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# A Review on Design of Elliptical Leaf Spring in Light Agricultural Machines.

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**ABSTRACT**

**The aim of this review paper is to represent a general study on the design, analysis of small agricultural elliptic leaf spring. In agricultural machines operator comfort and load carrying capacity, rigidity is important considerations. Machine ride comfort depends upon the suspension system. Suspension system in machine significantly affects the behavior of machine. Elliptic leaf springs are perhaps the simplest and are less expensive compared to other suspension. Elliptic leaf spring is therefore an important aspect in the suspension system design. Due to variation of load elliptic leaf springs are one of the most stressed components in agricultural machine therefore quality of machine depends upon the characteristics of leaf spring used in suspension unit, Performance measures of any leaf springs are its stress developed and weight. This paper present design of elliptic leaf spring used in light agricultural machines.**

**Keywords: Elliptic leaf Spring, Solid works, ANSYS, Composite elliptical spring and Light Agricultural Machine.**

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## I. INTRODUCTION

In the present paper the main focus of automobile manufacturers is to reduce stress developed in light agricultural machine. Stress developed is the predominant mode to reduce efficiency of operator. This is due to the fact that the operator has adverse circulatory and neural effects in the fingers. The signs and symptoms include numbness, pain, and blanching (turning pale and ashen). Agricultural machines are subjected to several of loads like shocks caused due to land irregularities traced by the wheels, the sudden loads due to the wheel traveling over the elliptic leaf spring etc. The elliptic leaf springs are more affected due to stress, as they are a part of the unstrung mass of the automobile. Performance measures of any leaf springs are its stress and deflection after application of load. Stress developed can be reduced by replacing traditional steel elliptic leaf springs by composite elliptic leaf springs.

Though there are many types of leaf springs, according to their shapes as "Elliptical" or "full elliptical" leaf springs referred to two circular arcs linked at their tips used for small agricultural machines.

**Figure 1: Elliptic leaf spring**

Abdul Karim Selman Abdul Karim et al[1] were investigated leaf spring for light truck. Three groups of light truck were considered simulation resembles to constrained condition when mounting on the vehicle, where each leaf in the system can be idealized in to a diamond shape. The number of cases studied equal 24 cases. The finite element method was applied as a method of analysis to examine the stress distribution for each leaf. They concluded the magnitude of stress in lower side surface for all leaves of spring is more than stress in upper side surface.

 

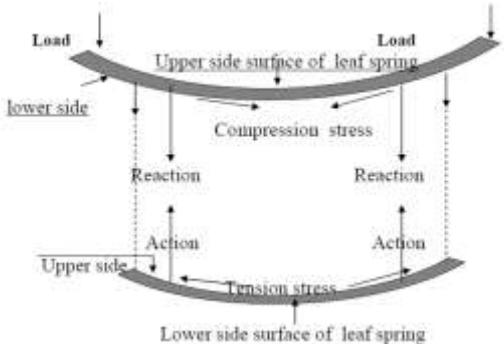


**Figure 2: Nature of stress developed after application of force**

Dev Dutt Dwivedi et. al [2] investigated the design and analysis of leaf spring. They designed leaf spring on ANSYS Workbench, stress and strain analysis had done on the designed leaf spring. The steel leaf spring is supplanted by composite leaf spring provided that Composite leaf spring is superior to steel leaf spring. Composite materials have more flexible strain and high quality to weight ratio to steel. It is reasoned that composite leaf spring is a successful trade for the current steel leaf spring in car. They found burdens in the composite leaf spring are much lower than that of the steel spring.

Ashish V. Amrute et.al[3] investigated a composite leaf spring to replace a steel leaf spring due to high strength to weight ratio for the same load carrying capacity and stiffness with same dimension as that of steel leaf spring. They designed a semi-elliptical multi leaf spring for a four wheel automobile and replaced with a composite multi leaf spring made of E-glass/epoxy composites. They found under the same static load conditions the stresses and the deflection in leaf springs are found with great difference. Stresses and deflection in composite leaf springs was found out to be less as compared to the conventional steel leaf springs. They found composite leaf spring were reduces the weight by 67.88% for E-Glass/Epoxy as compared with steel leaf spring for strength and weight.

W. Hufenbach et. al [4] described design and analysis of a conventional leaf spring under static loading conditions. They prepared 3D model in CATIA and then CAE analysis is performed using ANSYS-11. The results obtained from ANSYS as 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 %. They observed that 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 was below the Yield Stress i.e. 250MPa.Therefore they found design, is safe. It had observed 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. Hence they used CAD model for fatigue loading under defined boundary conditions.

A. strzat et. al[5] performed a three dimensional contact analysis of the car leaf spring. They considered static three dimensional contact problem of the leaf car spring and the solution is obtained by finite element method performed in ADINA 7.5 professional system. They chosen as reliability criterion for maximum displacement of car spring. They used different types of mathematical model starting from the easiest beam model and ending on complicated three dimensional non-linear model which takes into consideration large displacements and contact effects between subsequent spring leaves. The static characteristics of the car spring was obtained for different models and later on, it was compared with one obtained from experimental investigations.

B. vijaylakshmiet. et al[8] compared composite leaf spring with that of steel leaf spring for load carrying capacity, stiffness and weight savings for heavy vehicle. They used design constraints as stresses and deflections. The dimensions of an existing conventional steel leaf spring of a Heavy commercial vehicle are taken Same dimensions of conventional leaf spring are used to fabricate a composite multi leaf spring using E-GLASS/EPOXY, C-GLASS/EPOXY, S- GLASS/EPOXY unidirectional laminates. Pro/Engineer software is used for modeling and COSMOS is used for analysis. Static & Dynamic analysis of Leaf spring is performed using COSMOS.

H.A. Al Qureshiet. al[9] has described a single leaf, variable thickness spring of glass fiver reinforced plastic (GFRP) with similar mechanical and geometrical properties to the multi-leaf steel spring was designed, fabricated and tested.

M.L Aggarwal, et. al[10] has calculated fatigue strength of shot peening leaf spring from laboratory samples of EN45A spring steel specimen. They improved fatigue strength of material by creating compressive residual stress field in their surface layers through shot peening.

## II. METHODS

Stress developed during operation has adverse circulatory and neural effects in the fingers of operator. Replacing traditional steel elliptical leaf spring by composite elliptic leaf spring it is possible to reduce stress. Weight of elliptic leaf spring also will be reduced by replacing steel with composite materials.

### *1. Study of existing elliptic leaf spring and its design*

An elliptic leaf spring is defined as an elastic body, whose function is to distort when loaded and to recover its original shape when the load is removed. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system[6].

### *2. Design of elliptical spring for small agricultural machine.*

Elliptical leaf spring were designed solid work software.

### 3. *Simulate for the performance and failure of elliptical leaf spring developed using ANSYS 14.0.*

Studied the behaviour of two elliptical leaf springs, equivalent stresses, equivalent elastic strain and total deformation for different forces using ANSYS 14.0

 

***3. To analyse* for equivalent stresses, equivalent elastic strain and total deformation using ANSYS 14.0.**

The analysis of elliptical leaf spring will be conducted at different forces.

***4. Fabrication of elliptical leaf springs***

Different fabrication methods used to fabricate elliptical material using SS304 and CFRP material. Elliptical leaf springs will be fabricated using cutting, shearing, punching, drilling, grinding, straightening, finishing, fastening and assembly technique.

***5. Experimental study of elliptical leaf spring with SS304 material and elliptical leaf spring with CFRP to simulate elliptical leaf spring using analysis software.***

***6.***

***7. Comparative study and implementation of composite material by replacement of SS30.***

Comparison of equivalent stresses, equivalent elastic strain, total deformation and weight saving for elliptic leaf spring using SS304 and CFRP material.

## III. PROCEDURE FOR TESTING

1. The spring will be examined for load vs displacement
2. Plunger require to move up at desired height so that we can fix the fixture and elliptical leaf spring for test.

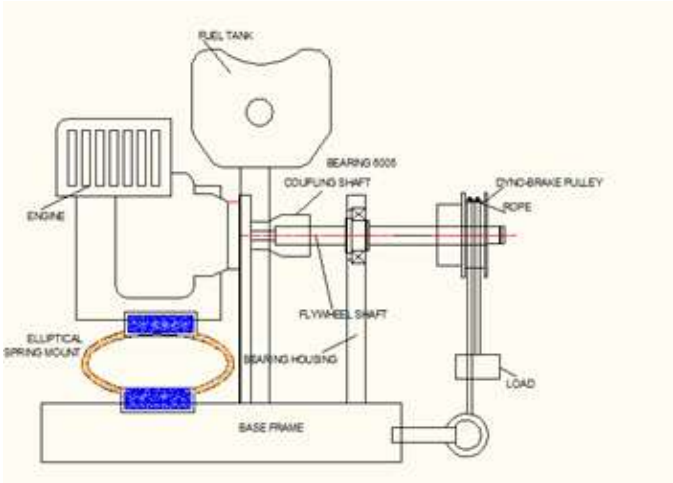


**Figure 3: Layout of project**

3. To fix the position of fixture.
4. Elliptical leaf spring require to fix on fixture.
5. The load is applied at the centre of spring, the vertical deflection of elliptical leaf spring takes place.
6. Results were obtained on software.

## IV. CONCLUSION

In this study general discussion on design, analysis of leaf spring is carried out for enhancement of the stress developed. The main purpose of doing this work is to reduction of the stresses at peak loading condition. For improve stress and its weights can be implemented by changing the material. This study will help to understand more the behavior of the spring by using CAE and give information for the manufacturer to improve the stress developed by changing design parameter. FEA will be carried out by changing design parameter with conventional spring and modified spring. The result will compared with experimental result.

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