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Simulation and Experimentation of Elliptical Leaf Spring for Light Agricultural Machines with SS304 Material

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ABSTRACT

In suspension system generally elliptic leaf springs used. In small agricultural machines reduction in stress is important. In this paper, ANSYS as simulation tool, used to study the stress of SS304 elliptic leaf springs. Simulation and experimental results of elliptical leaf spring were compared. The error observed in experimentation and simulation found 1.56%. Analysis of elliptic leaf spring for different forces were studied, 8Kg load gives minimum %error.

Keywords: SS304; ANSYS; Elliptical leaf spring.

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I. INTRODUCTION

Elliptical Leaf springs used in small agricultural machines as suspension system. YohannesRegassa et al [1] conducted multiple triles on different thickness values and materials for a better and modified design of the master leaf spring.D.N.Dubey et al [2] studied design and experimental analysis of a Maruti Omni Car for a mono parabolic leaf spring using conventional parabolic leaf, suggested composite material leaf spring like HM and HS carbon polymer.Pradeep B. Tapkir et al [3] optimized existing semi elliptic leaf spring for the critical part like eye, bolt etc. to minimize the overall weight of the assembly without hampering its structural strength. Bhaumik A. Bhandari et al[4] conducted static analysis of steel leaf spring and composite leaf spring tocompare compare the load carrying capacity, stiffness and weight savings.SubhashChandrabose et al [5] designed a Parabolic Leaf Springfor optimization, analysis and fabrication. They studied design of leaf spring and its boundry conditionsA. SHINOHARA et al [6] studieddeflection of a circular c-shaped spring and compared theoretical analysis of a circular C-shaped spring withexperimental verifications .G HARINATH GOWD et al [7] conducted STATIC ANALYSIS OF LEAF SPRING of TATA-407 commercial vehicles to found comfortable speed and stresses occurs.Baviskar A. C et al [8] studied design and analysis of a Leaf Spring for automobile suspension system to represent behavior of vehicle, i.e. vibration characteristics includingride comfort, stability etc.

II. METHODS

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. Elliptic leaf springs absorb the vehicle shocks, bump loads (induced due to road irregularities) and vibrations by means of spring deflections, so that the potential energy is stored in the leaf spring and then relieved slowly

2. Design of elliptical spring for small agricultural machine.

Elliptical leaf spring were designed solid work software. Multiple trials for different thickness values and materials, recommendations were given for a better and modified design of the elliptical leaf spring.

3. Simulate and analysefor the performance and failure of elliptical leaf spring developed using ANSYS 14.5.

Studied equivalent stresses, equivalent elastic strain and total deformation for different forces using ANSYS 14.5.

The analysis of elliptical leaf spring was conducted at different forces.

4. Fabrication of elliptical leaf springs

Different fabrication methods used to fabricate elliptical material using SS304 material. Elliptical leaf springs were fabricated using cutting, drilling, straightening, fastening and assembly technique.

5. Experimental study of elliptical leaf spring with SS304 Comparative study

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

6. To determine load for which stress developed minimum.

III. RESULTS

The geometry of elliptical leaf spring consistselliptical plate having 177mm major diameter, 81mm minordiameter, 85mm width and 1.5mm thickness. The mild steelplate 92mm length and 85mm width has used to join ends ofelliptical plate. In this study, force applied is varied by 4Kg,6Kg, 8Kg, 10Kg and 12Kg. Flat plate were joined to ellipticalleaf spring by using M5 nut and bolts. The same dimensionsof elliptical leaf spring were used in the simulation.It has seen that when loadincreases the bending stress increases linearly. At minimumloads both ANSYS and experimentation results were veryclose. It has observed that minimum stress developed at 4kg load.Static analysis were performed to find the Von-Mises stressby using ANSYS software and these results are comparedwith bending stresses calculated by experimentation atvarious loads.

The ANSYS simulation results are obtained as follows,

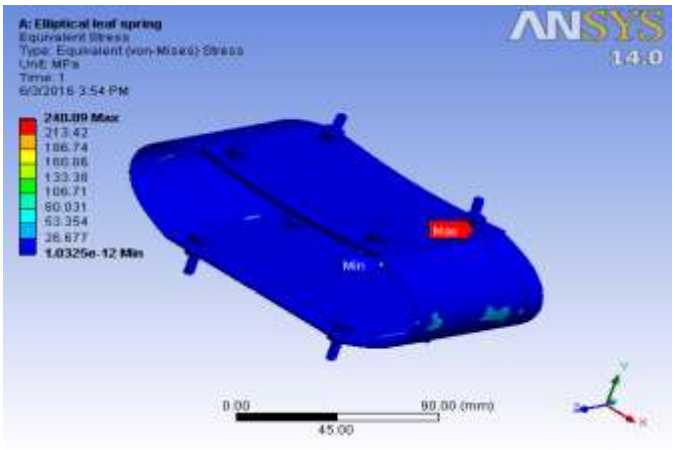

Figure 1 Equivalent(Von-Mises) stress developed in elliptical leaf spring with SS304 material after application of 12Kg load

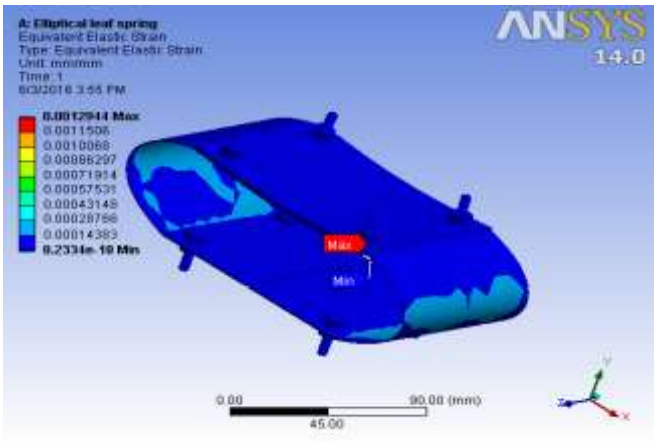

Figure 2 Equivalent elastic strain developed in elliptical leaf spring with SS304 material after application of 12Kg load

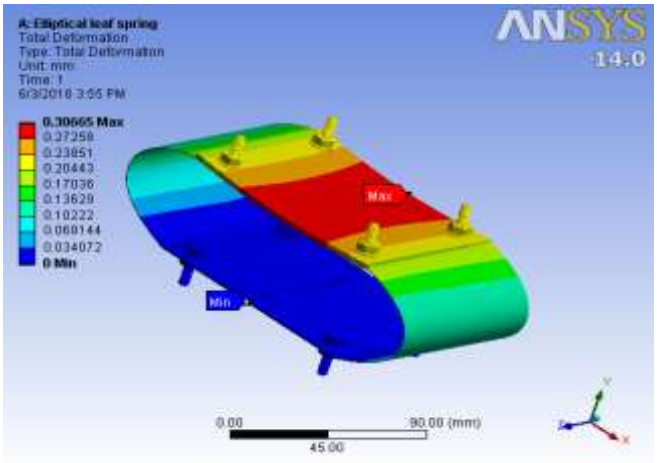

Figure 3 Total deformation of elliptical leaf spring with SS304 material after application of 12Kg load

It has been observed that deflection of elliptical leaf spring changes along with force applied.The experimental results obtained in strength of material laboratory at different forces as below,

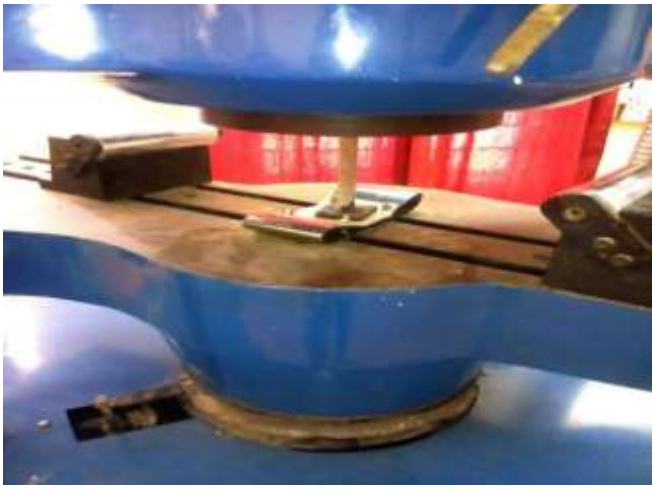

Figure 4 Fracture of elliptical leaf spring with SS304 material during test at 4250N

Sr no	Force applied (Kg)	Von-mises Stress developed in SS304 material (MPa)	
		Simulation	Experimentation
1	4	80.52	79.45
2	6	120.78	116.24
3	8	161.04	161.02
4	10	200.08	196.14
5	12	240.09	238.7

Table 1.0 Variation of Von-mises stress with loads

IV. DISCUSSION

Stresses generated by engine be reduced or isolated the handle from body of application.In this studyloading of elliptic leaf spring with SS304 material had done for different loads along with different parameters equivalent stress, equivalent elastic strain and total deformation. The stress developed at 4kg load is minimum as compared to all other loads.Stainless steel does not readily corrode, rust or stain with water as ordinary steel does. However, it is not fully stain-proof in low-oxygen, high-salinity, or poor air-circulation environments. Stainless steel is used where both the properties of steel and corrosion resistance are required.The elliptical leaf springs with SS304 were fabricated and used for experimentation.As testing results shows fracture of elliptical leaf spring with SS304 material at 4250N.

A graph is plotted with displacement(mm) on the X-Axis and load(Kg) on the YAxis.

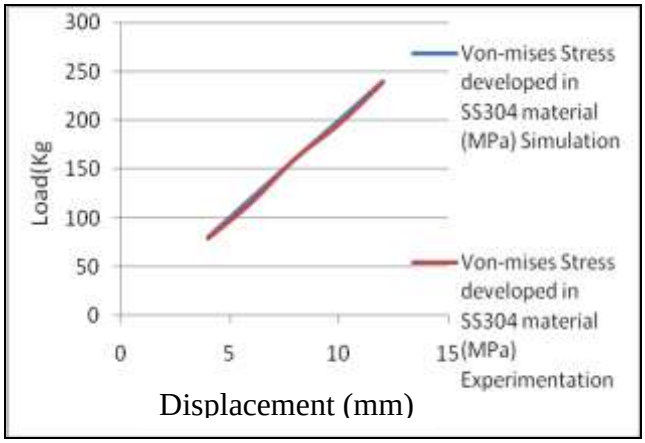

Figure 1.4 Comparison of ANSYS simulation results and experimental results

V. CONCLUSION

Simulation and experimentation on the elliptical leafspring were performed in this study. Simulation andexperimental stress were approximately same for ellipticalleaf spring. To improve the stress of elliptical leaf spring, useof deflection with forces i.e. 4Kg, 6Kg, 8Kg, 10Kg and 12Kgwere investigated. Based on the above simulated results, the following conclusions can be made:

1. Deflection of elliptic leaf spring mainly depends on force applied.
2. The results demonstrated that material can improve stresses.
3. All the simulation results are compared with the experimental results and it has found that they are nearly equal to each other.
4. The stress developed at 4Kg load minimum as compared to all other loads.
5. The 8Kg load gives minimum %error in bending stress.

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