

# **Review: Design and Failure analysis of Front Lower Suspension Arm of Car**

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**ABSTRACT:** Suspension systems have been widely applied to vehicles, from the horse-drawn carriage with flexible leaf springs fixed in the four corners, to the modern automobile with complex control algorithms. The suspension of a road vehicle is usually designed with two objectives to isolate the vehicle body from road irregularities and to maintain contact of the wheels with the roadway. The suspension link allows wheels to rise and fall on their own without affecting the opposite wheel. In this case, the wheels are either not connected at all or are connected through universal joints with a swing axle. Suspensions with other devices, such as anti-roll bar that link the wheels in some way are still classed as independent suspension link. Suspension arm is one of the main components in the suspension systems. Uneven tyre wear, suspension noise or misalignment, steering wheel shimmy or vibrations are the main causes of the failure of the lower suspension arm. Most of the cases the failures are catastrophic in nature. So the structural integrity of the suspension arm is crucial from design point of view both in static and dynamic conditions. This paper presents design, modelling and analysis of car front suspension lower arm to study the stress condition and to select the suitable materials for the front suspension lower arm. The main objectives of this study to determine critical locations and strain distributions of the component. The paper aims to complete Finite Element Analysis of the front suspension lower arm which consist the stress optimization loadings and analysis for deformation.

**KEYWORDS:** lower Suspension System, Fatigue Failure, Vehicle Modelling, Fea Analysis.

## **I. INTRODUCTION**

The vehicle suspension system is responsible for driving comfort and safety as the suspension carries the vehicle-body and transmits all forces between body and road. Positively, in order influence these properties, semi-active or active components are introduced, which enable the suspension system to adapt to various driving condition.

From a design point of view, there are two main categories of disturbances on a vehicle namely the road and load disturbances. Road disturbances have the characteristics of large magnitude in low frequency (such as hills) and small magnitude in high frequency (such as road roughness). Load disturbances include the variation of loads induced by accelerating, braking and cornering. Therefore, a good suspension design is concerned with disturbance rejection from these disturbances to the outputs. A conventional suspension needs to be "soft" to insulate against road disturbances and "hard" to insulate against load disturbances. Consequently, the suspension design is an art of compromise between these two goals. The Wishbone lower arm is a type of independent suspension used in motor vehicles. The general function of control arms is to keep the wheels of a motor vehicle from uncontrollably swerving when the road conditions are not smooth. The control arm suspension normally consists of upper and lower arms. The upper and lower control arms have different structures based on the model and purpose of the vehicle. By many accounts, the lower control arm is the better shock absorber than the upper arm because of its position and load bearing capacities In the automotive industry, the riding comfort and handling qualities of an automobile are greatly affected by the

suspension system, in which the suspended portion of the vehicle is attached to the wheels by elastic members in order to cushion the impact of road irregularities.

The specific nature of attaching linkages and spring elements varies widely among automobile models. The best rides are made possibly by independent suspension systems, which permit the wheels to move independently of each other. In these systems the unsprung weight of the vehicle is decreased, softer springs are permissible, and front-wheel vibration problems are minimized. Spring elements are used for automobile suspension, increasing order of their ability to store elastic energy per unit of weight.

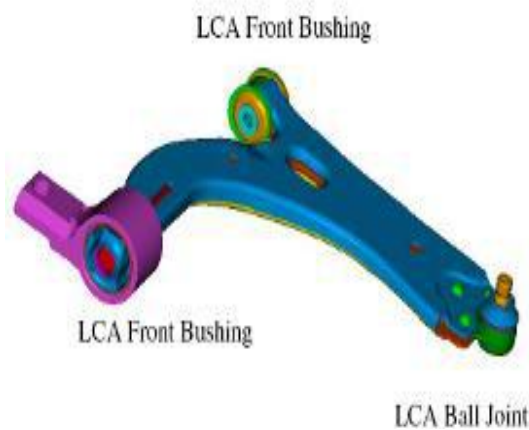


Fig. 1.1: Front Lower Arm

Suspension arm is one of the main components in the suspension systems. It can be seen in various types of the suspensions like wishbone or double wishbone suspensions. Most of the times it is called as A-type control arm. It joins the wheel hub to the vehicle frame allowing for a full range of motion while maintaining proper suspension alignment. Uneven tyre wear, suspension noise or misalignment, steering wheel shimmy or vibrations are the main causes of the failure of the lower suspension arm. Most of the cases the failures are catastrophic in nature. So the structural integrity of the suspension arm is crucial from design point of view both in static and dynamic conditions. As the Finite Element Method (FEM) gives better visualization of this kind of the failures so FEM analysis of the stress distributions around typical failure initiations sites is essential. Therefore in this dissertation work it is proposed to carry out the structural analysis of lower suspension arm of light commercial vehicle using FEM.

The suspension arm gets more attention by many researches like study dynamic analyses of the motor vehicle suspension system using the point-joint coordinate's formulation. The mechanical system is replaced by an equivalent constrained system of particles and then the laws of particle dynamics are used to derive the equations of motion. Modelling and simulation are indispensable when dealing with complex engineering systems. It makes it possible to do an essential assessment before systems are developed. It can alleviate the need for expensive experiments and provide support in all stages of a project from conceptual design, through commissioning and operation. The most effective way to improve product quality and reliability is to integrate them in the design and manufacturing process.

### 1.1 Role of Suspension System

1. It supports the weight of the vehicle.
2. Provides a smoother ride for the passengers.
3. The transmission medium is shared.
4. Keeps the wheels firmly pressed to the ground for better traction.
5. It isolates the vehicle from road shocks.

### 1.2 Type of Suspension System

The following types of suspension systems are generally available in the market:

**1. Mechanical Suspension System:**

a) Independent Suspension

The independent suspension system, allows one wheel to move upward and downward with a minimum effect on the other wheel (Figure 1.2). Mostly of the passenger cars and light truck use independent front suspension system, because provide much more space for installing vehicle engine, allow much more displacement of wheel, better resistance in steering vibration (wobble and shimmy) as well as offer higher performance in passenger comfort .

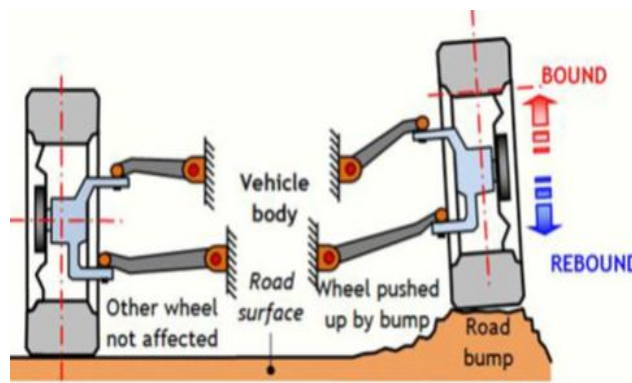


Fig 1.2: The independent suspension system (front view)

- i) Leaf Spring Suspension
- ii) MacPherson Suspension
- iii) Wishbone Suspension

b) Dependent Suspension

Dependent suspension system is the system in which two wheels (front or rear) are connected to each other by one continues rod called as trailing rod. In this system if any bump or potholes disturb to one wheel automatically pair wheel also affected because of trailing rod. The trailing rod is shown by arrow in figure 1.3.



Fig 1.3: Old Vehicle Dependent System

**2. Electric Suspension System**

**3. Magnetic Suspension System**

**1.3 Selection of Lower Arm Suspension System**

The selection of front lower Suspension Arm was done based on the following basic Parameters:

- 1. Load bearing capacity

2. Flexibility
3. Cost
4. Technical aspects: Camber, Stiffness, Rolling
5. Availability of parts and components

## II. LITERATURE REVIEW

### A. Dattatray Kothawale , Dr. Y.R.Kharde

This paper describe analysis of lower suspension arm using F.E.A. Approach. This paper was prepare CAD Model using PRO-E Software & finite element analysis using Ansys software. The important significance of analysis is to check the structural strength of LCA using dynamic forces. The aim of this paper analysis is to show the how finite element analysis is helping in complete product development cycle. Because it going to saves lot of cost, as every vehicle having generally 3-4 stages in complete product development cycle, stages are Proto-I, Aplha-II, Gamma-III & Beta-IV. This paper was show the validation of finite element analysis results with actual physical sample testing. In this Study they concluded that a how much the results by using analysis software as well as physical testing of model are similar or not [1].

### B.Mr.Balasaheb Gadade, Dr.R.G.Todkar

This paper describe Design, analysis of A-type front lower suspension arm in commercial vehicle. The main objective of this study was to calculate working life of the component under static loading. The A-type lower suspension arm was developed by using CAD software. Actual model was manufacture as per design by using AISI 1040 material. This paper result wasthis model imported in the hyper mesh. After meshing apply load on hub bush they found the weaker section in the model But it is require validating the FEA results with actual experimental test. To validate the FEA results we create a typical A-type suspension arm of same material of AISI 1040.as per the consideration in FEA we constraint two bushes and load apply on remaining wheel hub bush on universal testing machine. The load goes on increasing and at last they found the stress in material at maximum stressed area [2].

### C. Mr Prashanthasamy R.M.T, Dr. Sathisha, Mr. Jnanesh k.

This paper describes Design and analysis of lower wishbone suspension arm using FE approach. In this study is made on existing design with aluminium alloy. The 3D model was generated by Hyper Mesh and the Static and dynamic analysis was conducted by Abaqes.3d Cad Model of the design created and FE model of the design was created. Analysis under Static and modal condition was done. Based on the result obtained in analysis the design was optimized in different stage. They concluded that the stresses and deformation for the existing design with aluminium alloy is almost maximum compare to AISI 1040.New Design was developed to reduce stress and deformation existing in the current design with aluminium alloy. Finally they was concluded that from the FE analysis the new design 1 and new design 2 can be replaced with aluminium alloy existing design with AISI 1040 for Wishbone Suspension System [3].

### D. Prof. A. M. Patil, Prof. A.S. Todkar, Prof. R. S .Mithari

This paper describes Experimental & Finite Element Analysis of Left Side Lower Wishbone Arm of Independent Suspension System. Under the static load conditions deflection and stresses of steel lower wishbone arm and composite lower wishbone arm are found with the great difference. Carbon fibre suspension control arms that meet the same static requirements of the steel ones they replace. Deflection of Composite lower wishbone arm is high as compared to steel lower wishbone arm with the same loading condition. The redesigned suspension arms achieve an average weight saving of 27% with respect to the baseline steel arms. The natural frequency of composite material lower wishbone arm is higher than steel wishbone arm.

**E. Hemin M. Mohyaldeen's**

This thesis describes the analysis of lower automobile suspension arm using stochastic design improvement technique. The objectives of this study are to characterize the dynamic behaviour, to investigate the influencing factors of lower suspension arm using FEM incorporating design of experiment (DOE) and artificial neural network (ANN) approach and to analyse the lower suspension arm using robust design method. The structural three-dimensional solid modelling of lower arm was developed using the Solid works computer-aided drawing software [5].

**F. Patik S. Awati , Prof. L. M. Judulkar**

The paper aims at complete FEM analysis of a suspension link for bending vibrations, pitching, bouncing and combined mode dynamic analysis for deformation and stresses. For this a 3-D solid parametric model of a suspension link is used for this. Multi body system approach is used to determine the loads acting on the suspension component and the body pickup point as inputs to finite element models of the component or vehicle structure. As they have studied the result from ansys the safe mode by considering the result obtained in step 5, so the method they have used to add U shaped plate for our component to make it stiff and reduce the failure at the chassis connection point is valid one[4].

### III. PROBLEM DEFINITION

Due to the different functions control arm is important part in components suspension system. As vehicle passes through bump, speed breaker etc. different types of forces acting on the wheels which are transmitted to control arm via attachments i.e. ball joint assembly etc. to the wheel. These force and torque values are mentioned in the load case. So in this analysis the main concern is to find out the maximum stress region and stress value in control arm and compare this value with tensile yield strength of material and results of experimental testing of control arm at the same load which are mentioned in load case of control arm.

### IV. PROPOSED WORK

From the review of the literature on structural analysis lower suspension arm it is seen that there is a scope for research work in the area of stress analysis of the lower suspension arm. As such, it is proposed to carry out theoretical and experimental studies on stress analysis of lower suspension arm used in light commercial vehicles. For this purpose following work will be carried out:

**Theoretical Analysis:**

- i. Lower suspension arm will be selected for the suitable light commercial vehicles. The detailed 3 Dimensional model will be formulated in the suitable CAD software. Then based on the suspension system mechanics, the operating load will be calculated for the arm.
- ii. Finite element method will be used for the stress analysis of the lower suspension arm. This will be carried out using suitable element which will cause less time for the solution.

**Experimental Analysis:**

An experimental setup will be designed and developed to determine the stress distribution at the critical locations of the lower suspension arm. The experimental results will be correlated with the results obtained by design equations and those obtained by FEM analysis.

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**REFERENCES**

- [1] Dattatray Kothawale, Dr. Y.R.Kharde "Analysis of Lower Control Arm in Front Suspension System Using F.E.A. Approach" International Journal of Engineering Research And Development Volume 5 Issue 12 Feb 2013.
- [2] Mr. Balasaheb Gadade, Dr. R.G. Todkar "Design and Analysis of A- type Front Lower Suspension arm in Commercial vehicle" International Research Journal of Engineering and Technology (IRJET) Volume 2 Issue 7 Oct 2015.
- [3] Mr. Prashanthasamy R.M.T, Dr. Sathisha, Mr. Jnanesh k. "Design And Model Analysis Of Lower Wishbone Suspension Arm Using F.E. Approach" Imperial Journal Of Interdisciplinary Research (IJIR) Volume 2 Issue-9, 2016.
- [4] Patik S. Awati, Prof. L. M. Judulkar "Model and Analysis of Lower Wishbone Arm Along with Topology" International Journal Application Of Innovation in Engineering & management" Volume-3 Issue-5 May 2014.
- [5] Mr. Sushilkumar p. Taksande, Dr. A.V. Vanalkar "Methodology for Failure Analysis Of Car Front Suspension Lower Arm- a Review" International journal for Scientific Research & Development Volume-3 Issue- 5, 2015.
- [6] Prof. A. M. Patil, Prof. A.S. Todkar, Prof. R. S. Mithari "Experimental & Finite Element Analysis of Left Side Lower Wishbone Arm of Independent Suspension System" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 7, Issue 2 (May. - Jun. 2013), PP 43-48.
- [7] Hemin M. Mohyaldeen University Malaysia Pahang.
- [8] Shirahatt, A., Prasad, P.S.S., Panzade, P., Kulkarni, M.M., 2008, "Optimal Design of Passenger Car Suspension for Ride and Road Holding". Journal of the Brazilian Society of Mechanical Sciences and Engineering, Vol. 30, No. 1.