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Lower Wishbone Modeling and Analysis for Commercial Vehicle Independent Suspension System

T. Prabaharan[1], A. Bovas Herbert Bejaxhin[2*], P. Periyaswamy[3], N. Ramanan[4], K. Ramkumar[4] and Chandramohan. P[5]

[1]Department of Mechanical Engineering, St. Peter's University, Chennai-600 054, Tamilnadu, India. E-mail: prabaezhile1977@gmail.com

*[2]*Associate Professor, Department of Mechanical Engineering, Saveetha School of Engineering, SIMATS, Chennai, E-mail: herbert.mech2007@gmail.com*

[3]Assistant Professor, PSN Engineering College, Tirunelveli. E-mail: Ramananinjs2020@gmail.com.

[4]Assistant Professor, Department of Mechanical Engineering, Dhanalakshmi Srinivasan Institute of Technology, Tiruchirappalli, Tamilnadu, India. E-mail: ramkumar.k@dsit.ac.in

[5] Professor, Department of Mechatronics Engineering, Rajalakshmi Engineering College, Chennai.

Abstract

The primary goal of this paper is to design and analyse the entire double wishbone suspension system for a commercial vehicle in order to improve the vehicle's stability and handling. The suspension system has seen tremendous advancement. A commercial vehicle's suspension system must be long-lasting, light in weight, efficient, and cost-effective. The vehicle must be able to withstand the harsh off-road terrain environment. As a result, it is critical to concentrate on the stress strain analysis study of the lower wishbone arm in order to improve and modify the existing design.

Keywords: *Wishbone Arm, Independent suspension, Finite Element Analysis, ANSYS software.*

1.0 Introduction

The A-arm is another name for the Lower Wishbone. Wishbones are suitable for all-wheel independent suspension systems. Read on to learn more. A wishbone has two mountings on a car's chassis and one to locate the wheel to which it is connected. A double wishbone set up is so named because two rods are used on the two mounting points. Double wishbones add stability to high-speed wheel movements, reducing camber angle as the wheel moves up and down uneven surfaces. Wishbones are simple to adjust because every joint can be tweaked for optimal wheel movement. A double wishbone (or upper and lower A-arm) suspension is an independent suspension design in automobiles that uses two (occasionally parallel) wishbone-shaped arms to locate the wheel.

During normal operation, the maximum load is transferred from the upper wishbone arm to the lower arm, which increases the possibility of failure and bending of the lower wishbone arm at the ball joint location, as well as the control arm, due to the high impact load produced by the road condition. As a result, it is critical to concentrate on the stress strain analysis study of the lower wishbone arm in order to improve and modify the existing design. Composite materials are also replacing current conventional materials (mild steel).

*Corresponding author

2.0 Materials and Methods

Objectives Overview

The work is completed on the four wheel drive's left Lower Control Arm. Some durability tests on the entire vehicle were performed to identify problems in the vehicle. During the testing, force was measured, which served as the foundation for the stress limit check of the Independent Suspension Link in the actual working environment. A thorough investigation of the rolling, pitching, and braking effects on the link is carried out using Modal Analysis and the Finite Element Approach in Ansys software. Also, compare the two materials and select the best material for wishbone.

Modeling of Wishbone

The physical geometry of the lower wishbone link created with Cero software is required for the finite element model. The observation of the actual physical model is also required to validate or compare it with the model created at our location. As a result, we provided an onsite photograph of the wishbone model for comparison with the CAD model.

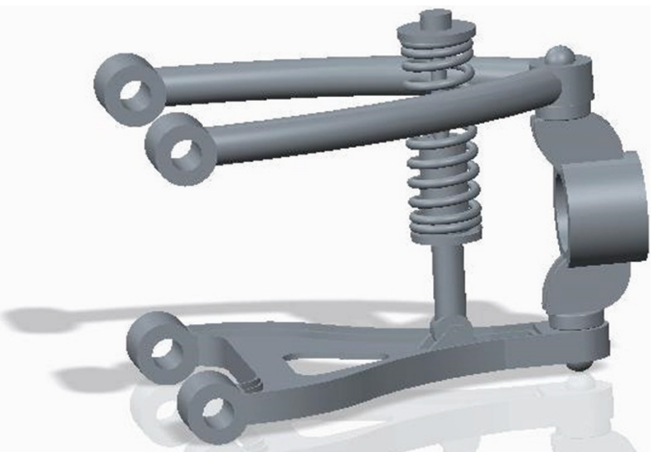


Figure 1: Model of wishbone

Finite Element Mesh Generation

Following model validation, the Finite Element Mesh is generated. Because the computations are so large, a very fine mesh causes a hardware space problem. The total degree of freedom of the model increases as the number of nodes increases. As a result, a designer must model it optimally, using fine mesh only in critical areas and coarse mesh in the rest. As a result, run times are reduced, and accuracy is improved.

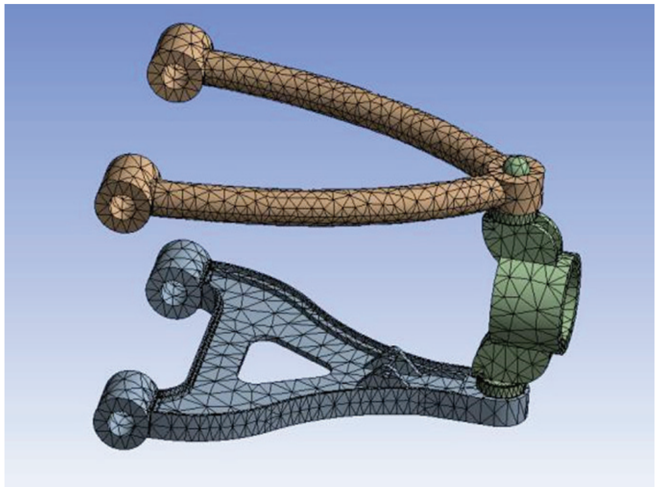


Figure 2: Meshing structure of wishbone

Selection of Material

Material consideration for the wishbone becomes the most important design and fabrication requirement. The material's strength should be sufficient to withstand all loads acting on it in dynamic conditions. A number of factors influence material selection, including carbon content, material properties, availability, and the most important parameter, cost. The main criteria were improved material strength and weight, as well as the lowest possible material cost. Carbon Fiber Polymer (Composite Material) is now used instead of Mild Steel, which was previously used.

3.0 Results and Discussion

Stress Examination Process in FEA

W1 = 5500 is the load applied to the Lower Wishbone Arm. The results of the stress analysis by ANASYS Software are shown in Figure 4. Graphical Representation of Stress at Different Load Conditions is Shown in Figure 3.

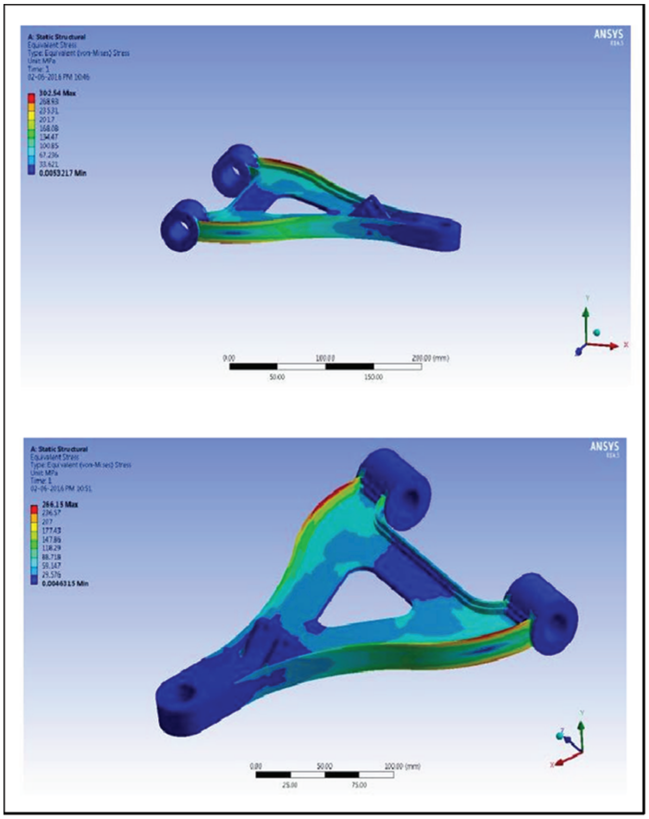
Strain AnalysisProcedure in FEA

W1 = 5500N is the load applied to the lower wishbone arm. The maximum and minimum strain values are then determined by ANASYS, and the results are shown in Fig.4.

Graphical representation of strain at different load conditions is given by.

Deformation Analysis Procedure in FEA Wishbone Arm

The load applied on Lower Wishbone Arm is W1 = 5500N. Then maximum and minimum total deformation values are



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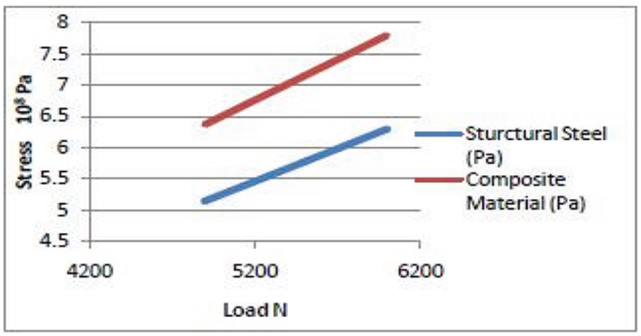
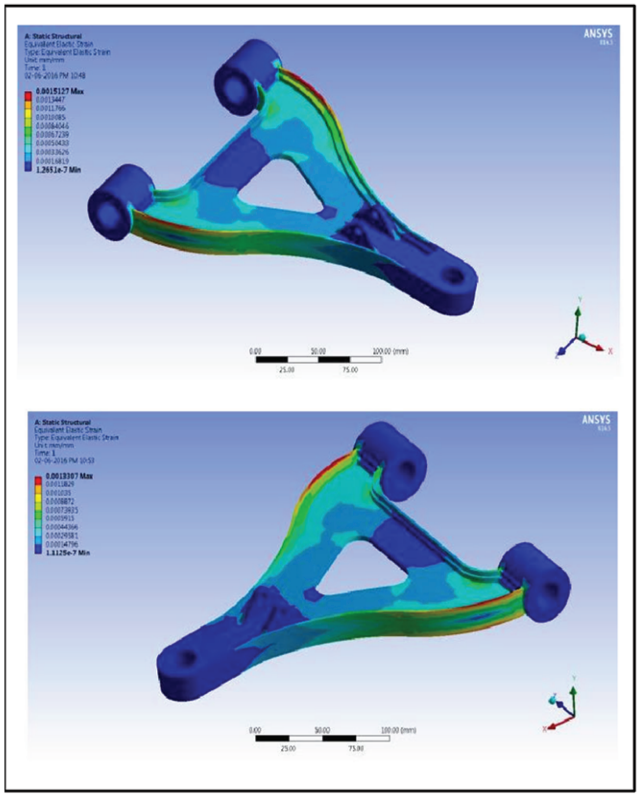


(b)

Figure 3: (a) Stress in Lower Wishbone Arm in structural steel and composite material, (b) Load curve between Stress and Load for SS and Composite material

Table 1: Load variation result on structural steel and composite material

Load (N)	Structural Steel (Pa)	Composite Material (Pa)
4900	5.1421e8	6.3719e8
5500	5.71717e8	7.1522e8
6000	6.2964e8	7.8024e8



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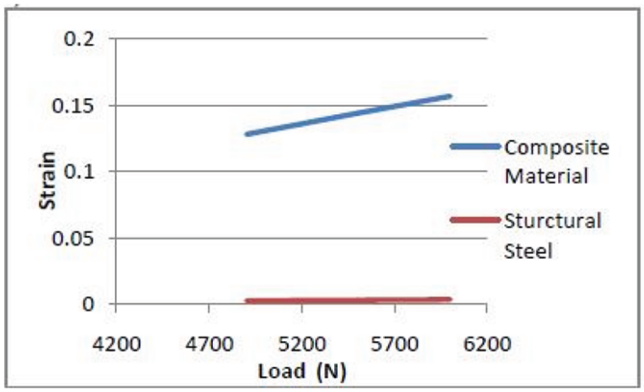
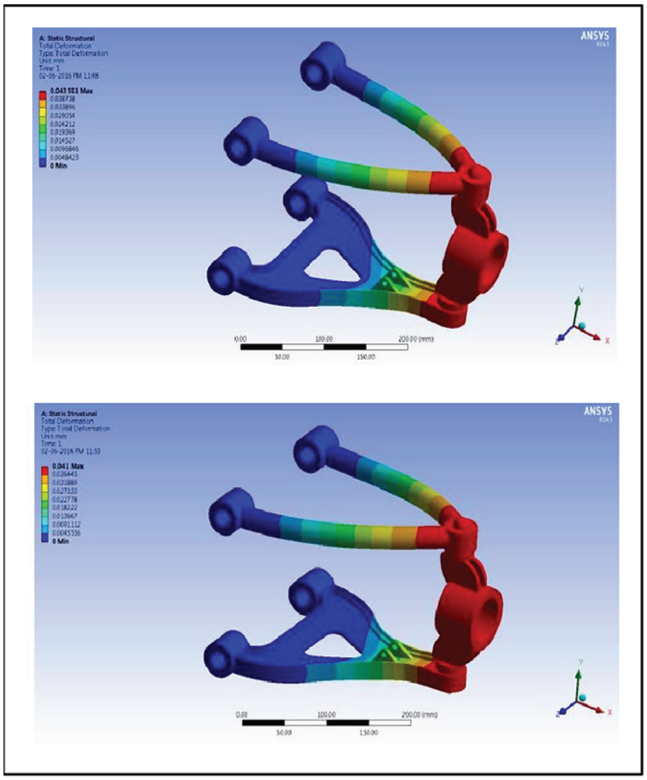


(b)

Figure 4:(a) Lower Wishbone Strain Arm made of structural steel and composite materials. (b)Steel and composite strain-versus-load curves

Table 2: Load variation result on structural steel and composite material

Load (N)	Structural Steel	Composite Material
4900	0.002571	0.12804
5500	0.002885	0.14372
6000	0.0031482	0.15679



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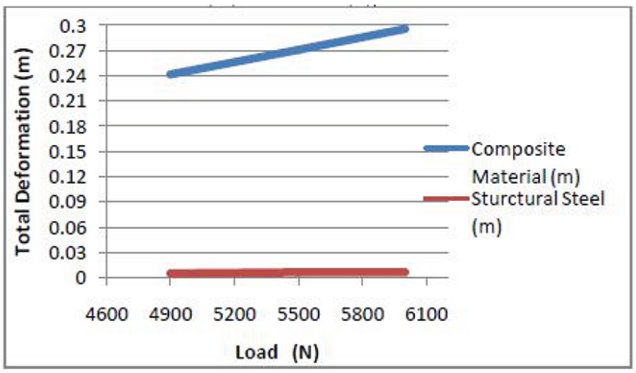

(b)

Figure 5: (a) Wishbone Arm deformation in structural steel and composite material, (b) Total Deformation (M) vs Load Graph (N)

Table 3: Load variation result on structural steel and composite material

Load (N)	Structural Steel (m)	Composite Material (m)
4900	0.0056037	0.24123
5500	0.0062898	0.27076
6000	0.0068616	0.29538

found by ANASYS the results are given by following Fig.5.

The graphical representation of total deformation under various load conditions is provided by (Table 3).

4.0 Conclusion

Under static load conditions, the deflection and stresses of a steel lower wishbone arm and a composite lower wishbone arm differ significantly. Carbon fibre suspension control arms that meet the same static requirements as steel suspension control arms. The deflection of a composite lower wishbone arm is greater than that of a steel lower wishbone arm under the same loading conditions. In comparison with the baseline steel arms, the redesigned suspension arms save an average of 18% in weight.

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