Analysis and Optimization of Spring Design with Fatigue Failure

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Abstract— In now a day the fuel proficiency and outflow gas direction of cars are two essential issues. To satisfy this issue the car enterprises are attempting to make new vehicle which can give high productivity ease. The most ideal approach to build the fuel proficiency is to decrease the heaviness of the vehicle. The weight lessening can be accomplished fundamentally by the presentation of better material, outline streamlining and better assembling forms. The accomplishment of weight lessening with satisfactory change of mechanical properties has made composite a decent substitution material for traditional steel. The car vehicles have number of parts which can have the capacity to supplant by composite material, yet because of the change of mechanical properties of composite material. It has more versatile quality and high quality to weight proportion has contrasted and those of steel material. Thus, out of numerous parts one of the segments of car, the leaf spring which use for done the entire weight of the vehicle is best choice for substitution of steel material by composite material. Leaf springs are one of the most seasoned suspension parts they are still every now and again utilized, particularly in business vehicles. The past writing review demonstrates that leaf springs are planned as summed up compel components where the position, speed and introduction of the pivot mounting gives the response constrains in the undercarriage connection positions. Another part must be engaged, is the vehicle business has demonstrated expanded enthusiasm for the supplanting of steel spring with composite leaf spring because of high quality to weight proportion. Along these lines, investigation of the composite material turns out to be similarly imperative to ponder the conduct of Composite Leaf Spring. The goal of this paper is to introduce displaying and examination of composite mono leaf spring (GFRP) and think about its outcomes. Demonstrating is finished utilizing CATIA 5.0 and Analysis is completed by utilizing ANSYS 15.0 programming for better understanding. A relative report has been made amongst steel and composite leaf spring concerning quality and weight. Composite leaf spring lessens the weight by 74.54% for E-glass/epoxy, 79.66% for Carbon epoxy and 79.77% for Graphite epoxy over steel leaf spring. The size improvement has been done for additionally mass lessening of composite leaf spring. Composite leaf spring diminishes the weight by 78.21% for E-glass/epoxy, 82.56% for Carbon epoxy and 82.67% for Graphite epoxy contrasted with steel leaf spring.

Key words: IBVR, Video Retrieval, Shots, Feature Extraction

I. Introduction

In now a day the fuel productivity and emanation gas direction of cars are two essential issues. To satisfy this issue the car businesses are attempting to make new vehicle which can furnish high proficiency with minimal effort. The most ideal approach to expand the fuel effectiveness is to diminish the heaviness of the vehicle. The weight diminishment can be accomplished essentially by the presentation of better material, plan advancement and better assembling forms. The accomplishment of weight lessening with sufficient change of mechanical properties has made composite a decent swap material for regular steel. In vehicle auto out of numerous parts one of the segments of car which can be effectively supplanted is leaf spring. A leaf spring is a basic type of spring, usually utilized for the suspension in wheeled vehicles. The suspension of leaf spring is the range which needs to center to enhance the suspensions of the vehicle for comfort ride. The suspension leaf spring is one of the potential things for weight lessening in car as it represents 10 to 20% of unspring weight. It is a known fact that springs are intended to retain stuns. So the strain vitality of the material turns into a central point in outlining the springs.

II. Literature review

Before starting any dissertation work, the literature review of the topic is must, because it helps us in knowing the amount of work that has been done in that topic by the different researchers. It also helps us in doing the further work by taking the reference of the previous work done in the best possible way.

Pankaj Saini, Ashish Goel and Dushyant Kumar have worked on design and analysis of composite leaf spring for light vehicles. In this paper, they consider passenger vehicle with ten-leaf steel spring for analysis of stress and deflection by using ANSYS 9 software. The objective is to compare the stresses and weight savings of composite leaf spring with that of steel leaf spring. The material selected was E-glass/epoxy, carbon epoxy and graphite epoxy which is use against conventional steel. The dimensions and the number of leaves for both steel leaf spring and composite leaf springs are considered to be the same. They consider design constraints were stresses and deflections.

From the static analysis results it was found that there is a maximum displacement of 10.16mm in the steel leaf spring and the corresponding displacements in E-glass/epoxy, Graphite epoxy, and Carbon epoxy are 15 mm, 15.75 mm and 16.21 mm. From the static analysis results, the von-mises stress the steel is 453.92 MPa and the von-mises stress in E-glass epoxy, Graphite epoxy and Carbon epoxy is 163.22 MPa, 653.68 MPa and 300.30 MPa was exiting respectively. A comparative study has been made between steel and composite leaf spring with respect to strength and weight. Composite mono leaf spring reduces the weight by 81.22% for E-Glass/epoxy, 91.95% for Graphite epoxy, and 90.51 % for Carbon epoxy over conventional leaf spring

III. Modeling and analysis of steel leaf spring

Based on the dimensions obtained from the conventional design of leaf spring, the model of the leaf spring was created with the help of the 3-D modelling CAD software ANSYS 15.0.

After conducting the static structural analysis on steel leaf spring, maximum deflection and stresses were determined for various loads, a result table of which has been drawn below-

S. No.	Load (N)	Maximum Deflection(mm)	Stress (N/mm^2)
1	800	488.956	1794.213
2	1000	615.687	2155.012
3	1200	736.159	2476.259
4	1400	858.654	2794.753
5	1600	980.254	3140.934
6	1800	1098.258	3489.142
7	2000	1221.984	3835.964

Table 1: load vs stress

IV. ANALYSIS OF COMPOSITE LEAF SPRING

Material	Load (N)	Maximum Stress (N/mm^2)	Maximum Deformation (mm)	Weight (kg)
Steel Leaf Spring	800	1794.213	488.956	
	1000	2155.012	615.687	
	1200	2476.259	736.159	
	1400	2794.753	858.654	
	1600	3140.934	980.254	
	1800	3489.142	1098.258	
	2000	3835.964	1221.984	
Composite E-glass/epoxy Leaf Spring	800	3081.268	402.321	
	1000	3318.256	506.486	
	1200	3559.297	605.256	
	1400	3798.856	707.125	
	1600	4038.251	805.562	
	1800	4277.861	906.415	
	2000	4518.245	1007.731	

Table 2: Comparison of Steel and Composite Leaf Spring Analysis Data

A. *Assumptions:*

- Software to be used for ANSYS 15.0
- Model simplification for FEA.
- Meshing size is limited to computer compatibilities.
- Static analysis is considered.
- Material used for steel leaf spring analysis is isotropic.

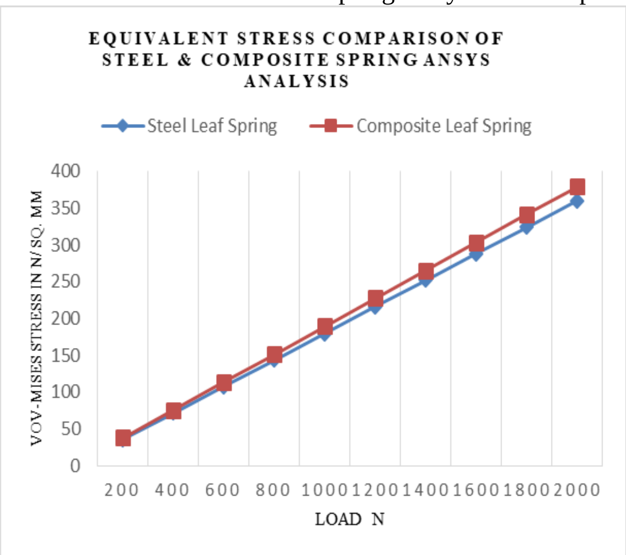

Fig. 1: Graph for ANSYS Analysis Stress Comparison

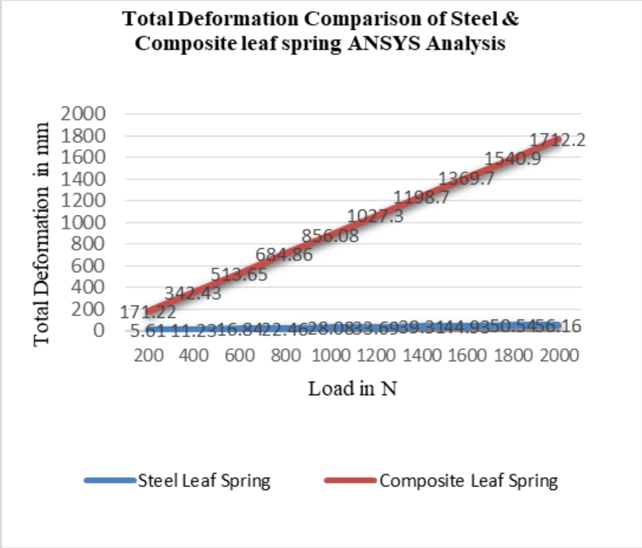

Fig. 2: Graph for ANSYS Analysis Deformation Comparison

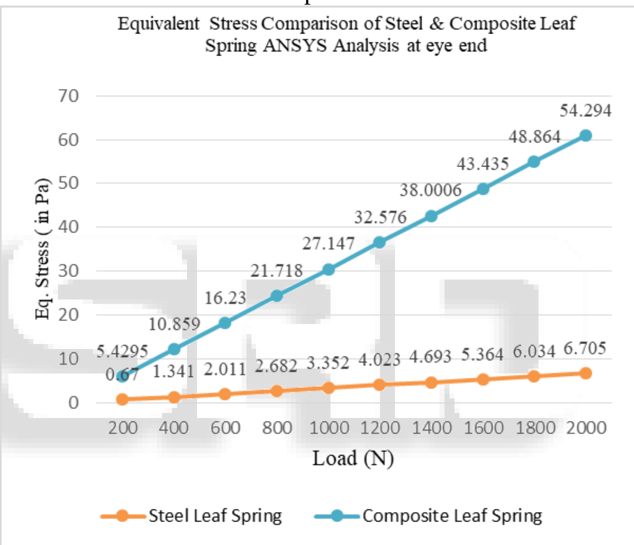

Fig. 3: Equivalent Stress Comparison of ANSYS Analysis for Steel & Composite Spring at eye end of the spring

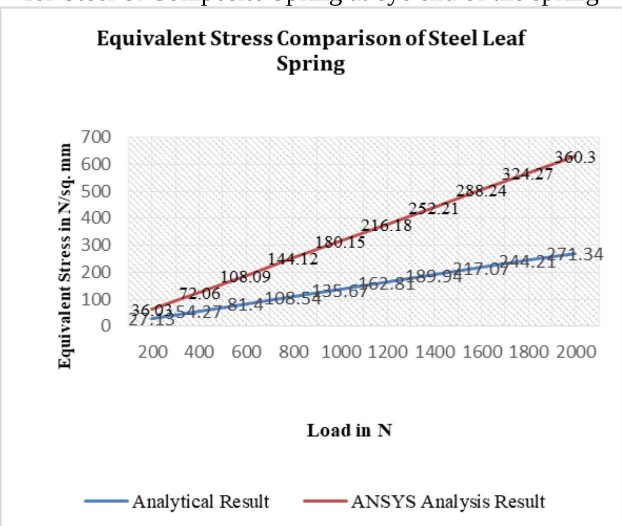

Fig. 4: Analytical & ANSYS Analysis Comparison for Equivalent Stress of Steel Leaf Spring

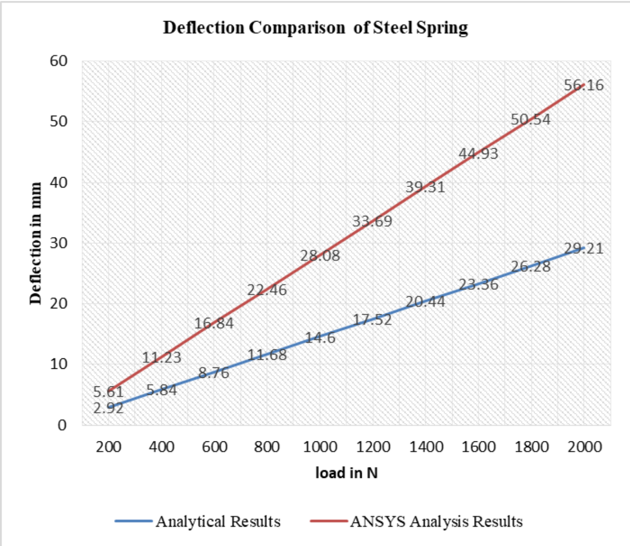

Fig. 5: Analytical & ANSYS Analysis Comparison for Deflection of Steel Leaf Spring

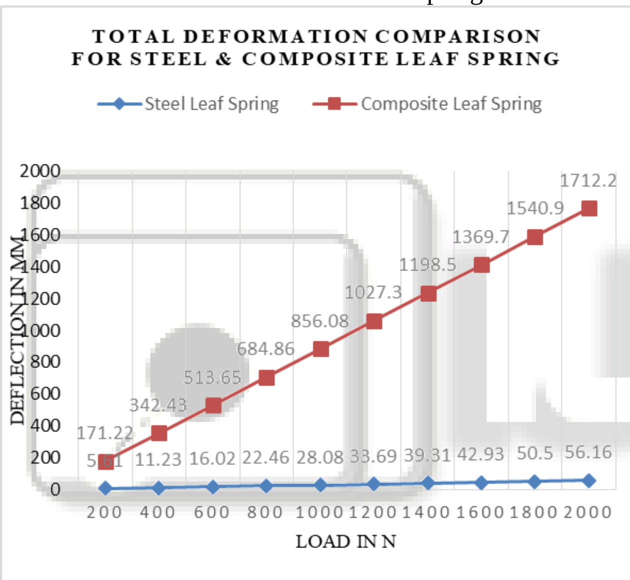

Fig. 6: Total Deformation Comparison of ANSYS Analysis for Steel & Composite Spring at eye end of the spring

V. CONCLUSION

The design and static structural analysis of steel leaf spring and composite leaf has been carried out. Comparison has been made between composite leaf with steel leaf spring having same design and same load carrying capacity. The stress and displacements have been calculated using analytically as well as using ANSYS for steel leaf spring and composite leaf spring. From the static analysis results it is found that there is a maximum displacement of 615.687 mm in the steel leaf spring and the corresponding displacements in E-glass/epoxy is 506.486 mm.

From the static analysis results, it also seen that the von-mises stress in the steel leaf spring is 2155.012 MPa and in E-glass/epoxy it is 1817.2 MPa. Composite leaf spring has lower displacements and stresses than that of existing steel leaf spring.

A comparative study has been made between steel and composite leaf spring with respect to strength and weight. Composite leaf spring reduces the weight by 85.44% for E-glass/epoxy over steel leaf spring. Another comparison between stresses developed in both the cases shows that in case of composite spring there is a better distribution of stress when compared to steel leaf spring hence it can be widely used for numerous suspension problems.

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