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ISSN : 2348 - 5612 | Volume : 05 , Issue : 06 | April – June 2018

"Stress and deformation analysis of Leaf Spring based on different material"

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Abstract— *Present scenario increasing competition and innovation in reducing the weight of the automobile products by maintaining the strength. Leaf springs are one of the oldest suspension components that are still being used widely in automobiles. Automobile sector leaf springs are used in suspension system and it is prepared by steel materials which are replaced by composite materials due to its high strength to weight ratio, high strain energy capability. The use of the composite material in leaf spring is reducing the weight without reducing load carrying capacity and stiffness. In this work objective is to compare the stiffness and weight saving of the composite leaf spring and traditional mild steel leaf spring. Various composite materials KEVLAR49, CFRP, Al Alloy and Magnesium Alloy selected as a spring materials instead of existing conventional material. Modeling is done using CATIA and analysis is carried out by using ANSYS workbench.*

Keywords- Leaf spring; composite materials; Finite element analysi; natural fibres.

I. INTRODUCTION

The spring plays very essential part of every automobile for suspension point of view. Leaf spring is the main type of suspension system which is used in many light and heavy vehicles. Leaf spring used in many vehicles due to having some main characteristics which are shown below.

1) Uniformly load distribution

2) Lower cost

3) Rough used

4) Easier in Isolation and tightly attached with working frame

Today every automobile company has been working on increasing the efficiency with reducing the weight without having any load carrying capacity. In this paper we would like to review some previous research work performed on the leaf spring by previous researchers for increasing the working condition and capacity with load reduction. The paper based on material composition, experimental testing and load (Steady, Dynamic) study etc.

ISSN : 2348-5612 © URR

A leaf spring is the simple form of spring commonly used for the suspension in wheeled vehicles. Leaf spring is mainly made up of steel, but due to issue of weight today most of the automobile companies used composite materials for the manufacturing of leaf springs. The composite materials KEVLAR49, CFRP, Al Alloy and Magnesium Alloy selected as a spring materials.

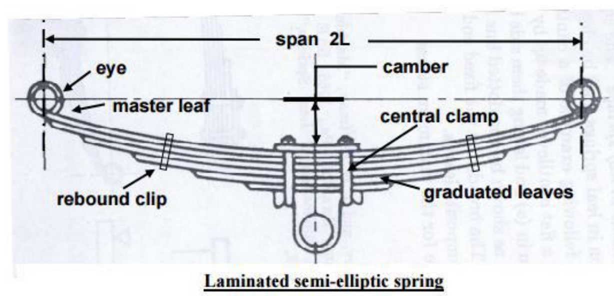

Figure 1 Leaf Spring

II. LITRETURE REVIEW

(Vamsi Krishna dommeti, 2017) said that, for last decades in automobile, reduction of weight is their vital task. Leaf is mainly used for suspensions. Replacing material of leaf spring with composite materials, weight can be easily reduced, improves quality and strength, reduce cost of modelling of the complete multi leaf spring structure is performed by using CAT and model of leaf spring is now imported into for E47 steel and GFRP reinforced with natural fibers made between steel, GFRP and GFRP reinforced with natural fibers, Static and Fatigue analysis has been conducted to predict the stress and displacement at different locations for various load value.

(Chintada. Vinod Babu, 2017) research in present scenario is increasing competition and innovation in reducing the weight of the automobile products by maintaining the strength. Leaf springs are one of the oldest suspension components that are being still used widely in automobiles.

Automobile sector leaf springs are used in suspension system and it is prepared by steel materials are replaced by composite materials due to its high strength to weight ratio, high strain energy capability. The use of the composite material in leaf spring is reducing the weight without reducing load carrying capacity and stiffness. In this work objective is to compare the stiffness and weight saving of the composite leaf spring and traditional mild steel leaf spring. Various composite materials Eglass/ Epoxy, CFRP, Carbon/Epoxy, Kevlar/Epoxy and Graphite/Epoxy selected as a spring materials instead of existing conventional material. Modeling is done using solid edge and analysis is carried out by using ANSYS workbench

(Dewanji, 2016) deals with the Design and analysis of composite leaf spring. The analysis has been conducted by using ANSYS-12 software with the help of static structural tool. A three layer composite leaf spring with full length leave made of E-Glass/epoxy composite material has been used. The results of Conventional steel leaf spring have been compared with the present results obtained for composite leaf spring. E-glass/epoxy material is better in strength and lighter in weight as compared to the conventional steel leaf spring. Lot of work has been done and is shown in this paper in an interest of justifying the title of the paper.

(R., Sudeesh, M., Sadanandan, & George, 2016) Research in Structural analysis of leaf spring using different composite materials in light commercial vehicle. Leaf springs are unique kind of springs used in vehicle suspension systems. The benefit of leaf spring over helical spring is that the ends of the spring may be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing machine. The main function of leaf spring is not only to bear vertical load but also to isolate road induced vibrations. A typical leaf spring configuration of TATA-ACE light commercial vehicle is chosen for study. Finite element analysis has been carried out to find out the safe stresses and pay loads. The prologue of composite materials has made it likely to diminish the weight of the leaf spring without any diminution in load carrying capability and stiffness. Leaf spring is modeled in CATIA V5 R20 software and it is imported in ANSYS workbench 14.5. The conventional steel leaf spring and the composite leaf spring were examined under parallel conditions using ANSYS software and the outcome are Stresses, deflection and strain energy results for both steel and composite leaf spring material were obtained.

III. OBJECTIVE

1. Increase the performance of Leaf Spring by changing conventional material to natural fiber'
2. The enhancement in the performance and efficiency of an spring the higher manufacturing cost can be neglected.
3. Introducing the new suitable materials for manufacturing Leaf spring, it can give better results and performances with maintained cost.
4. Improvement in reliability, efficiency of leaf spring and performance after changing the material of leaf spring will be the expected outcome.

IV. EXPECTED MTHADOLOGY

A. Model creation

Modeling generally refers to a process in design which employs mathematical representation of model for 3D Surface of a model. There are various tools used for the modeling purpose in design industry, CATIA V5 R20 which is one of them is used for the modeling Pistons in this research work.

The model of the multi leaf spring structures also includes many complicated parts, which are difficult to make by any of other CAD Modelling as well as Finite Element software. CAD Modelling of the complete multi leaf spring structure is performed by using CATIVA V5 R20 software.

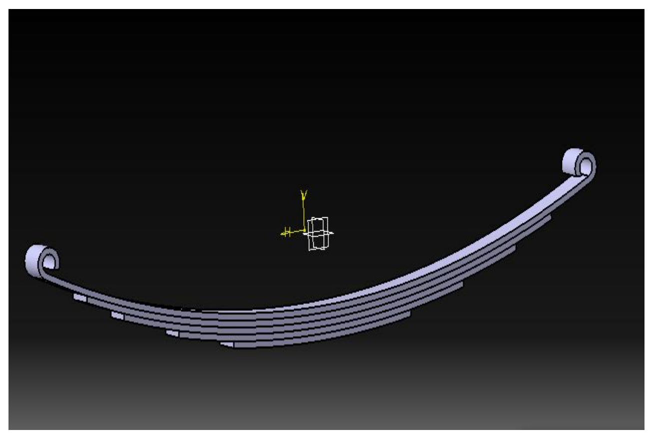

Figure 2 Cad Model of a Leaf Spring

B. Finite Element Analysis

The finite element analysis is a numerical method for solving problems of engineering. It is traditionally a branch of Solid Mechanics. Most common areas of interest are Heat Transfer, Structural Analysis, and Mass Transport. For the designed Pistons it is a must to compare the performance of both pistons and for this purpose ANSYS 15 is used as FEA tool. ANSYS 15 is software used for solving a number of mathematical problems.

Finite Element method divides the structure into a number of finite elements and these elements are bridged with the help of nodes. The elements are chosen after study of the response and geometry of analyzed component. The results which are obtained by post analysis procedure depend on the mesh size. ANSYS Workbench provides potent, practical applications which simplifies the process of mesh generation, decreases the design cycle time, reduces the number of prototype production and testing, thus helps providing an optimum design.

The Process of Analysis is divided in following steps;

1. Pre-Processing
2. Solver
3. Post-Processing

C. Material properties

Table 1 Material property

MATERIAL	DENSITY (kg/M^3)	YOUNGS MODULUS (GPA)	POISSION RATIO	WEIGHT (Kg)
KEVLAR49	1380	76	0.35	6.4709
CFRP	1600	110	0.10	7.5025
Al Alloy 356.2	2700	69	0.3	12.66
Magnesium alloy AZ91	1800	42	0.35	8.4403

D. Meshing

Discretising of model into the small sections called as the element. The number of Mesh nodes 1280 and is Elements 115.

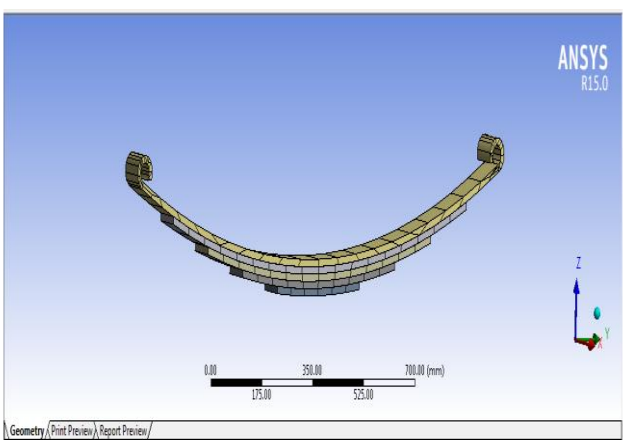

Figure 2 Meshing of a Leaf Spring

V. RESULT

A. Kevlar49

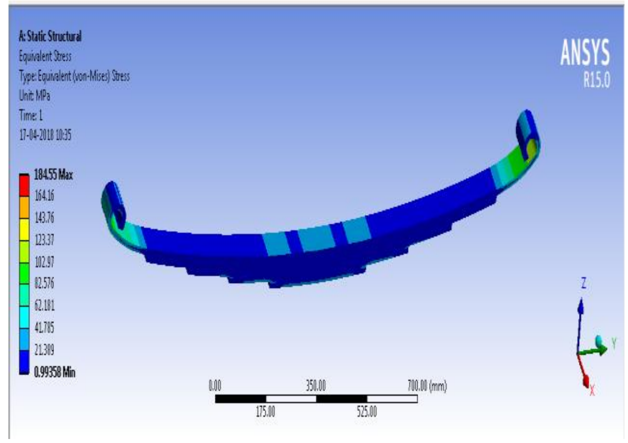

Figure 3 Von misses stress of kevlar49

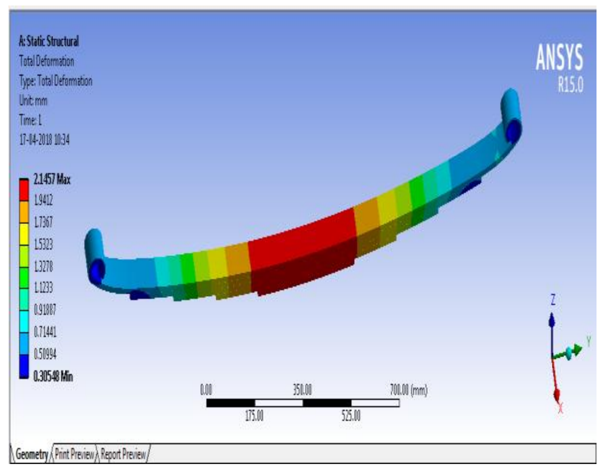

Figure 4 Total deformation of kevlar49

B. CFRP

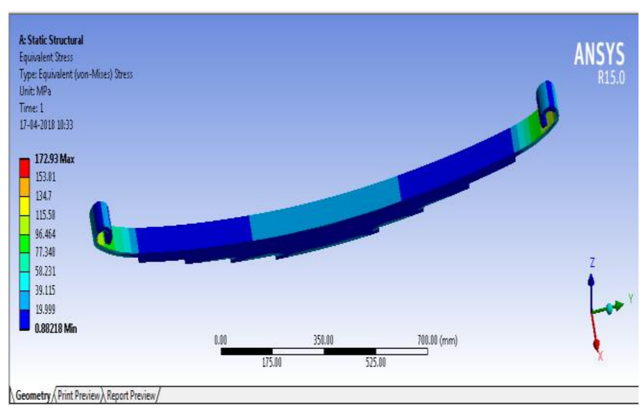

Figure 5 Von misses stress of CFRP

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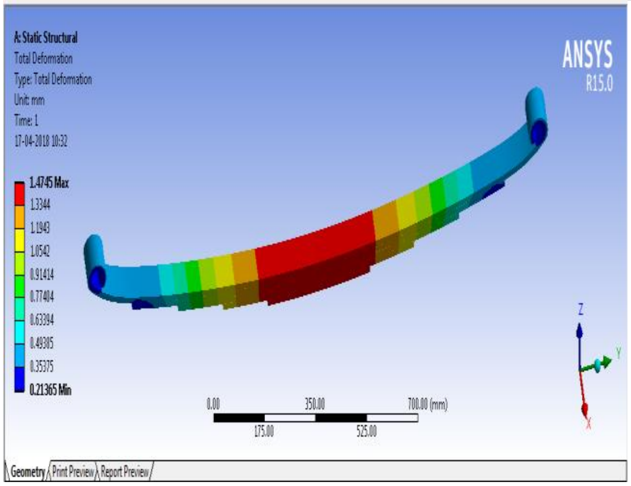


Figure 4 Total deformation of CFRP

C. Al 356.2 alloy

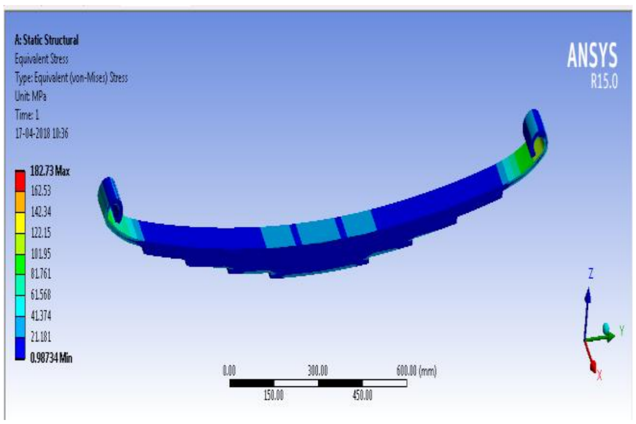


Figure 5 Von misses stress of Al 356.2 alloy

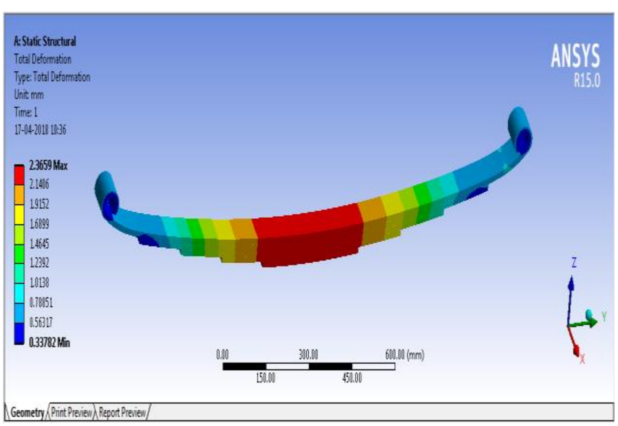


Figure 6 Total Deformation of Al 356.2 alloy

D. Magnesium alloy AZ91

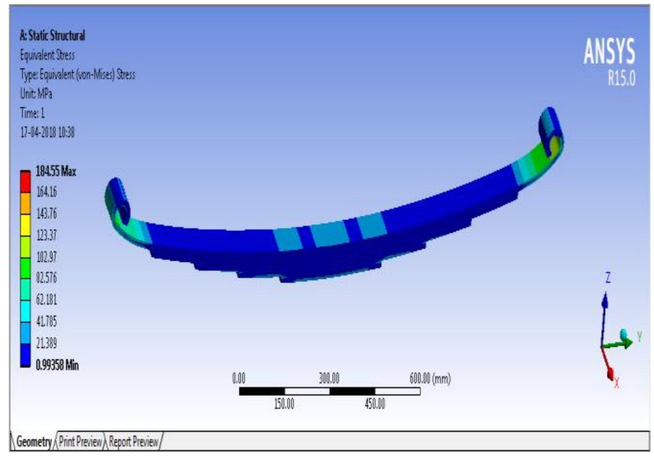


Figure 7 Von misses stress of Magnesium alloy AZ91

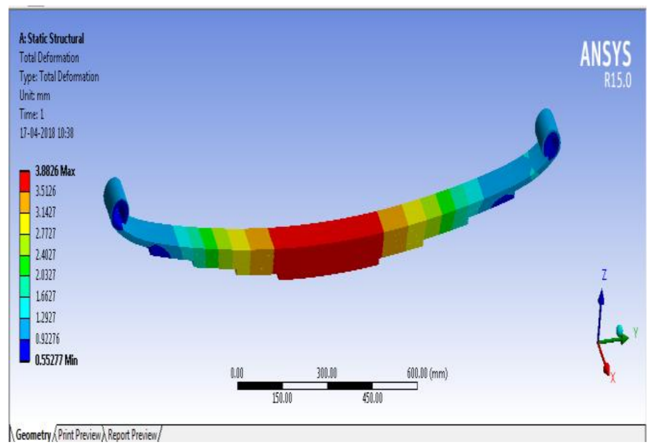
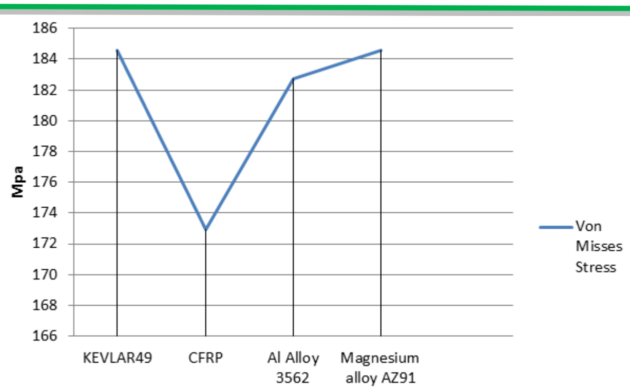


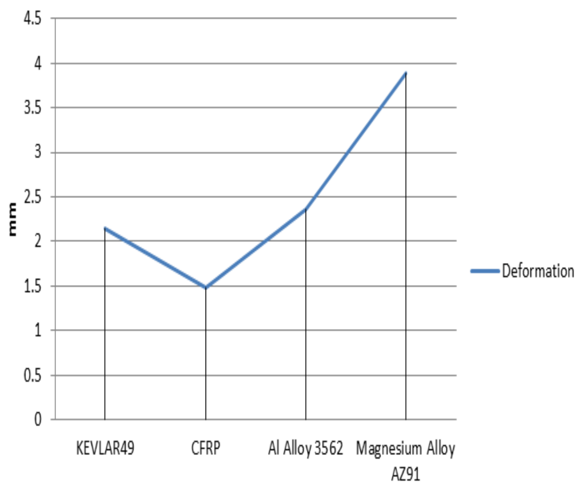
Figure 8 Total Deformation of Magnesium alloy AZ91

Table 2 Result Comparison

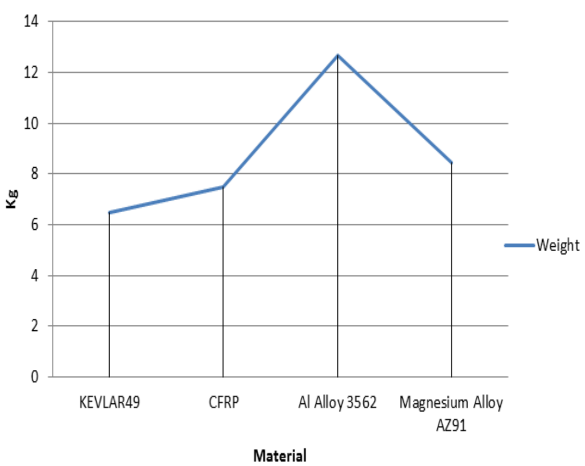
MATERIAL	VON MISSES STRESS (MPa)	TOTAL DEFORMATION(mm)
KEVLAR49	184.55	2.1457
CFRP	172.93	1.4745
Al Alloy	182.73	2.3659
Magnesium alloy AZ91	184.55	3.8826



Graph 1 Comparisone of Von Misses stress



Graph 2 Comparisone of Total deformation



Graph 3 Comparisone of Weight

VI. Counclusion

The result show maximum von misses stresses are found in KEVLAR49 and Magnesium alloy AZ91. And minimum stress is found in CFRP. And maximum deformation are found in Magnesium alloy AZ91and minimum deformation are found in CFRP

This is clear for result CFRP is most suitable in manufacturing Leaf spring for vehicle.

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