

# Review on The Design and Analysis of Vehicle Suspension System

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**Abstract-In automobiles, a double wishbone suspension is an independent suspension design using two wishbone-shaped arms to support the wheel and the maximum load is transferred from upper wishbone arm to the lower arm which may cause failure and bending of lower wishbone arm. The developed lower control arm consists of three holes at one end, which are fixed to the wheel hub and other end is connected with chassis which is placed in between the steering link. In this study, topology optimization approach is presented to create a new design of a lower control arm.**

**Keyword - Double wishbone suspension, lower control arm.**

## I. INTRODUCTION

A vehicle suspension system is introduced from the point of view of ride comfort, handling and safety. Also the perception of ride comfort has been presented using various standard graphs showing human tolerance criteria. Various types of vehicle models taken for analysis of ride dynamics have been presented. An overview of types of the shock absorbers has been presented along with introduction to modeling and simulation [1].

The tendency of the automobile manufacturers has been to produce upper end, high-grade automobiles. The suspension of these automobiles should be of appropriate isolation characteristics. This has made the automobile engineers to develop new approaches to the design of the dampers/shock absorbers, which play an important role in the control of vibration amplitude of the vehicle system, especially in the neighborhood on the resonance [2].

Although some active and semi-active suspension systems have been developed and successfully implemented in practice, the requirement of an external energy source and control systems with a large number of sensors limit the application of active suspension to the cases where the performance outweighs the disadvantages associated with costs and complexities [3].

The cost, complexities and the chatter associated with semi active "on-off" control may still be prohibitive for its general applications. Thus the designers have to consider appropriate changes in the passive suspension system to obtain better vibration isolation characteristics over a wide range of excitation frequency. Traditionally, automotive suspension designs have been a compromise between the three conflicting criteria of road holding, load carrying and passenger comfort. The suspension system must support vehicle body, provide directional control during handling maneuvers and provide effective isolation of passenger/payload from road disturbances. Good ride comfort requires a soft suspension, whereas insensitivity to applied loads requires stiff suspension, while good handling requires a suspension setting somewhere between the two. Due to these conflicting demands, suspension design has had to be something of a compromise. So a typical passive suspension system is usually a compromise between the aforementioned conflicting demands. That means once it is installed in the car, its character changes little.

A passive suspension system of a road vehicle traditionally consists of a spring and a damper mounted in parallel [4]. The spring supports the static weight of the mass, while the damper/shock absorber dissipates the energy from disturbances. The damper and the spring are

interposed on a vehicle between its sprung mass (the vehicle body) and the unstrung mass.

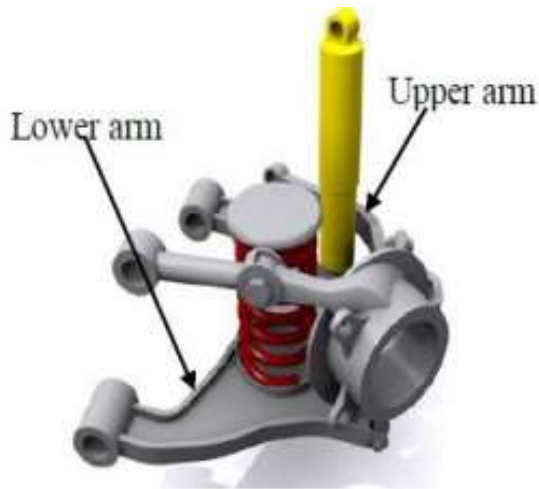


Figure 1: Suspension system

## II. LITERATURE REVIEW

**Bankole I et al [1]** In this paper, an investigation was carried out on vehicle suspension system (VSS) by employing Finite Element Analysis (FEA) to analyze the fatigue life, von misses stress, factor of safety and stability of the suspension system and how the weight and size can be reduced. Solidworks14® was employed to analyze different materials used in the design and development of VSS; comparison amongst the various materials used was carried out to inform that there can be reduction in the size and weight of the four suspension system by using Titanium Ti-13V-11Cr-3Al Treated, which will drastically reduce the weight of the car and give better result of strength and durability, ultimately reducing CO<sub>2</sub> emission and its negative effect on the climate. This innovative design can be introduced as a reference for the automotive industry.

**Vi Kie Soo et al. [2]** the use of lightweight materials and multi-material concepts in car manufacturing has been focused to produce more sustainable vehicles. This has resulted in significant reduction of carbon dioxide (CO<sub>2</sub>) emissions during use phase to achieve the strict vehicle emission standards. Nevertheless, the varied range of joining techniques used to join multi-material vehicle designs presents challenges at the end-of-life, especially the feasibility of current recycling processes to recover materials in a closed-loop recycling.

**Youli Zhu et al. [3]** this paper analyzed why a compression coil spring fractured at the transition position from the bearing coil to the first active coil in service, while the nominal stress here should always be much less than that at the inside coil position of a fully active coil. Visual observations indicated that a wear scar was formed on the first active coil and the fracture surface showed radiating ridges emanating from the wear scar. Scanning electron microscopy examination showed crescent shaped region and beach marks, typical of fatigue failure. ZnCaph phosphate layer and painting around the contact zone were worn out due to contact and friction and resulted in corrosion and corrosion pits induced local stress concentration. Stress analysis indicated severe stress singularities at the edges of the contact zone, which facilitated cycle slip and fatigue crack nucleation. Recommendations were also made for improving the fatigue performance of the suspension springs.

## III. COMPROMISE BETWEEN STABILITY AND COMFORT

Automotive customers are demanding vehicles with both improved comfort and improved handling. The damping constant of the damper determines both stability of vehicle and the comfort of travelers. A heavy suspension with firm springs and dampers with high damping characteristics will yield good vehicle handling and stability keeping the tyres in contact with the road and preventing frame oscillations and other problems, but will also transfer most of road oscillations to the passengers causing an uncomfortable ride. However a light suspension with soft springs and dampers with low damping characteristics will yield a more comfortable ride, but at the same time can reduce the stability of the vehicle. Therefore, it is general practice to make a compromise between stability and comfort while designing a passive suspension system.

## IV. VEHICLE RIDE MODELS

To study the ride quality of ground vehicles, various ride models have been developed. For a passenger car with independent front suspension, a seven degrees-of-freedom model may be used. In this model, the pitch, bounce and roll of the vehicle body, as well as the bounce of the two front wheels, and the bounce and roll (tramp) of the solid rear axle are taken into consideration. The mass representing the wheel, tire, brakes and part of the suspension linkage mass is referred to as unstrung mass

and mass of the frame, body, engine, transmission and any part that moves directly with the frame and body is referred to as sprung mass. For a cross-country military tracked vehicle a fifteen degrees-of-freedom model may be used, which includes the pitch, bounce, and roll of the vehicle body and the bounce of the each road wheel.

**V. METHODOLOGY**

In methodology, the steps are discussed. Mainly two steps are there. First is design the component and second is analysis with meshing. Design is done in 3D modelling CATIA, meshing and analysis is done in HYPERMESH. Initially we have developed the existing model using CATIA, based existing geometry. CATIA model is meshed with the help of HYPERMESH and analysis is carried out for two different materials (base material: Mild steel, using HYPERWORKS. After completion of the analysis of existing model, the optimized model using topology optimization and the analysis is carried out for the optimized model with the same materials used for existing model. Based on the results in this study, we proposed the best suited material for the lower control arm.

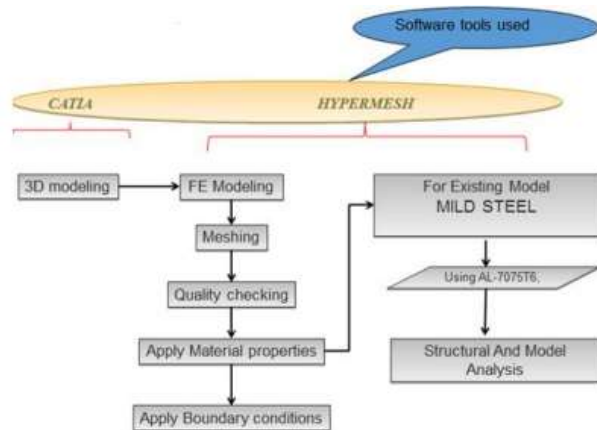


Figure 2: Methodology

**VI. PROCESS METHODOLOGY USED IN TOPOLOGY OPTISTRUCT**

Topology optimization is a method which distributes the density of an initially homogenous volume to achieve a certain objective function while observing the defined constraints. Minimize volume is usually considered as an objective function, while the stress acts as a constraint and with manufacturing constrain such as draw direction. Topology optimization is often used in the early design

process to define the optimum part layout. The optimized models performance in the form of stiffness and strength evaluation is done and linear static analysis is carried out using RADIOSS according to fulfil the design and testing standard values.

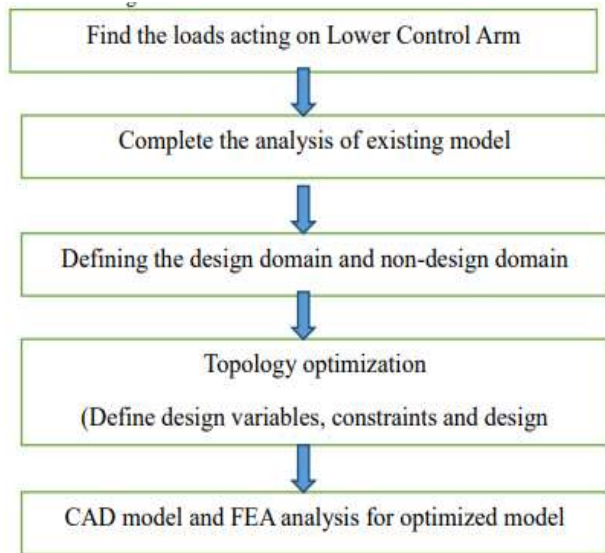


Figure 3: Flow chart for Optimization

**VII. CONCLUSION**

Topology optimization approach is presented to create a new design of a lower control arm. It was concluded that the process of the topology optimization involves the material distribution, which resulted that the weight of the existing industrial component is reduced. The lower control arm can further undergone weight reduction using the different materials.

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