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"A Review On The Design And Analysis Of Composite Leaf Spring"

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Abstract: ***The aim of this review paper is to represent a general study on the design, analysis of multi leaf spring. In passenger vehicles ride comfort and load carrying capacity, rigidity is important considerations. Vehicle ride comfort depends upon the suspension system. Suspension system in automobile significantly affects the behavior of vehicle. Leaf springs are perhaps the simplest and are less expensive compared to other suspension. Leaf spring is therefore an important aspect in the suspension system design. . Due to variation of load leaf springs are one of the most dynamically stressed components in automobile therefore quality of vehicle ride depends upon the characteristics of leaf spring used in suspension unit, Performance measures of any leaf springs are its stiffness and fatigue life. This paper present analysis of leaf spring used in light commercial vehicle.***

Keywords: Multi Leaf Spring, FEA, Fatigue Life

I. INTRODUCTION

Spring act as a flexible joint in between two parts or bodies . A spring is defined as an elastic body, whose function is to distort when loaded and torecover its original shape when the load is removed. Springs are elastic bodies that can betwisted, pulled or stretched by some force. They can return to their original shape when theforce is released.

Leaf springs are one of the earliest suspension components used in automobile system they are still oftenly used, especially in commercial vehicles. This paper covers a critical review to represent a general study on the design and analysis of leaf spring. Performance measures of any leaf springs are its stiffness and fatigue life.These two factors plays vital role for the performance of Leaf springs.

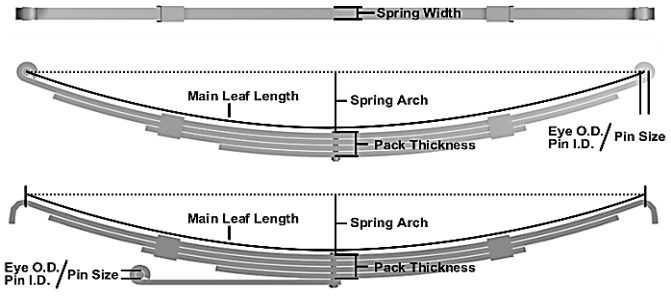

Figure 1

II. LITERATURE REVIEW

A. FATIGUE FAILURE

The existence of irregularities or discontinuities, such as holes, grooves, or notches, in a part increase the magnitude of stresses significantly in the immediate vicinity of the discontinuity. Fatigue failure mostly originates from such places. Hence its effect must be accounted. The following research has been accomplished for the failure analysis

MANJUNATH H.N ET.AL.(JULY 2014) gives research work on static analysis for various leaf springs is carried out using ANSYS 10 and the fatigue life of various composite leaf springs is calculated. From the obtained results it can be concluded that comparative study has been made between different composite materials and with steel in respect of stiffness, deflection and stress. Obtained FEA results have good agreement with theoretical results. Boron/Aluminum has minimum deflection and stress, and posses high stiffness as compared to other composites.

In this research work an attempt has been made to check the suitability of composite materials like E-Glass/Epoxy, Graphite/Epoxy, Boron/Aluminum, Carbon/Epoxy and Kevlar/Epoxy for light commercial vehicle leaf spring. First the static analysis is carried out for steel and different composite leaf spring using FE solver ANSYS V10. The

obtained results are compared with theoretical values and observed that they have good agreement with each other. The fatigue life of various composite leaf springs is calculated using Hwang and Han relation. From the results it can be concluded that Boron/Aluminum and Graphite/Epoxy are best suitable composite material for leaf spring.

KUMAR KRISHAN AND AGGARWAL M.L (JULY 2012) carried out a research on a multi leaf spring having nine leaves used by a commercial vehicle The finite element modelling and analysis of a multi leaf spring has been carried out. It included two full length leaves in which one is with eyed ends and seven graduated length leaves. The FE model of the leaf spring has been generated in CATIA V5 R17 and imported in ANSYS-11 for finite element analysis. Bending stress and deflection are the targeted results. A comparison of both i.e. experimental and FEA results has been done to conclude. When the leaf spring is fully loaded, a variation of 0.632 % in deflection is observed between the experimental and FEA result, and same in case of half load, which validates the model and analysis.

PARKHE RAVINDRA AND SANJAY BELKAR (APRIL 2014) describes design and analysis of composite mono leaf spring. Weight reduction is now the main issue in automobile industries. In the present work, existing mono steel leaf spring of a light vehicle is taken for modelling and analysis. A composite mono leaf spring with Carbon/Epoxy composite materials is modelled and subjected to the same load as that of a steel spring. The design constraints were stresses and deflections. The composite mono leaf springs have been modeled by considering Varying cross-section, with unidirectional fiber orientation angle for each lamina of a laminate. Static analysis of a 3-D model has been performed using ANSYS 12.0. In present project work comparative analysis of Carbon/epoxy composite leaf spring and steel leaf spring is done by analytical, FEA using ANSYS 12. The result of FEA is also experimentally verified. Compared to mono steel leaf spring the laminated composite mono leaf spring is found lesser stresses and weight reduction of 22.15% is achieved.

VINKEL ARORA ET. AL.(2011) This work involves design and analysis of a conventional leaf spring under static loading conditions. The 3D model was prepared in CATIA and then CAE analysis was performed using ANSYS-11. From the results obtained from ANSYS, and it was concluded that the leaf spring is fully /half loaded, a variation of 1.17% in deflection is observed among the Experimental & CAE value, which proves the validation of our CAD model and analysis.

At the same time bending stress for fully loaded, is increased by 12.30 % in CAE analysis as compared with experimental and for half loaded bending stress is increased by 12.02 %. This may be observed because the actual material is 65Si7 but for CAE analysis Structural steel is used. The maximum equivalent stress is 172.5 MPa & 86.29 MPa for fully and half loaded leaf spring respectively, which is below the Yield Stress i.e. 250MPa.Therefore the design, is safe. It is concluded that when CONTA72, TARGET71 type of contact and SOLID 92 mesh element is used for CAE analysis the results are closer to the Experimental results. Therefore the CAD model can be used for fatigue loading under defined boundary conditions.

BHUSHAN B. DESHMUKH ET AL (2011) concluded that the leaf spring is design by considering as it is behave like a cantilever beam. For the analysis purpose ANSYS software is selected as it gives good result. For the analysis of composite leaf spring the SOLID46 element is selected and mapped meshing is done. The fabrication of constant width constant thickness composite leaf spring is done by filament winding machine and constant width varying thickness leaf spring is fabricated with the help of hand lay-up method. The spacemen is tested experimentally by conducting a single point bending test. In almost all the paper it is concluded that by using composite material heavy reduction in the weight is obtain with many other advantages such as reduction in noise, increasing in comfort ride

VIDYADHAR ET. AL. (2014) in this paper Light weight material and design have always being important topic's in products design across several Automobile industries An parabolic leaf spring contributes considerable amount of weight to the vehicle and need to be strong enough. This work aim's to focus on reducing weight and increasing or maintaining strength and fatigue life we conducted Analysis of mono leaf spring in Hyper-mesh and Femfat software and tried to find alternative to existing design to reduce weight of spring.

DR. ASHESH TIWARI ET. AL. founds that improper maintenance practices can reduce fatigue life of leaf spring. Improper retightening of U-Bolt nuts, in regular interval may one of major cause of earlier failure of leaf spring from centre & other location. The U-bolts must be tightened to the proper torque specifications to eliminate any movement between the spring and the axle and between each leaf of the spring. If the U-bolts be loose will one of the causes of leaf spring stake failure or individual leaf failure from the centre. When installing new springs, be sure to use new U-bolts & Nuts. If using Dacromate finish U-Bolts, then reuse one or two times based on quality of U-Bolts. But do not reuse Nuts at the same time. Always insured that use new Nuts during installation of leaf springs.

B. MATERIAL FOR LEAF SPRING

The material used for leaf springs is usually a plain carbon steel having 0.90 to 1.0% carbon. The leaves are heat treated after the forming process. The heat treatment of spring steel products greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties

Most of the researchers carried out the study based on the spring materials.

PARKHE RAVINDRA ET. AL. describes design and analysis of composite mono leaf spring. In this research work, existing mono steel leaf spring of a light vehicle is taken for modeling and analysis. A composite mono leaf spring with Carbon/Epoxy composite materials is modeled and subjected to the same load as that of a steel spring. The design constraints were stresses and deflections. The result of FEA was experimentally verified. They founds that the stresses

induced in the Carbon/Epoxy composite leaf spring are 42% less than that of the steel spring nearly.

MANJUNATH H.N ET AL. check the suitability of composite materials like E-Glass/Epoxy, Graphite/Epoxy, Boron/Aluminum, Carbon/Epoxy and Kevlar/Epoxy for light commercial vehicle leaf spring. The results are compared with theoretical values and concluded that they have good agreement with each other. They calculated the fatigue life of various composite leaf springs using Hwang and Han relation. They found that Boron/Aluminum and Graphite/Epoxy are best suitable composite material for leaf spring.

SORATHIYA MEHUL AND DHAVAL B. SHAH compares the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. The dimensions of an existing conventional steel leaf spring of a Light design calculations. Static Analysis of 3-D model of conventional leaf spring is performed using ANSYS 11.0 and hyper mesh. Same dimensions used in composite multi leaf spring using carbon/Epoxy and Graphite/Epoxy unidirectional laminates. The load carrying capacity, and weight of composite leaf spring are compared with that of steel leaf spring. They achieved a weight reduction of 79.617 % by using composite leaf spring. And in case of Mono leaf spring then Weight reduction is achieved 90.09%.

The various research for composite material used in leaf spring are tabulated in table 1

Sr No	Composite Materials	Researcher
1	(CFRP) Carbon Fiber Reinforced Plastic	P.Beardmore(1986)
2	S2-glass fiber/Epoxy and E-glass/Epoxy	W.J. Yu. Kim(1988)
3	Glass fiber, Carbon fibre	Andra Corvi(1990)
4	E-glass fibre with two layer of bidirectional fabric	Erol Sancatar (1999)
5	E-glass/Epoxy	Max. X.Sardou et.al (2000), M. Senthil (2007),Mahmood Shokrieh (2003), Dara Ashok(2012), Laxinarayana (2012), Asish Amrute(2013), Shishay Amare Gebremeskel(2012)
6	E-glass/Epoxy and carbon fiber/Epoxy	H.A.Al. Qureshi(2001)
7	E-Glass/Epoxy, C-Glass/Epoxy, S-Glass/Epoxy	B.Vijaya Lakshmi, Satyanarayana(2012)

Table 1: Composite Materials Proposed for Leaf Spring

III. CONCLUSION

This review paper provides a brief summary on the work carried out for material selection, design, analysis and optimization of composite leaf spring. All the above parameters on composite leaf spring were discussed and compared with existing steel leaf spring for vehicles. The different analysis namely static analysis, fatigue analysis, modal and shock analysis were performed using analytical, numerical and experimental approaches on steel as well as composite leaf spring by many researchers. Sometimes apart from experimental method a wide range of software packages such as CATIA, PRO/Engineer, CAE, ANSYS were used. Finally from various research papers, it is concluded that compared to conventional mono and multi steel leaf spring for vehicle the composite leaf spring have lesser stresses, weight, noise, vibration, harshness characteristic and increasing in fatigue life, strength and comfort ride.

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