel, controlling parameters such as camber angle, caster angle, toe, roll centre height, scrub radius, scuff and more thereby resulting in a better tuned suspension system for good ride, handling etc.

These parameters affect factors from lateral force to steering effort to anti-dive/and-squat characteristics of the vehicle. Two of the wheel parameters that significantly affect the car handling characteristics are camber and toe. The double-wishbone suspension can also be referred to as "double A-arms," though the arms themselves can be A-shaped, L-shaped, or even a single bar linkage. A single wishbone or Arm can also be used in various other suspension types, such as MacPherson strut and Chapman strut. The upper arm is usually shorter to induce negative camber as the suspension jounces (rises), and often this arrangement is titled an "SLA" or "short long arms" suspension.

3 LITERATURE SURVEY

Pranav Upadhyay[2] From literature survey that various software's are available to conduct analysis on suspension geometry and to conduct structural analysis of A-arms. Out of these software's they found out that a combination of Solid Works and Lotus. The analysis conducted by all the researchers has been done for various configuration of their vehicles. They are conducted analysis for tadpole geometry solar vehicle being manufactured for ESVC-2019. Analysis results for various configurations of A-arms are presented in paper and final optimized results for Lotus geometry are show cased in this paper. Main objective is to reduce weight and optimize geometry in order to maintain stability of vehicle and maintain traction with road.

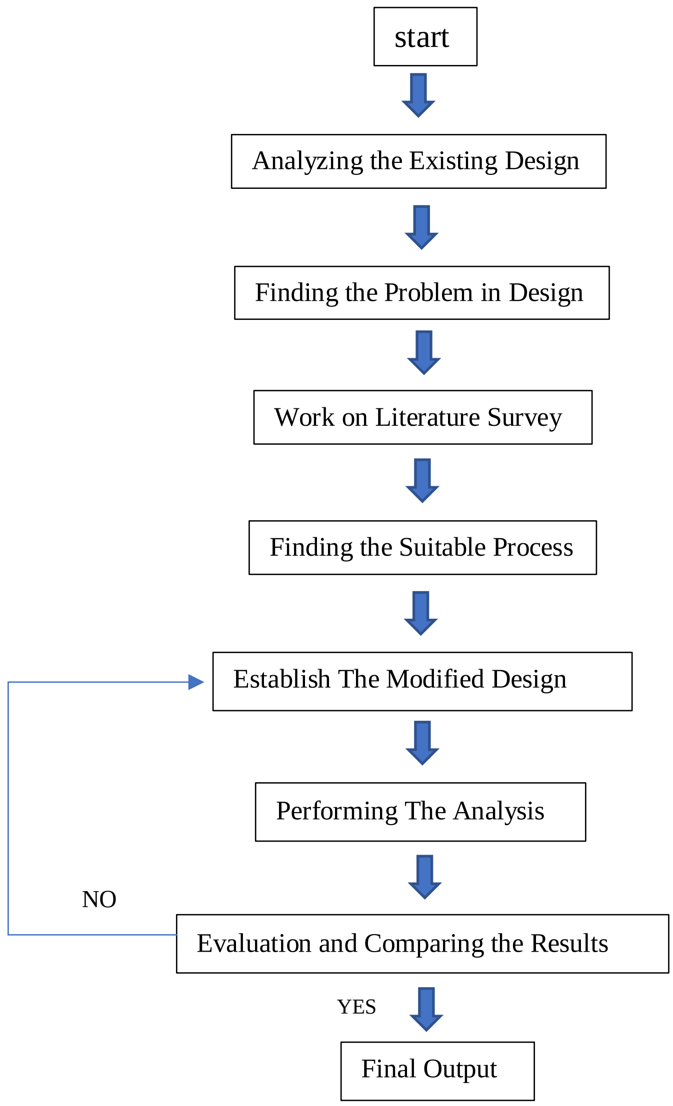
D.S.Balaji[3]This paper deals with the optimization of wishbone suspension system in car model. The car model is generated in a virtual representation with the suspension system and the analysis was done by ANSYS. The analytical values are calculated using vehicle dynamic values and they are entered in the ADAMS software. In this result reveals that the modification carried out in suspension is safe. The wheel travel is varied from -100 to 100 revolutions the corresponding scub radius is linearly increasing and reached till 36.750mm. The steering wheel has a maximum of 33.935degrees.

S. NARAYAN[4] The Role of paper is Shock absorber and Spring in double wishbone suspension method of analysis and design. Modelling of components and assembly is done in CATIA and finite element analysis has been done in applications ANSYS. The aim of project is to design a component in cost-effective. To determine pressure concentration space and find maximum pressure values compared with the results gained from analysis.

Suyash Yashwant Wagh[5]They produced a compact, lightweight, and reliable suspension system to increase vehicle performance. Combining analytical calculations result with FEA as it provides a good design. This paper gives a clear idea of how the forces are taken into consideration. Material is selected based upon calculated forces. Double-wishbone is designed using suspension points and dynamic force applied considering the factor of safety. Design is validated by using Ansys 16.0 software. This design is fabricated and tested in the Formula Student race car in all dynamic conditions.

G.Arun Kumar[6] In this paper, they observed that the enhanced design exhibits significant achievements for the Fork and Wishbone through the FEA Investigation. Following the design and recreating process, bulk and FOS are also provided with optimal Fork and Wishbone calculations using Autodesk Fusion 360° software. It also has the right methods for designing the suspension. The force and distortion outcomes for the improved DWSS elements are conducted within a sufficient well-being limit factor limit, which confirms the design and evaluation of the suspension parts. Generative design may ultimately be beneficial for reducing weight by up to 8% of the DWSS.

4 METHODOLOGY



5 MODELLING

Catia (PC supported three-dimensional intelligent application) is a multi-stage programming suite for PC helped plan (miscreant), PC helped producing (cam), PC helped designing (cae), plm and 3d, created by the French organization Dassault frameworks.

Catia empowers the production of 3d sections, from 3d portrays, sheet metal, composites, shaped, fashioned or tooling parts up to the meaning of mechanical gatherings. The product gives propelled advances to mechanical surfacing and biw. It gives devices to finish item definition, including utilitarian resistances and additionally kinematics definition. Catia gives an extensive variety of uses for tooling outline, for both generic tooling and mold & die.

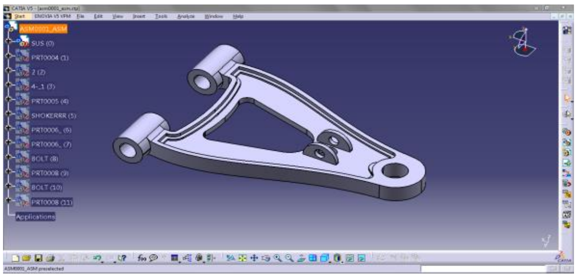


Fig. 5.1 Lower Arm

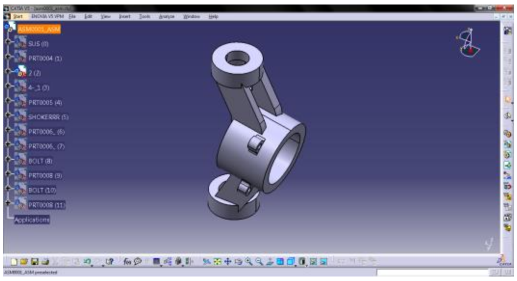


Fig. 5.2 Lower Arm

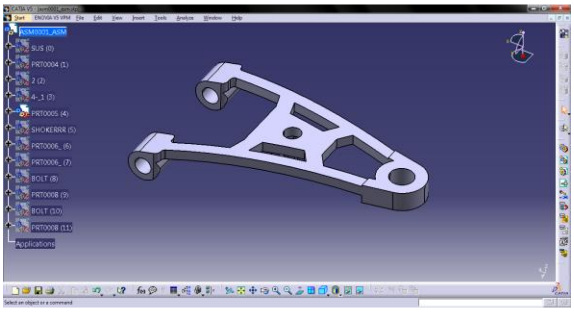


Fig. 5.3 Upper Arm

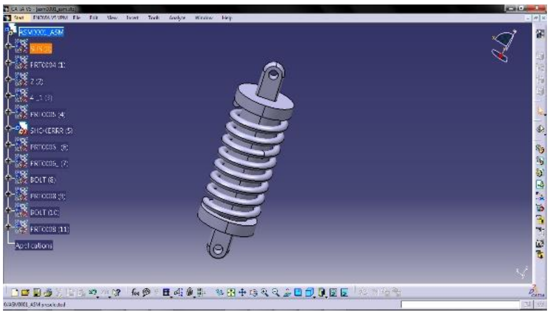


Fig. 5.4 Shock absorber

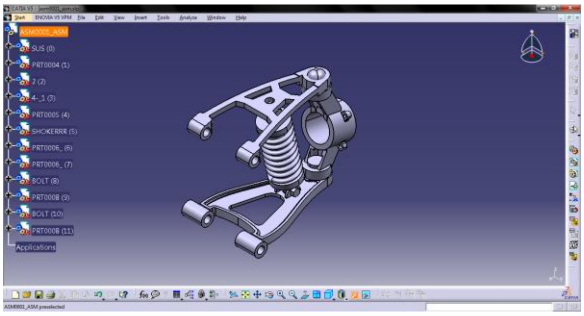


Fig. 5.5 Assembly

6 ANALSYS

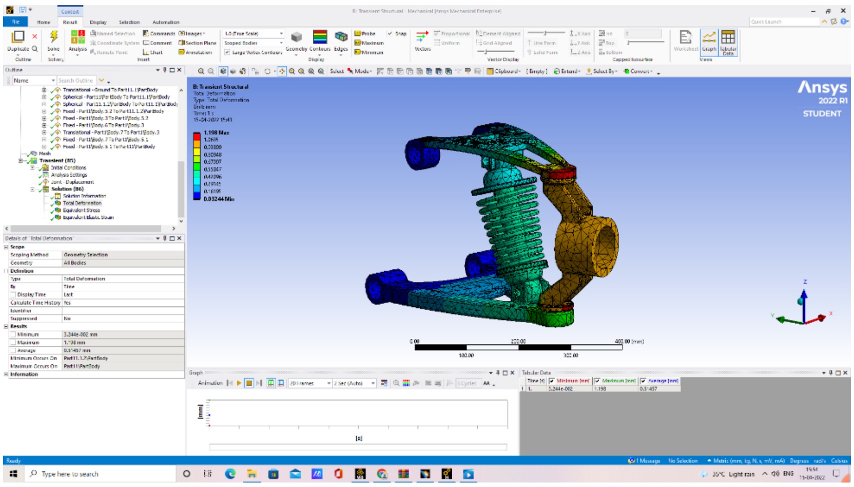


Fig. 6.1 Stress Analysis of Wish Bone Suspension System

After mesh the model, it is required to specify the boundary and loading conditions.

1. In the Mechanical window, select the Static Structural node from the Tree Outline; the Details of "Static Structural" window is displayed along with the Environment contextual toolbar.
2. Choose the Fixed Support tool from the Supports drop-down in the Environment contextual toolbar; Fixed Support is added under the Static Structural node. Also, the Details of" Static Structural" window is displayed.
3. Select faces on the model. Next, choose the Apply button in the geometry selection box; the selected faces turn purple indicating that Fixed support is applied.
4. Choose the Apply button from the geometry selection box; the cylindrical face turns red indicating that the Force load is applied.
5. In the Details of "Total Deformation" window, expand the Results node, if it is not already expanded. Note that the maximum and minimum deformations displayed are respectively.

   By Analysis of wishbone suspension system above figures shows damage at the upper arm hinge.

7 MATERIAL SELECTION:-

➢ MS AISI 1018

Based on our research, we have concluded to use AISI 1018 for suspension arms, lifters and spacers. The composition includes Carbon (0.14% - 0.20%), Iron (98.81% - 99.26%), Manganese (0.6% - 0.9%), Phosphorus (less than or equal to 0, 04%), Sulfur (less than or equal to 0.05%). These have better properties than the competition, i.e., the maximum strength is 270 MPa compared to S235 at 160 MPa maximum. It has 9% higher shear strength and 8% higher compressive strength than S235. The properties owned are

1) Ultimate tensile strength = 355 Mpa
2) Yield Strength = 275 Mpa
3) Elongation = 17%
4) Bulk Modulus = 145 GPa
5) Shear Modulus = 29 GPa
6) Poisson's Ratio = 0.33
7) Machinability = 60%

The price is Rs 65 /kg vs. 60/kg for Steel S235 but for the properties it possesses the extra cost is worth it.

➢ Aluminium Alloy 7075 T6

Based on our research we have concluded that to use Aluminium Alloy 7075 for Bell-Crank. Chemical Composition of this Alloy includes:- Silicon(0.4%), Copper(2%), Magnesium(2.9%), Manganese (0.3%), Iron(0.5%) , Chromium(0.28%), Zinc(6.1%), Titanium(0.2%) and remaining is Aluminium. The price of the alloy is 600/kg.

Properties of the alloy includes:-

1) Density = 2.8 gm/cc
2) Melting Point = 483°C
3) Tensile Strength = 220 MPa
4) Fatigue Strength = 160 Mpa

5) Hardness = 60 Hv

The tensile strength of 7075-T6 is nearly double to that of 6061-T6 having 276 MPa.

The shear strength of 7075-T6 is roughly 1.5 times to that of 6061-T6 having 207 MPa

- **Steel S335**

Based on our research we have concluded that to use Steel S335 for Rod Ends and Arm Ends.

The maximum Carbon and manganese concentrations are higher for S355 thus making it strong as well as flexible enough to withstand the repeated load that will act on it during the working of the system.

The concentration of C is 0.20 – 0.24% and of Mn is 1.6%, respectively for S335.

8 PROBLEM STATEMENT

The double-wishbone suspension system is independent. This design allows the All-Terrain vehicles (ATV) engineers to control the wheel's motion throughout suspension travel, controlling the parameters such as camber angle, caster angle, toe, roll center height, and scrub radius.

They are a force transmitting and kinematic part, so dynamic stability is the most crucial factor. Designing by using lightweight material along with it being cost-efficient is the recent discovery many teams are trying to develop. In the era of upgrading trends, many teams are trying to evolve in a world full of research related to advanced materials.

9 OBJECTIVES

The objective of our project was to study the static parameter of the suspension system of an ATV by determining and analysing the dynamics of the vehicle when driving on an off-road racetrack. Though, there are many parameters which affect the performance of the ATV, the scope of this project work is limited to optimization, determination, design and analysis of suspension systems and to integrate them into whole vehicle systems for best results.

10 RESULTS

After considering different parameters on arms of double wishbone suspension system below results were obtained.

Table 2 Change of Weights Due to Modification on Suspension System

S.no	Modal	Attempt 1	Attempt 2	Attempt 3	Attempt 4	Attempt 5	Attempt 6	Attempt 7	Attempt 8
	Weight	No Changes	Change Of Upper	Change Of Lower	Spring	Spring + Upper	Spring + Lower	Lower + Upper	All Changes
1	Complete	432.48	437.44	439.58	451.87	442.549	452.87	440.42	453.82
2	Upper Wise Bone	20.306	25.415	20.306	20.306	25.415	20.306	25.415	25.415
3	Lower Wise	32.395	32.395	33.359	32.395	32.395	33.359	33.359	33.359

	Bone								
4	Spring	1.9345	1.9345	1.9345	5.9486	5.9486	5.9486	5.9486	1.9345
5	Lower Suspension	8.3006	8.3006	8.3006	8.3006	8.3006	8.3006	8.3006	8.3006

Table 6 Results for Ansys Workbench

S. No	Type	Results
1	Total Deformation	1.0011 Mm
2	Equivalent Stress	305.68 Mpa
3	Life	6616.3
4	Damage	1.51E+05

By considering different parameters for selection of materials like MS AISI 1018 and Aluminium alloy 7075T6 having maximum strength as 270MPa and 276MPa respectively.

11 CONCLUSION

From literature survey above it is evident that various software's are available to conduct analysis on suspension geometry and to conduct structural analysis of A-arms. Out of these software's we found out that a combination of CatiaV5 and Ansys will suit our purpose. The analysis conducted by all the researchers has been done for various configurations of their vehicles. We are conducting analysis for tadpole geometry solar vehicles being manufactured for ESVC. Analysis results for various configurations of A-arms are presented in paper and final optimized results for geometry are showcased in this paper. The objective is to reduce weight and optimize geometry in order to maintain stability of the vehicle and maintain traction with the road.

REFERENCE

1. Milliken William F. Race Car Vehicle Dynamics. Society of Automotive Engineers, 1995
2. M. D. Pranav Upadhyay1, "Design and analysis of double wishbone suspension system," nternational Conference on Mechanical and Energy Technologies, 2020.
3. D.S.Balaji and .Umanath, "DESIGN AND ANALYSIS OF THE DOUBLE WISHBONE," Journal of Advanced Research in Dynamical and Control Systems, 2/09/2017.
4. F. O. M. &. S. NARAYAN, "DESIGN AND ANALYSIS OF DOUBLE WISHBONE SUSPENSION SYSTEMS FOR AUTOMOTIVE APPLICATIONS," International Journal of Mechanical and Production , Nov 14, 2019.
5. S. Y. Wagh and Eshita Amal Nandi, "Design and Analytical Calculations of Double Wishbone for Formula Student Race Car," International Journal of Engineering Research & Technology (IJERT), 09/09/2020.
6. G. A. Kumar and Parthiv Manepalli, "Design optimization of double wishbone suspension system for motorcycle," International Conference on Advances in Thermal Engineering and Application, 2021.