Review paper on Analysis of Mono Composite Leaf Spring for Light Commercial Vehicle Using Finite Element Method

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Abstract— Leaf springs probably are the oldest automobile suspension gadgets still in active use. Weight reduction has been the main focus of automobile manufacturers in the present scenario. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. In this dissertation work the material of the leaf spring is changed. The new Leaf spring is used which is made of composite material and high weight reduction is achieved. The main objective of research work is to carry out Sensation analysis of composite leaf spring with nonlinear parameters. Here free and forced Sensational Analysis of Composite Leaf Spring is done and compared with Steel Leaf Spring. The nonlinear Sensation analysis is carried out. So, to achieve this, CATIA and ANSYS software's are used for three dimensional modeling and analysis respectively. The simulated results are compared with experimental results. The result shows good Agreement between experimental results and numerical results.

Keywords: ANSYS, Composite, FFT, Layup, Leaf spring, Metal Matrix Composite, Mode Shapes, Von- Misses Stress

I. INTRODUCTION

Inside the automotive Industrial Sectors, increasing competition and innovation seek to alter Current goods or replacing old with new goods and creative Material items. The mechanism of suspension for automobiles it is also an area where these inventions are carried out on a daily basis. Further attempts are made to enhance the comfort of the customer. A simple requirement is the required combination of comfort riding characteristics and economy in leaf spring manufacturing. Many changes have occurred over time to strengthen the suspension mechanism. Many of these recent changes to suspension structures are developments the use of composite materials for these springs in parabolic leaf springs [1].

A typical type of steel spring, typically used in suspension system for automobiles, is a mono/multiple leaf spring. To absorb sensations caused during the motion of the vehicle, it uses a leaf spring, which is an automotive component. Leaf springs are long and thin plates mounted above or below the vehicle axle mostly on chassis of a vehicle. Based on the application needed, Single leaf springs and multi-leaf springs are used. Leading to the weight of the vehicle and payload, it also serves as a frame to allow vertical loading. The behavior of the spring of the leaf is complex under operating conditions because of its impact on clamping and interleaf communication, His research is therefore essential to predict mode frequency and displacement [2].

In the current scenario, weight reduction has become the key priority of car producers to save natural resources and save oil. The Weight loss could be necessary accomplished mainly by the use of better materials, Model optimization and enhanced methods of production. The oldest vehicle suspension gadgets currently in active use are probably Leaf springs. Their simplicity and efficacy may lead to this. The idea that an enormous load is well maintained while the resultant pain is considerably decreased increases their durability. As it constitutes 10-20% of the unleashed weight, one of the potential items for vehicle losing weight is the suspension leaf spring. This adds Better fuel performance and improved vehicle riding features [3, 6].

Composite materials also decreased the weight of the sheet-fed without reducing the capacity and stiffness of the cargo. In contrast with steel, the composite materials have a larger capacity for retaining elastic potential energy and have a higher weight ratio. The composite materials are replaced with single leaf plastic springs. The composite material offers considerable weight savings benefits, but is not necessarily cheaper than its equivalents in steel [4].

Sport Utility Vehicles (SUV 'S) are becoming increasingly aware of highway traffic safety and car rollover incidents. Catastrophic SUV rollover incidents, among other items, are attracting growing Emphasis on architecture and protection specifications for cars. Present and successful SUV model computer simulations are important in planning, analyzing the performance and analyzing the reliability of such vehicle systems. To change the condition riding Convenience and to accommodate High charges, the majority of SUVs and trucks are fitted leaf springs with suspension mechanisms of the front or rear axle. However, due to interaction it is generally recognized that the suspension properties of the leaf springs are extremely nonlinear between spring leaves and hysterics due to friction [5].

Nonlinear conduct is exhibited by most real-world phenomena. There are several circumstances under which assuming linear behaviour may provide adequate results for the physical system. There are situations or phenomena that, on the other hand, involve a nonlinear solution. Due to Material and geometric non-linearity's, both and changes within boundary and structural integrity conditions, a nonlinear structural behaviour can arise.

II. REVELENCE

In an industrial setting, there are various sources of sensations: Due to fracturing of solder joints, electronic malfunctions and abrasion of insulation around electrical conductor causing shorts. People's occupational sensitivity to sensations contributes to pain, irritation and decreased performance.

Sensations control research has been a persistent analysis since mechanical systems for decades were invented. In order to minimize the sensations levels of mechanical systems and simultaneously improve human comfort and safety, engineers and researchers have been trying to fully understand the complex behaviour of mechanical systems. Mechanical systems are subject to loads creating discomfort,

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feeling and noise in the different structural components during service. This needs the components to have sufficient power, rigidity and exhaustion to withstand these loads.

A sensation is an immortal phenomenon, common and complex. It is an interdisciplinary field in which a closed loop communicates with physicists, mathematicians and engineers. A sensation manifests and permeates the entire universe in several ways. The engineers appeared with sensations issues on the scene that started to confuse the design and construction of Structures and devices. The engineers threatened the industry with perception and noise problems. Processor tools such as spectrum analyzer, shaker, piezoelectric accelerometer with developments on optical and hybrid systems, optimized circuitry, as well as software and hardware advancements, sensations issues can be tackled in such diverse areas. The dynamic behaviour analysis of mechanical systems is also focused on methods appropriate for systems with linear characteristics.

A condensed explanation of the mechanical system is given by linear theory, which simplifies both computer-based equations and experimental procedures in turn. In practice, engineering structures, mostly combining non-linear material properties, geometric effects, structural joints and non-linear boundaries, exhibit a certain degree of non-linearity. These effects are usually ignored under the planned range of work by linearization. However, it is becoming more and more important to take nonlinear effects into account. One factor is the continuing ambition to extend the engineering structures' efficiency envelope while reducing weight.

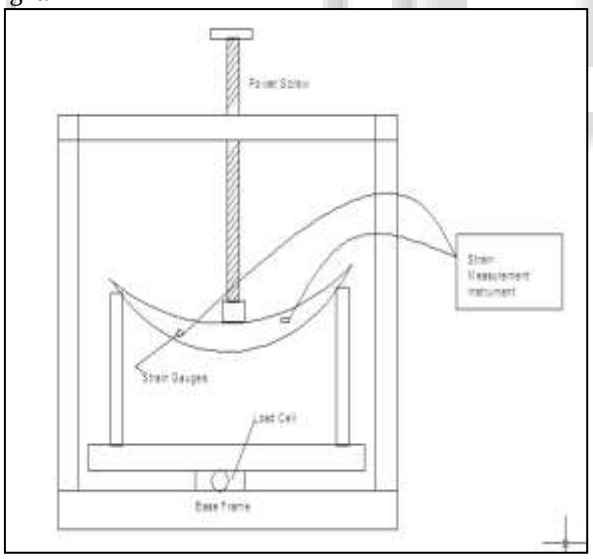

Fig. 1: Proposed Experimental Setup

III. LITERATURE REVIEW

1) Patunkar and Dolas [6] have discussed the analysis of the glass fiber reinforced plastic composite mono-leaf spring. Traditional leaf springs were initially Static environments tested. In the same static load state, simulation was then carried out for the composite spring of glass fiber. A comparison between the deflection and the distribution of stress was carried out. In the traditional spring, it has been found that there is great deflection than composite spring. In addition, Traditional leaf springs have more weight than hybrid leaf springs.
2) Krishan and Aggarwal [8] have presented the research of multileaf spring analysis using FET. The work on a multileaf spring with nine leaves used by a commercial vehicle was carried out. It had two long, one eye ends and seven long, differentiated leaves. 65Si7 / SUP9 were the material for the leaf spring. Bending pressure and deflection were observed and both experimental and FEA outcomes were compared. When the leaf spring was fully loaded, it was found that the difference in the defection in experimental and FEM outcomes was 0.632 %.
3) Dhoshi et al. [9] have the inquiry and the alteration of the FEM tractor trailer blade spring is addressed. An empirical model has been used to evaluate the proper dimensions of the spring under such loading conditions. In FEM, modeled for the same spring, the stress distribution was observed. It was found that the stresses produced by analytical and FEM outcomes do not differ much. So some modifications were tested in the spring. It was found that the stress distribution does not vary much if the number of leaf springs is decreased in this case from seventeen to thirteen, and the design is also safe. This achieves a weight loss of approximately 6 Kg and a 20 % cost reduction.
4) Shokrieh and Rezaei [10] have discussed the Leaf Spring Composite optimization. Current analytical and experimental solutions have confirmed the FEM findings. Then the optimization of form and weight was carried out. The Leaf Spring Composite has been shown to save 80 % of the weight compared to the traditional spring by linearly increased density and hyperbolically decreasing the width. Again, the Leaf Spring Composite's natural frequency is higher than the traditional one.
5) WieslawKrason and JózefWysocki [12] have discussed Forced sensations of the rear suspension of the biaxial vehicle, fitted with the model of the double spring space shell and the viscous damper, with the transient response provided under the force pulse input. A particular feature of the double spring system is the contact between the master and the auxiliary spring. For three variants of viscous attenuation, numerical tests were taken. Using the MSC Patran pre-processor, Modeling and assessment challenges, including contact issues, have been overcome. Through the use of the Finite Element Approach (FEM), computational analyses of the suspension model have been performed with geometric non-linearity, the viscous attenuations, and time variations. The selected findings were obtained from the model experiments by the selected master-stress suspension and auxiliary point springs as relative suspension displacements and deformations. The full model of the suspension system helps to research the relationship and the phenomena of the dynamic reaction of such a complex system.
6) M. Venkatesan and D. Helmen Devaraj [13] have presented the construction and experimental study of the glass fiber reinforced polymer Leaf Spring Composite. It was determined that the Leaf Spring Composites can be

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contrasted with the Leaf Spring (Steel)s for load carriage capacity, rigidity and weight savings. The function drawbacks were pressures and deflections. Steps were taken on a standard light commercial vehicle leaf spring (steel). For a composite multi-leaf spring using multidirectional laminates E-Glass / Epoxy, the same dimensions as traditional leaf springs were used. The static study of the traditional leaf spring 2-D model was also carried out using ANSYS and compared to the experimental findings. The Leaf Spring Composite is having 67.35 % less tension, 64.95 % more stiffness and 126.98 % more natural frequency as compared to present Leaf Spring (Steel) relative to steel spring. The optimized Leaf Spring Composite is used to achieve a weight reduction of 76.4 %.

7) Muhammad Ashiqur Rahman et al. [14] have presented Non-linear cantilever beam analysis. In relation to the constant beam cross-section, the leaf sources are even more deflective in the field of geometric non-linearity. This article is investigating the reaction of a parabolic-shape leaf spring, presumed built of very elastic steel. Numerical modeling has been carried out in both small and large deflection theories to test stress and dislocation of the same ray. It was found that non-linear analysis had a major impact on the reaction of the beam under a tip load. It has been shown that, determined by nonlinear theory, at the fixed end the actual bending stress is 2.30-3.39% lower than with a standard leaf spring of the same material volume. Oddly, maximal stress occurs in an area far from the fixed end of the designed parabola spring.
8) Gulur Siddaramanna Shiva Shankar and Sambagam Vijayarangan [15] have discussed Plan, study and testing for light commercial vehicles of the mono Leaf Spring Composite. In this paper, along with its design and study, a minimum-cost manufacturing of full mono Leaf Spring Composite and mono Leaf Spring Composite with bonded end joints was introduced. A single, variable-size and width single sheet of unidirectional fiber - reinforced plastics (GFRP) has been developed, manufactured and tested, with clear cross-sectional areas with identical mechanical and geometrical properties to a multi-leaf spring. For the configuration of the constant transversal blade spring, the C-language computer algorithm was used. The findings revealed a hyperbolic decrease in spring width and a linear rise in thickness from the spring eyes to the axle position. With empirical and experimental findings, final factor results were checked using the ANSYS software with tension and deflection. The architecture shortcomings were pressures (Criterium Tsai-Wu failure) and displacement. The composite spring has lower stress than the steel spring, a higher standard frequency and a higher spring weight. With bonded end joint and full eye unit is almost 85 % lower.
9) K. K. Jadhao et al. [7] published paper on Experimental results and Numerical evaluation of Leaf Spring Composite. They worked on the design, manufacture, experimental testing and study of E-glass fiber composite spring, Split strand mat and epoxy resin with a continuous length of width and thickness (general resin). By checking the leaf springs under static loading conditions, they measured experimental values of the Breakdowns and pressures. These findings are also correlated with the results from the F.E.A. By replacing Leaf Spring (Steel) s with Leaf Spring Composites, about 85% of weight is reduced. The output of the existing Leaf Spring (Steel) was contrasted with that of the imported Leaf Spring Composite. Unidirectional E-Glass / Epoxy mono Leaf Spring Composite research has been performed. As the Leaf Spring Composite is capable to take static load, they concluded that they were able to substitute the traditional leaf spring with the Leaf Spring Composite, from the point of view there was still no objection of power.

IV. METHODOLOGY

Analysis of mono Leaf Spring Composite for light commercial vehicle using finite element method will be carried out.

- Design validation for existing Traditional leaf spring using theoretical approach.
- Detailed stress and modal analysis using FEM of Traditional leaf spring to determine the peak stress counters in the Traditional leaf spring and its mode shapes and natural frequencies.
- Design of mono Leaf Spring Composite for the similar load and its stress and modal analysis using FEM to find out stress distribution and its natural frequencies.
- Experimental validation of stress results obtained by FEM using strain gauge technique for both springs.
- Experimental validation of natural frequencies obtained by FEM using F.F.T. analyzer.
- Determination of minimum thickness for the same load of mono Leaf Spring Composite in order to reduce the material weight and with increased strength using ANSYS only.

V. COMPLETION

Successive conclusions are drawn from the theoretical, numerical and experimental data.

1) From theoretical, numerical and experimental evidence, successive conclusions are drawn.
2) The normal frequency decreases more quickly for both steel and composite material in the first mode.
3) The normal frequency of the cantilever beam rises rapidly after first mode for both steel and composite material.
4) It is found that the normal frequencies of induced sensations are almost identical to those of free sensations.
5) The theoretical research it not only gives an understanding of geometric nonlinearities, but also a greater understanding of the basic definition of material mechanics.

Since the experimental and numerical effects of Composite and Leaf Spring (Steel) s sensations research are closer to each other. Finally, it is mentioned that numerical analysis of a beam by instead of doing more expensive and time intensive experimental research, ANSYS will be completed.

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