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Experimental & Finite Element Analysis of Left Side Lower Wishbone Arm of Independent Suspension System

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Abstract : *The Wishbone control 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. It has an "A" shape on the bottom known as wishbone shape which carries most of the load from the shock received. The lower control arm takes most of the impact that the road has on the wheels of the motor vehicle. It either stores that impact or sends it to the coils of the suspension depending on its shape.*
During the actual working condition, the maximum load is transferred from upper wishbone arm to the lower arm which creates possibility of failure in the arm. Similarly, impact loading produces the bending which is not desirable. Hence it is essential to focus on the stress strain analysis study of lower wishbone arm to improve and modify the existing design. The present study will contribute in this problem by using finite element analysis approach.
Keywords – *Lower Wishbone Arm, Independent suspension, Finite Element Analysis, ANSYS software.*

I. Introduction

The Lower Wishbone is also called A-arm. Wishbones can be used in an all wheel independent suspension setup. Read on to know more a wishbone has two mountings on the chassis of a car and one to locate the wheel it is connected to. Because two rods are used on the two mounting points it is called a double wishbone setup. Double wishbones provide more stability to wheel movements at high speeds which reduces camber angle as the wheel moves up and down over uneven surfaces. Wishbones can be very easily adjusted as every joint can be tweaked for optimal wheel movement. In automobiles, a double wishbone (or upper and lower A-arm) suspension is an independent suspension design using two (occasionally parallel) wishbone-shaped arms to locate the wheel.

During the actual working condition, the maximum load is transferred from upper wishbone arm to the lower arm which is possibility of failure & bending of lower wishbone arm at the ball joint location as well as control arm because of high impact load by produces road condition which is not desirable. Hence it is essential to focus on the stress strain analysis study of lower wishbone arm to improve and modify the existing design. Also current conventional material (mild steel) is replaced by composite materials (Carbon fiber polymer).

The current car used double wishbone suspension arm built from mild steel and it can affect the weight of vehicle. Therefore, in order to make new improvement and overcome this problem, a study about car suspension has been carry away and it involving composite material. Carbon fiber polymer has proven for it strength beyond the steel and provide less weight. By apply this fact; the study about car suspension in composite form has taken place.

II. Solid Modeling Of Lower Wishbone Arm In Catia V5 R17

To carry out FEM analysis of any component, the solid model of the same is essential. It is also called body in white. So the solid model of Independent Suspension is require and this can be done in special CAD package like CATIA V5 R17.

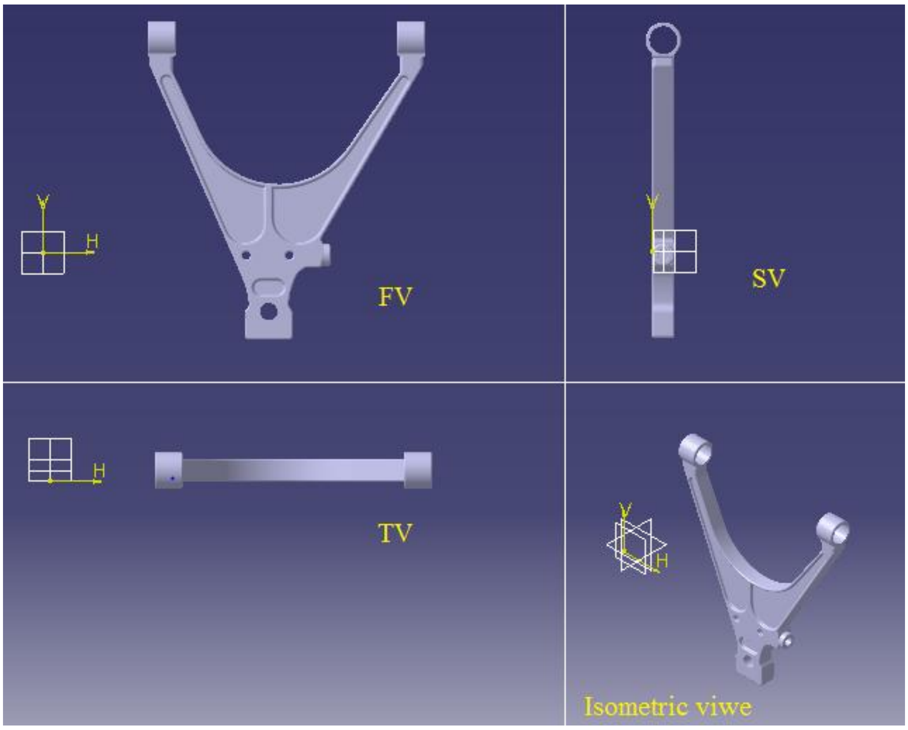


Fig. 1.1 CATIA Modeling of Lower Wishbone Arm.

III. Stress Analysis Procedure In Fea:-

- The load applied on Lower Wishbone Arm is **W1 = 4900N.** Then stress analysis by **ANASYS** Software the results are given by following fig.

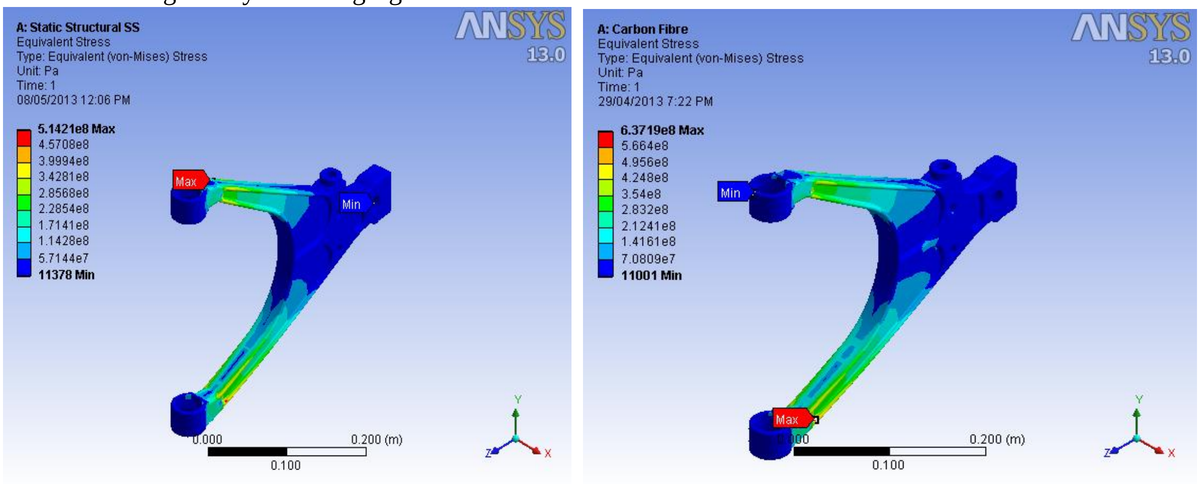
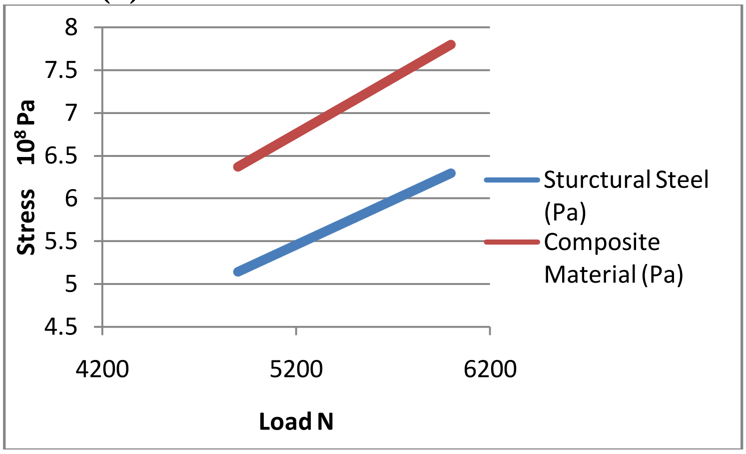


Fig. 1.2 Stress in Lower Wishbone Arm in structural steel & composite material.

- **GRAPHICAL REPRESENTATION OF STRESS AT DIFFERENT LOAD CONDITIONS IS GIVEN BY.**

SR. NO.	LOAD (N)	STRUCTURAL STEEL (Pa)	COMPOSITE MATERIAL (Pa)
1.	4900	5.1421e8	6.3719e8
2.	5500	5.7717e8	7.1522e8
3.	6000	6.2964e8	7.8024e8

STRESS (10^8 PA) VS LOAD (N) CURVE:-



- The load applied on Lower Wishbone Arm is **W1 = 4900N.** Then maximum & minimum strain values are found by **ANASYS** the results are given by following fig.

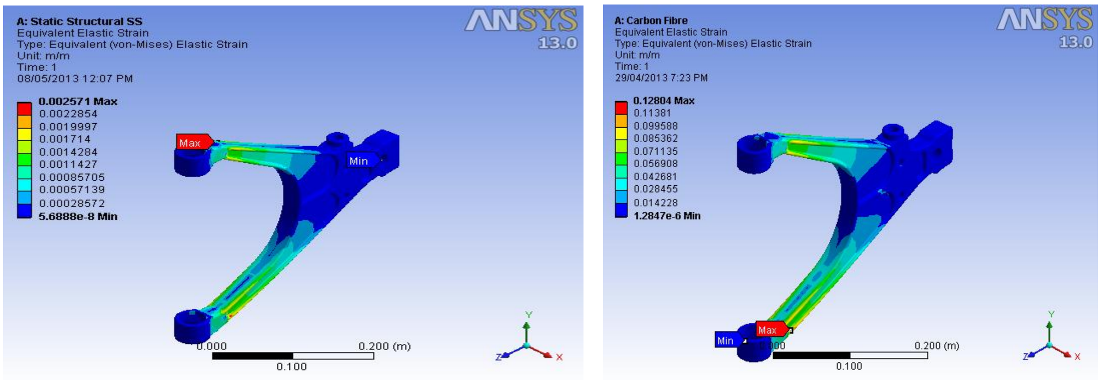
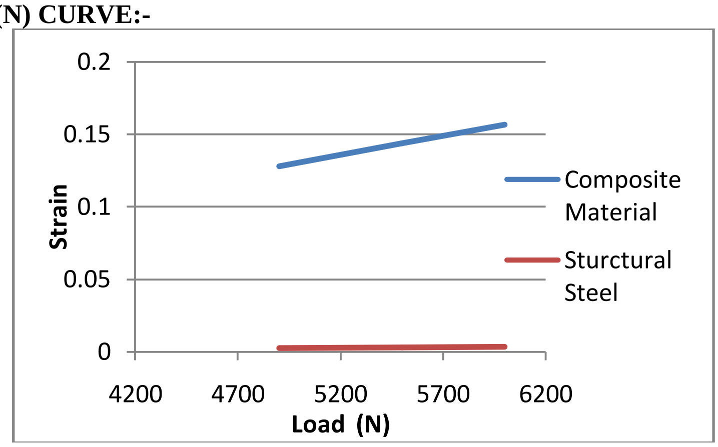


Fig. 1.3 Strain in Lower Wishbone Arm in structural steel & composite material.

- **GRAPHICAL REPRESENTATION OF STRAIN AT DIFFERENT LOAD CONDITIONS IS GIVEN BY.**

SR. NO.	LOAD (N)	STRUCTURAL STEEL	COMPOSITE MATERIAL
1.	4900	0.002571	0.12804
2.	5500	0.002885	0.14372
3.	6000	0.0031482	0.15679

STRAIN VS LOAD (N) CURVE:-



- The load applied on Lower Wishbone Arm is **W1 = 4900N.** Then maximum & minimum total deformation values are found by **ANASYS** the results are given by following fig.

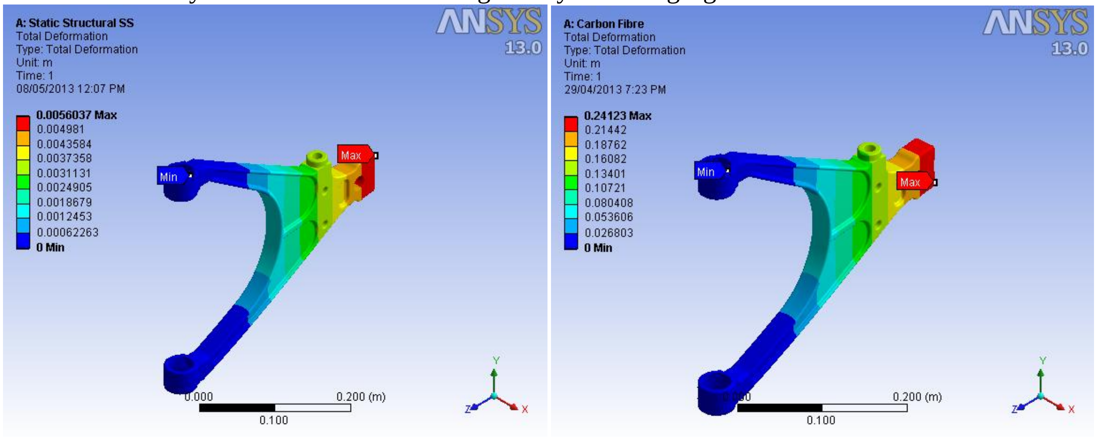
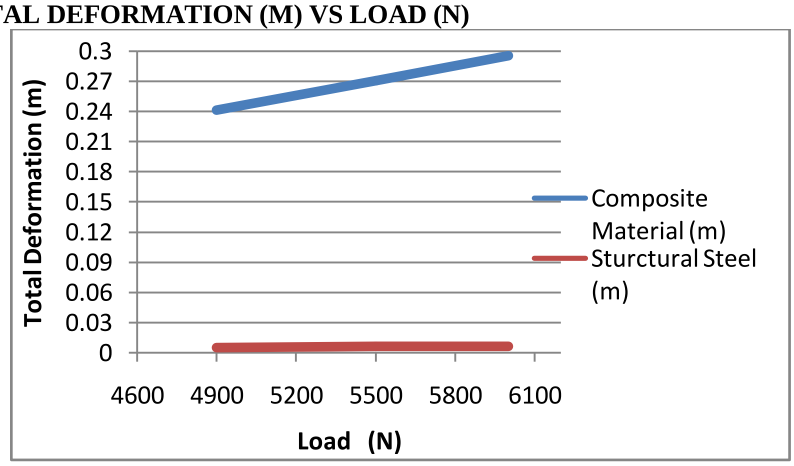


Fig. 1.4 Total deformation in Lower Wishbone Arm in structural steel & composite material.

- **GRAPHICAL REPRESENTATION OF TOTAL DEFORMATION AT DIFFERENT LOAD CONDITIONS IS GIVEN BY.**

SR. NO.	LOAD (N)	STRUCTURAL STEEL(m)	COMPOSITE MATERIAL (m)
1.	4900	0.0056037	0.24123
2.	5500	0.0062898	0.27076
3.	6000	0.0068616	0.29538

GRAPH OF TOTAL DEFORMATION (M) VS LOAD (N)



Natural Frequency measurement by FFT Analyzer:

Frequency response Function of Independent Suspension Link gives the natural frequency at the peaks with corresponding amplitude at respective location of accelerometer on the Link.

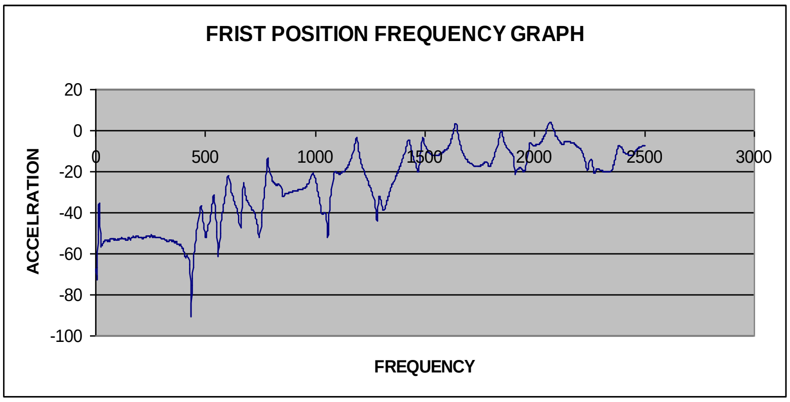


Fig.1.5 frequency graph at position near front control arm

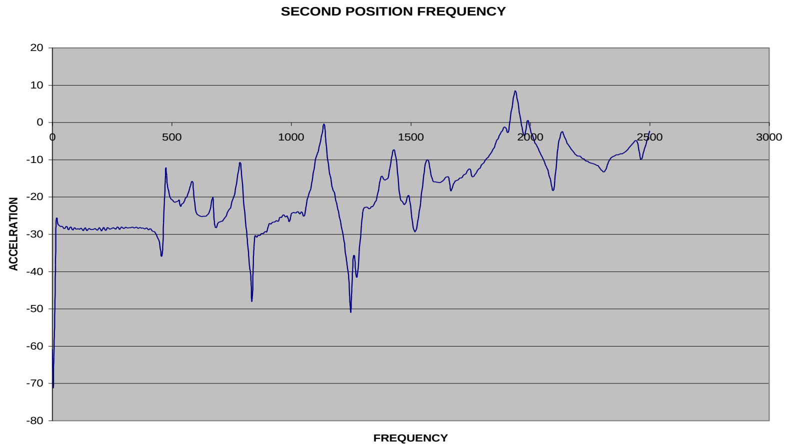


Fig.1.6 frequency graph at position near rear control arm.

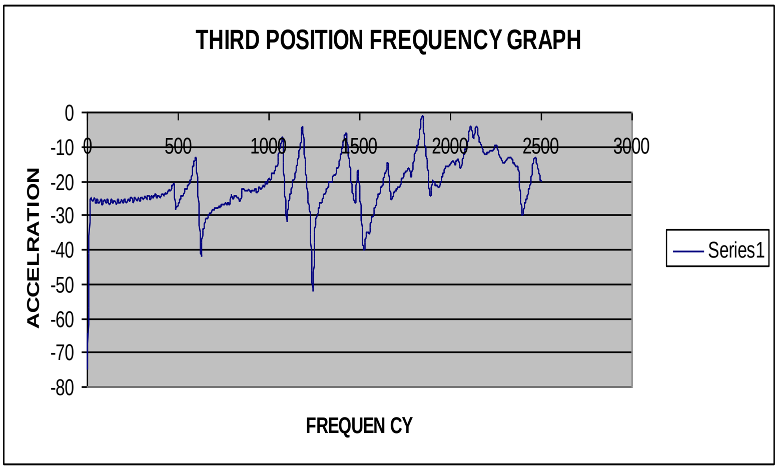


Fig.1.7 frequency graph at position near wheel centre

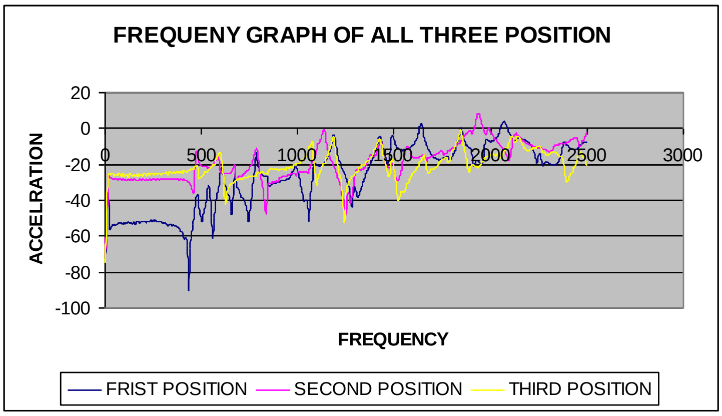


Fig.1.8 frequency graph at all three position near front control arm

IV. Comparisons of Natural frequencies by FEM and Experimental Method.

In the present study modal analysis of Independent Suspension Link is done by Fem as well as Experimental method. Now to obtain the validation for FEM result we can compare those with the experimental results. The below table gives the comparison of natural frequencies obtained by Fem and Exponential method along with percentage difference at error obtained for Independent Link.

Sr. No.	Natural Frequency by ANSYS in Hz	Experimental Natural Frequency in Hz	Percentage deviation
1	577.76	481.125	16.72
2	694.05	596.875	13.99
3	826.55	793.75	3.96
4	842.33	859.375	-2.02
5	1023.7	1071.875	-4.7
6	1185.1	1184.375	0.0061
7	1245.9	1378.125	-1
8	1329.3	1428.125	-7.38
9	1363.6	1490.46	-9.3
10	1485.1	1556	-4.7

Table 7.3: Comparison of Natural Frequencies by FEM and Experimental Method.

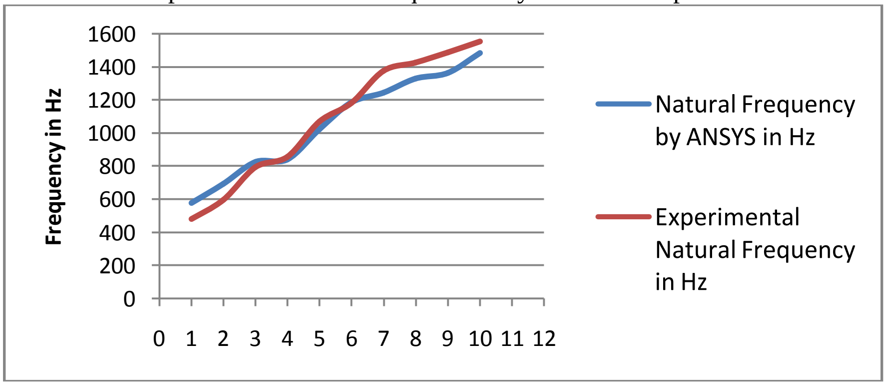


Fig.1.9 Comparison of Natural Frequencies

Remark: The Four channel F.F.T. Analyzer is used for experimentation. The average percentage deviation in experimental natural frequencies and natural frequencies by ANSYS software are found to be 6.3756 %.

IV. Conclusion

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 fiber 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.

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