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Research Article

Experimental Investigation and Statistical Characteristics of Steel and Composite Leaf Spring

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Abstract

Increasing competition and innovations in automobile sector tends to modify the existing products or replacing old products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. More efforts are taken in order to increase the comfort of user. Appropriate balance of comfort riding qualities and economy in manufacturing of leaf spring becomes an obvious necessity. To improve the suspension system many modification have taken place over the time. Inventions of parabolic leaf spring, use of composite materials for these springs are some of these latest modifications in suspension systems. The implementation of composite materials by replacing steel in conventional leaf springs of a suspension system. Automobile-sector is showing an increased interest in the area of composite material-leaf springs due to their high strength to weight ratio. Therefore analysis of composite material (like E-glass/epoxy, S- glass/ epoxy and Carbon/epoxy composites) leaf springs has become essential in showing the Comparative results with conventional leaf springs.

Keywords: *Composite material, E-glass/epoxy, S- glass/ epoxy ,Leaf Spring, Steel , Statistical Characteristics*

1. Introduction

1.1 Scope of Work

Leaf springs are one of the bygone suspension part they are still used. The literature survey represents that leaf springs are intend as normal force section where the position, velocity and orientation of the axle mounting allow the reaction forces in the chassis attachment positions. Another part has to be focused, is the automobile industry has shown increased interest in the replacement of steel spring with compound leaf spring because of high strength to weight ratio. That is why analysis of the compound material suits equally important to study the nature of Compound Leaf Spring (Rajendra,*et al*, 2001).

In order to preserve natural resources and economize energy, weight depletion has been the main focus of automobile manufacturers in the present scenario. Weight depletion can be getting primarily by the introduction of material, design optimization and better production processes. The suspension leaf spring is one of the potential items for weight depletion. Suspension leaf spring achieved the vehicle with more fuel regulation and improved riding standard. The nature of compound materials was made it possible to diminish the weight of the leaf spring without any depletion on load conveys capacity and stiffness. Since, the compound materials have more elastic strain energy storage capacity and high strength to weight ratio as collate with those of steel, multi- leaf steel springs are taking the place of mono leaf compound laminated springs(H A. Al-Qureshi, 2001). The compound material offer opportunities for substantial weight saving but not always are cost effective over their steel counter sections. The leaf spring should absorb the vertical vibrations and impacts due to road deformity by means of vibrations in the spring diversion so that the potential energy is stow in spring as strain energy and then released slowly.

So, increasing the energy storage capability of a leaf spring ensures a more compliant suspension system. According to the studies made a material with large strength and minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring (J.P. Hou ,*et al*, 2007). In this work, an attempt is made to change the existing mono steel leaf spring used in Maruti 800 passenger car with a laminated compound mono steel leaf spring made of 3 different compound materials viz., E-glass/epoxy, S-glass/epoxy and Carbon/epoxy compounds. Dimensions and the number of leaves for both steel leaf spring and laminated compound leaf springs are considered to be the same.

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1.2 Problem Definition

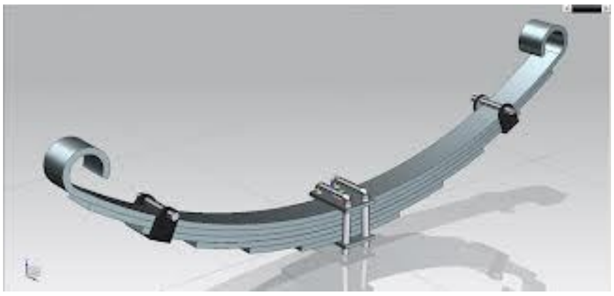

Fig.1 Compound leaf spring (H A. Al-Qureshi, 2001)

In order to preserve natural resources and economize energy, weight depletion has been the main focus of automobile production in the present scenario. Weight depletion can be achieved primarily by the introduction of better material, design optimization and better production processes. The suspension leaf spring is one of the potential items for weight depletion in automobiles as it accounts for 10% - 20% of the weight. This achieves the vehicle with more fuel efficiency and improved riding standard. The nature of compound materials was made it possible to reduce the weight of the leaf spring without any depletion on load carrying capacity and stiffness. So, My Objective is that to reduce weight of the leaf spring by replacing the material of spring.

1.3 Materials for Leaf springs

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. After the heat treatment process spring steel products gets higher strength and therefore greater load capacity, higher range of deflection and better fatigue characteristics.

1.4 Relevance / Motivation

The goal of the work is to design and analyses of compound leaf spring made of 3 different compound material compounds. A virtual model of compound leaf spring will generate in modeling software will import in post processing software for analysis by applying normal load conditions. After analyis a comparison is made between simulation result of compound leaf spring.

2. Literature Survey

A literature study was direct to obtain an idea of the leaf spring models that have been represented and whether they are able to acquire proper predictions of the force displacement nature of the leaf spring as well as reaction forces on the vehicle attachment points. The application of the different leaf spring modeling methods in vehicle simulations is noted along with whether they were validated.

From this literature survey it can be concluded that there is not a clear best leaf spring model. Different models exist and various studies have shown that these models can indeed represent aspects of the leaf spring accurately and give good results when used in simulations. It would seem that the type of model that can be used to give accurate predictions depend on the kind of parameters that are to be predicted. Thus, these models are very particular to the problem they are used in, and they may not give the same results in a different application, or when other sets of parameters are to be predicted.

3. Experimental Setup

3.1 Introduction

The project was executed at Dr. D Y PATIL KNOWLEDGE CITY, Lohegaon. DYP provides technical expertise in R & D, testing, certification, homologation and framing of vehicle regulations.

3.2 Major Facilities

2000 LPM, 210 Bar, Hydraulic Power-Pack
Rectilinear Actuators (Force Capacity up to ±250 kN)
Rotary Actuators (Torque Capacity up to ±22.6 kN-m)
128 Channels of Simultaneous Data Acquisition
Material Test Machine (±250 kN)
Channel controller

Fig.2 Experimental setup of Universal Testing Machine

Dr. D Y PATIL College has recently installed High Frequency Resonance test Machine pulsator at Structural Dynamics Lab. The machine works on the resonance principle. The machine is designed as a three-mass swing system and includes additional screw-on masses in order to be used to influence the test frequency. This machine is of maximum 250kN capacity. This machine is useful for testing of high stiffness parts such as connecting rod, crankshaft, bolts, Brackets, Gear teeth, Knuckle, suspension springs etc. With the introduction of this machine, the test duration can be reduced significantly since test frequency of machine can go as high as 100 Hz depending on the stiffness of the test part. E-motion software of the machine is useful to conduct the Static, Single Load & Block Program tests. One of the most important features of this machine is that it could detect crack initiation at very early stage as the resonance frequency will change with crack initiation in the test part. Software has facility to detect frequency variation and to terminate the test or to study crack propagation nature.

3.3 Testing of Leaf Springs

a) Tensile Test

The springs are tested on Universal Testing Machine and the readings are noted. The leaf springs to be tested are to be examined for any defects like cracks, surface abnormalities, etc.

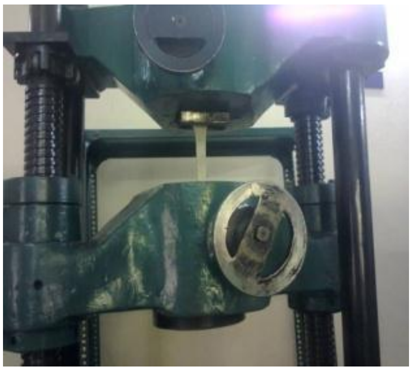

Fig .3 Closure View of UTM Machine

Table 1 Tensile test results of UTM Machine

Sr no	Parameter	Value
1	Specimen type	Leaf Spring
2	Specimen Thickness	13mm
3	Specimen Width	70mm
4	Cross Sectional area	$15.40*10^4$ mm^2
5	Final gauge length	1540
6	Ultimate load	25Kg
7	Ultimate Tensile Strength	4000N/mm

b) Impact test

Charpy test and Izod impact tests are done and readings are noted.

1. Charpy Test

The principle of the test differs from that of the Izod test in that the test piece is tested as a beam supported at each end; a notch is cut across the middle of one face, and the striker hits the opposite face directly behind the notch.

2. Izod Test

In the Izod impact test, the test piece is a cantilever, clamped upright in an anvil, with a V notch at the level of the top of the clamp. The test piece is hit by a striker carried on a pendulum which is allowed to fall freely from a fixed height, to give a blow of 120 ftlb energy. After fracturing the test piece, the height to which the pendulum rises is recorded by a slave friction pointer mounted on the dial, from which the absorbed energy amount is read.

Table 2 Impact test results

1. Steel

Sr. no	Parameter	Charpy –V	Izod-V
1	Notch Depth	2mm	2mm
2	Notch Angle	45°	45°
3	Specimen Size	10*10*75mm & notch 28mm from one end	10*10*55mm & notch At center
4	Observed Value	96 J	98 J

Fig.2 Test Specimen (Steel)

Fig.3 After Impact

2. E- Glass/epoxy

Table 3 Impact test results

Sr. no	Parameter	Charpy –V	Izod-V
1	Notch Depth	2mm	2mm
2	Notch Angle	45°	45°
3	Specimen Size	12*12*75mm & notch 28mm from one end	12*12*55mm & notch At center
4	Observed Value	141 J	150J

Fig.4 Test Specimen

Fig. 5 Putting specimen in the slot

3.4 Testing of Steel and Composite leaf spring

A comparative analysis of conventional steel leaf spring is done with a virtual model of a compound leaf spring under static load condition only. Conventional leaf spring is first tested under static load condition by using Hydraulic Static Load Test Rig. Mounting of the leaf spring is done by keeping it in inverted manner on the test bed. Two eye ends are held in the clamping devices and load is applied from the top, at the center of leaf spring.

3.5 Results

The following table represents result data in tabular form for experimental results. The resulting value of Deformation and Stress for steel leaf spring and compound leaf spring is tabulated below.

Table 4 Experimental Results

Sr no	Description	Maximum Deformation, mm	Maximum Stress, Mpa
1	Steel	107.5	503.3
2	Compound	105	473

Conclusions

The development of a compound 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.

The study demonstrated that compounds can be used for leaf springs for light weight vehicles and meet the requirements, together with substantial weight savings. A comparative study has been made between compound and steel leaf springwith respect to weight, cost and strength.

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