Performance Analysis of Two Mono Leaf Spring used for Maruti 800 Vehicle

Jadhav Mahesh V, Zoman Digambar B, Y R Kharde, R R Kharde

Abstract: ***In this paper we look on the suitability of composite leaf spring on vehicles and their advantages. Efforts have been made to reduce the cost of composite leaf spring to that of steel leaf spring. The achievement of weight reduction with adequate improvement of mechanical properties has made composite a very replacement material for convectional steel. Material and manufacturing process are selected upon on the cost and strength factor. The design method is selected on the basis of mass production.***

From the comparative study, it is seen that the composite leaf spring are higher and more economical than convectional leaf spring. After prolonged use of conventional metal Coil Spring, its strength reduces and vehicle starts running back side down and also hits on the bump stoppers (i.e. Chassis). This problem is entirely removed by our special purpose Composite leaf Springs.

Keywords: Ansys 14.0, Mono composite leaf Spring, Pro-E Wildfire 4.0

I. INTRODUCTION

In order to conserve natural resources and economic, energy, weight reduction has been the main focus of automobile manufactures. Mono leaf springs are simple forms of springs, commonly used for the suspension system in wheeled vehicles. Vehicle suspension system is made out of springs that have basic role in power transfer, vehicle motion and driving. Therefore, springs performance optimization plays important role in improvement of car dynamic. The automobile industry tends to improve the comfort of user and reach appropriate balance of comfort riding qualities and economy. There is increased interested in the replacement of steel leaf spring with composite leaf spring due to high strength to weight ratio.

On the other hand, there is a limitation at the amount of applied loads in springs. The increase in applied load makes problem at geometrical alignment of car height and erodes other parts of car. So, springs design in point of strength and durability is very important. Reduction of spring weight is also principal parameter in improvement of car dynamic. By replacement of steel leaf spring with composite leaf spring will reduce spring weight in addition to resistance raise under the effect of applied loads. In this paper, a static analysis is employed to investigate behavior of steel and composite leaf spring related to light vehicle suspension system. Steel spring has been replaced by three different composite leaf in ANSYS software and results have been compared with analytical solution. The objective is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. Advanced composite fibers such as glass, carbon and Kevlar- reinforced suitable resins, are expected to be widely used in vehicle suspension system application so that spring of different shapes can be obtained. This refers to the high specific strength (strength – to- density ratio) and high specific modules (modules – to-density ratio) of this advanced composite materials. Although epoxy is relatively sensitive to moisture, it has better mechanical property relative to other polyesters.

Many industries are manufactured steel leaf spring by EN 47 material; these materials are widely used for production of parabolic leaf spring and conventional multi leaf spring. Leaf spring absorbed the vertical vibrations, shocks and bumps loads (induced due to road irregularities) by means of spring deflection, so that the potential energy stored in the leaf spring and then relieved slowly. Ability to store and absorb more amount of strain energy insures the comfortable suspension system.

II. MATERIALS

SELECTION OF MATERIAL

Materials of the leaf spring should be consist of nearly 60%-70% of the vehicle cost and contribute to the quality and the performance of the vehicle. Even a small amount in weight reduction of the vehicle, may have a wider economic impact. Composite materials are proved as suitable substitutes for steel in connection with weight reduction of the vehicle. Hence, the composite materials have been selected for leaf spring design.

FIBRES SELECTION

The commonly used fibers are carbon, glass, keviar, etc. Among these, the glass fiber has been selected based on the cost factor and strength. The types of glass fibers are C-glass, S-glass and E-glass. The C-glass fiber is designed to give improved surface finish. S-glass fiber is design to give very high modular, which is used particularly in aeronautic industries. The E-glass fiber is a high quality glass, which is used as standard reinforcement fiber for all the present systems well complying with mechanical property requirements. Thus, E-glass fiber was found appropriate for this application.

RESINS SELECTION

In a FRP leaf spring , the inter laminar shear strengths is controlled by the matrix system used. Since these are reinforcement fibers in the thickness direction, fiber do not influence inter laminar shear strength. Therefore, the matrix system should have good inter

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laminar shear strength characteristics compatibility to the selected reinforcement fiber. Many thermo set resins such as polyester, vinyl ester, epoxy resin are being used for fiber reinforcement plastics (FRP) fabrication. Among these resin systems, epoxies show better inter laminar shear strength and good mechanical properties. Hence, epoxide is found to be the best resins that would suit this application. Different grades of epoxy resins and hardener combinations are classifieds, based on the mechanical properties.

Among these grades, the grade of epoxy resin selected is Dobeckot 520 F and the grade of hardener used for this application is 758. Dobeckot 520 F is a solvent less epoxy resin.

This in combination with hardener 758 cures into hard resin. Hardener 758 is a low viscosity polyamine. Dobeckot 520 F, hardener 758 combinations is characterized by good mechanical and electrical properties, faster curing at room temperature and good chemical resistance properties.

MANUFACTURING OF COMPOSITE LEAF SPRING

Hand layup technique is suitable for manufacturing of composite leaf spring with suitable effective properties. In this process a mould cavity made up with the help of green sand mould, after manufacturing cavity of suitable size optical gel coating of suitable thickness layer is made in the boundary of cavity then after this resin in liquid form is poured in that cavity and for getting require shape the consolidation roller rolls over the two layer of resin and dry reinforcement fabric layer of given thickness.

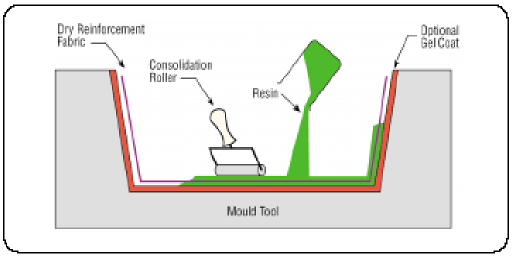

Fig. 1 Hand Lay up Technique

MECHANICAL PROPERTIES OF MATERIAL

Table 1: The mechanical properties of EN 47

Properties	Value	Unit
Young's modulus	200000 - 200000	MPa
Tensile strength	650 - 880	MPa
Elongation	8 - 25	%
Fatigue	275 - 275	MPa
Yield strength	350 - 550	MPa
Density	7700	Kg/m3

Table 2: The mechanical properties of E-glass/epoxy

Properties	Value
Tensile modulus along X-direction (Ex), MPa	34000
Tensile modulus along Y-direction (Ey), MPa	6530
Tensile modulus along Z-direction (Ez), MPa	6530
Tensile strength of the material, MPa	900
Compressive strength of the material, MPa	450
Shear modulus along XY-direction (Gxy), MPa	2433
Shear modulus along YZ-direction (Gyz), MPa	1698
Shear modulus along ZX-direction (Gzx), MPa	2433
Poisson ratio along XY-direction (NUxy)	0.217
Poisson ratio along YZ-direction (NUyz)	0.366
Poisson ratio along ZX-direction (NUzx)	0.217
Mass density of the material (ρ), kg/mm3	2.6·106
Flexural modulus of the material, MPa	40000
Flexural strength of the material, MPa	1200

III. DESIGN PARAMETER OF STEEL LEAF SPRING

Two leaf steel spring use in this work includes : total length (eye to eye) 965 mm; arc height of axle seat (camber) 125mm; width of leaves 45 mm (EN 47 material); thickness of leaves 30 mm, full bump loading 2943 N. even though the leaf spring is simply supported at the end. Specifications of Leaf spring related suspension light vehicle is shown in Table3.

Table 3: Leaf spring specifications

Length(L)	965 mm
Width (b)	45mm
Thickness (t)	30mm
Camber height	125mm

Before analysis of leaf spring, the Strain energy (U), stresses (σ), Deflection is needed to be calculated.

IV. SOLID MODELING OF STEEL LEAF SPRING

Steel leaf springs have the characteristic parameters that affect their behaviors. In addition to the physical properties of its material, the spring length (L), Spring thickness (t), Spring width (b) and the camber are the parameters that affect the behavior of leaf spring. These parameters have been illustrated in Fig. 1.

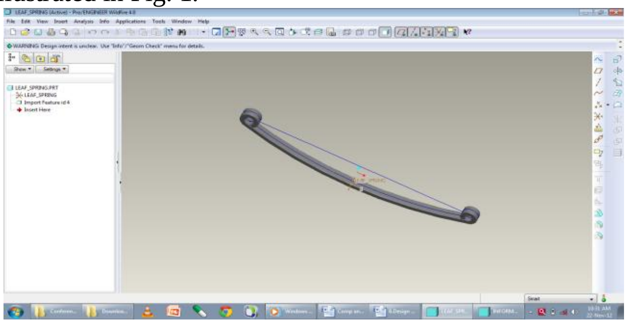

Fig.1 Modelling of Leaf Spring by Pro-E 4.0

V. ANALYSIS USING ANSYS

The model of leaf spring now imported into ANSYS 14 the boundary conditions and material properties are specified as for the standards used in the practical application. The material used for the leaf spring for analysis is structure steel, which have approximately similar isotropic behavior and properties as compared to SUP 9 and Composite material. Model of parabolic spring was partition into small region for

easier mashing process method is used patch conforming method the boundary condition was set according to rear static load which is the front eye was allowing on a rotational at y axis and rear eye was constrained in y and z translation and x and z rotations alloying free x translation and y rotation. Contact from main to helper leaf also been defined helper leaf was constant 2nd degree of freedom to represent the clip that holds that to spring together. Finally vertical load was applied at the center of the leaf spring.

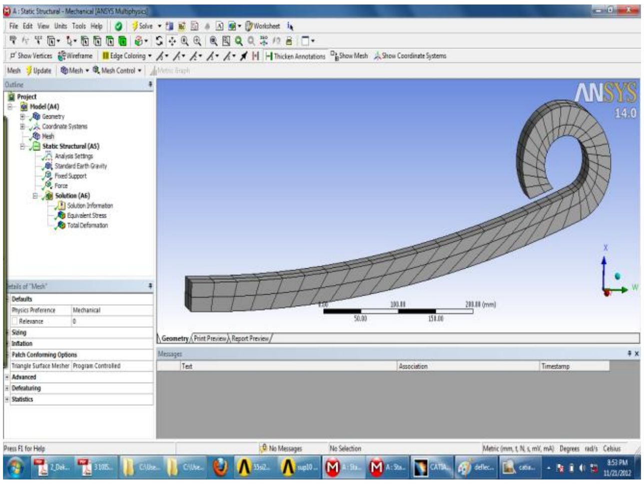

Fig.2 : Meshing of Model

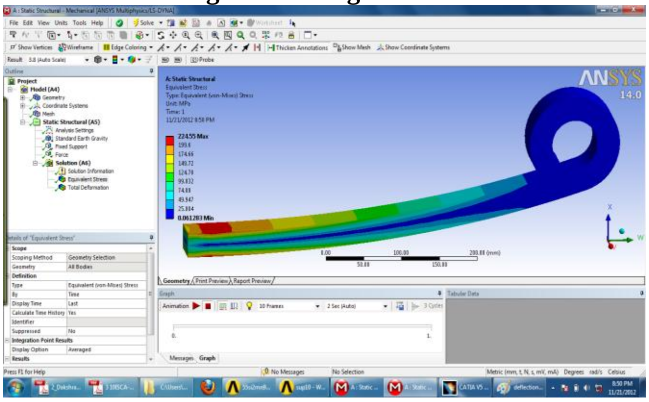

Fig. 2 : Stress analysis of EN 47 Materials (FEA Analysis)

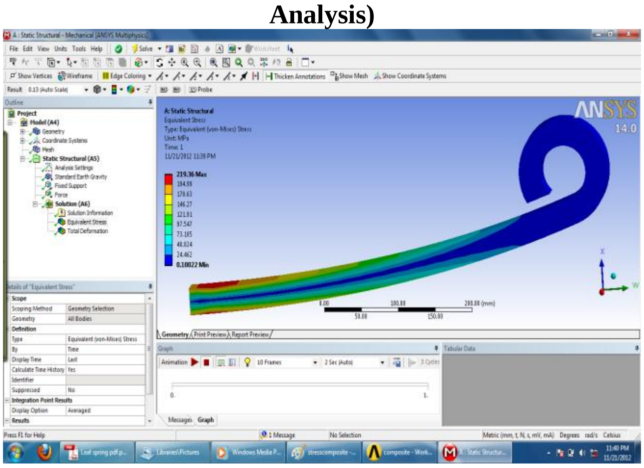

Fig. 3 : Stress analysis of Composite Materials (FEA Analysis)

Table 4. Analytical and FEA Analysis

	ANLYTICAL		FEA	
Parameters	Composite Material	EN 47	Composit e Material	EN 47
Load (N)	2943	2943	2943	2943
Maximum stress(MPa)	210.37	210.37	219.36	224.6

VI. ADVANTAGES

- Specially made to give effects like Air Suspension without any extra external energy.
- No Permanent Deformation Hence No Re-tensioning. Thus No Maintenance.
- Minimum Wear & Tear of Body parts and tyre. Due to delicate tendency of absorbing road shocks, Jerks & vibrations.
- Softer ride, Lower Noise level, due to better damping characteristics.
- Excellent Corrosion Resistance against atmospheric Pollutions.
- Better life with consistency in performance around 1 million Fatigue Life Cycle. i.e. Minimum Five times better than metal leaf Spring.
- Fully inter – changeable with conventional spring without any modification.
- Increase in Fuel Efficiency due to better Aerodynamic. It cuts the wind with low coefficient of friction.

VII. CONCLUSION

These work involves the comparison of conventional EN 47 and Composite material leaf spring under static loading conditions the model is preferred of in Pro-E 4.0 and then analysis is perform through ANSYS 14.0 from the result obtained it will be concluded that the development of a composite mono leaf spring having constant cross sectional area, where the stress level at any station in the leaf spring is considered constant due to the parabolic type of the thickness of the spring, has proved to be very effective.

VIII. FUTURE SCOPE

(a) Experimental work.
(b) Harmonic analysis with finding and compression of first five natural frequencies.
(c) Analysis leaf spring by varying thickness.

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