Deformation Analysis of Leaf Spring Using Different Materialsand Different loads

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Abstract

The main objective of this project is experimental and finite element analysis of leaf spring using hybrid composite material with aluminum powder, leaf spring is a suspension system in heavy vehicles and material of the leaf spring have more stiffness and high strength conventionally leaf spring is made up of steel material and recently using composite material for reducing the weight of leaf spring but have less stiffness, ductility property and cost of production using of glass fiber and banana fiber composite material with aluminum powder is a new material for leaf spring and compare the material with conventional steel material in structural analysis in FEA simulation

Keywords: *Finite element analysis, Suspension,Composite Materials*

1. Introduction

A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times.

A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section. In the most common configuration, the center of the arc provides location for the axle, while tie holes are provided at either end for attaching to the vehicle body. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in station in the motion of the suspension. For this reason some manufacturers have used mono-leaf springs.

1.1. Suspension (Vehicle)

Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems serve a dual purpose — contributing to the vehicle's road holding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and a ride quality reasonably well isolated from road noise, bumps, vibrations, etc. These goals are generally at odds, so the tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. The design of front and rear suspension of a car may be different.

1.3. Leaf Spring

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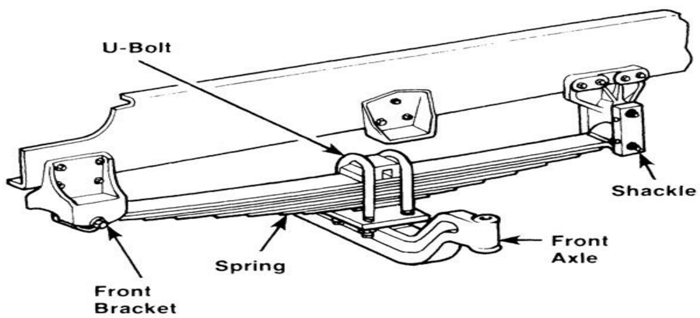


Figure 1. Characteristics of leaf spring

1.4. Composite Materials

A judicious combination of two or more materials produces a synergistic effect. A material system composed of two or more physically distinct phases whose combination produces aggregate properties that are different from those of its constituents.

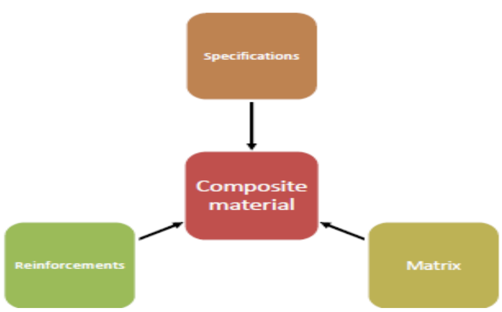


Figure 2. Composite

2. Materials and Methods

2.1. Material for Leaf Spring

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. The heat treatment of spring steel produces greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties. Materials constitute nearly 60%-70% of the vehicle cost and contribute to the quality and the performance of the vehicle. Even a small amount in weight reduction of the vehicle, may have a wider economic impact. Composite materials are proved as suitable substitutes for steel in connection with weight reduction of the vehicle. Hence, the composite materials have been selected for leaf spring design.

2.2. Aluminum A360 Alloy

Increased demand for light weight components, primarily driven by the need to reduce energy consumption in a variety of societal and structural components, has led to increased use of aluminium. Additionally, the cost of fabrication coupled with a need to improve part recovery has led to significant growth in the net-shaped component manufacturing processes. Aluminium Powder Metallurgy (P/M) offers components with exceptional mechanical and fatigue properties, low density, corrosion resistance, high thermal and electrical conductivity, excellent mach inability, good response to a variety of finishing processes, and which are competitive on a cost per unit volume basis. In addition, aluminium P/M parts can be further processed to eliminate porosity and improve bonding yielding properties that compare favourably to those of conventional wrought Aluminium products.

2.3. Graphite

Natural Graphite is a mineral consisting of graphitic carbon. It varies considerably in crystalline. Most commercial (natural) graphite's are mined and often contain other minerals. Subsequent to mining the graphite often requires a considerable amount of mineral processing such as froth flotation to concentrate the graphite. Natural graphite is an excellent conductor of heat and electricity. It is stable over a wide range of temperatures. Graphite is a highly refractory material with a high melting point (3650˚C.)

Table 1. Material Properties

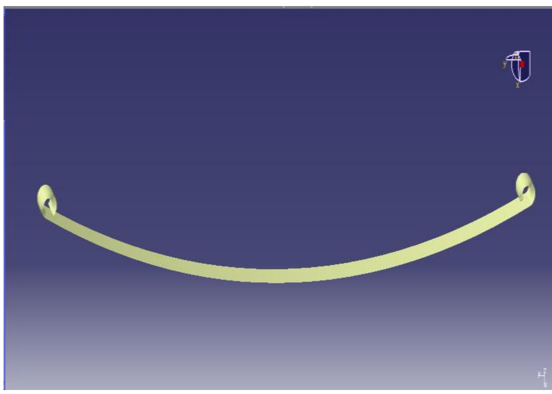
	E-GLASS FIBRE	BANANA FIBRE	ALUMINIUM	40%E-Glass Fiber 40% Banana Fiber-20% Aluminium powder	40%E-Glass Fiber 50% Banana Fiber-10% Aluminium powder
DENSITY (Kg/m3)	2550	1400	2700	2120	1990
POISSON RATIO	0.21	0.2	0.3	0.224	0.214
YOUNG'S MODULUS (Gpa)	72	30	70	54.8	50.8

2.4. Finite Element Methods

The finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in engineering schools and industries. In more and more engineering situations today, we find that it is necessary to obtain approximate solutions to problems rather than exact closed form solution.

It is not possible to obtain analytical mathematical solutions for many engineering problems. An analytical solutions is a mathematical expression that gives the values of the desired unknown quantity at any location in the body, as consequence it is valid for infinite number of location in the body. For problems involving complex material properties and boundary conditions, the engineer resorts to numerical methods that provides approximate, but acceptable solutions. The finite element method has become a powerful tool for the numerical solutions of a wide range of engineering problems. It has developed simultaneously with the increasing use of the high-speed electronic digital computers and with the growing emphasis on numerical methods for engineering analysis. This method started as a generalization of the structural idea to some problems of elastic continuum problem, started in terms of different equations or as an extranet problem.

2.5. Model of Leaf Spring



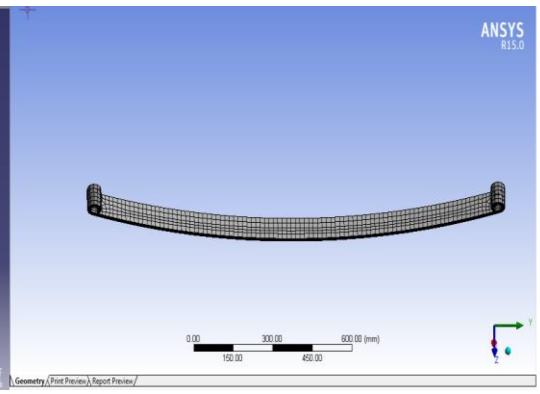
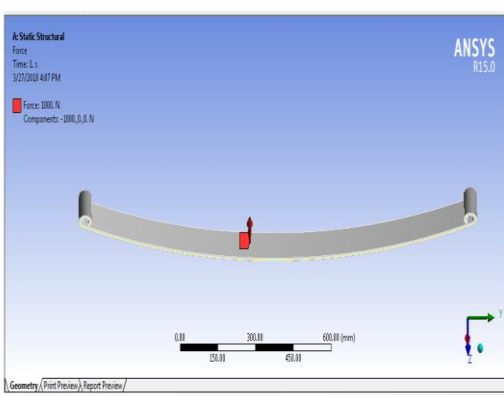


Figure 3. Model of leaf spring **Figure 4. Mesh image of leaf spring**

2.6. Boundary Conditions



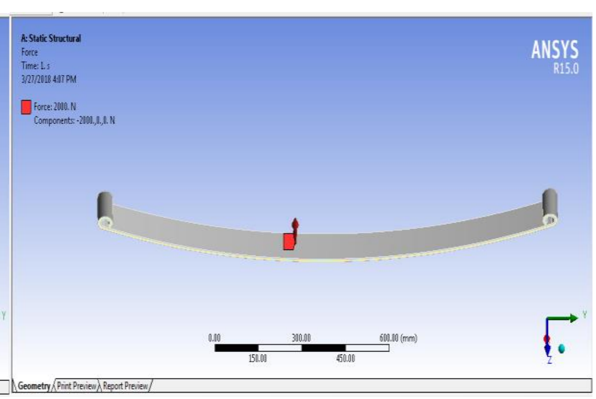
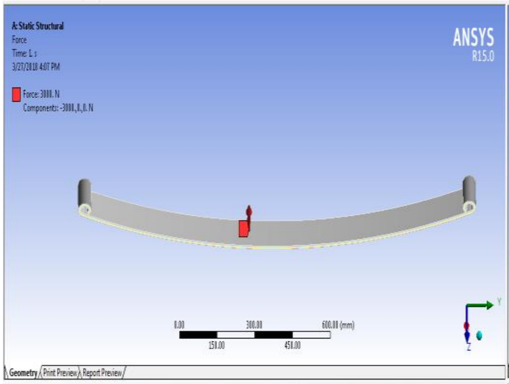


Figure 4.1000N **Figure 5.2000 N**



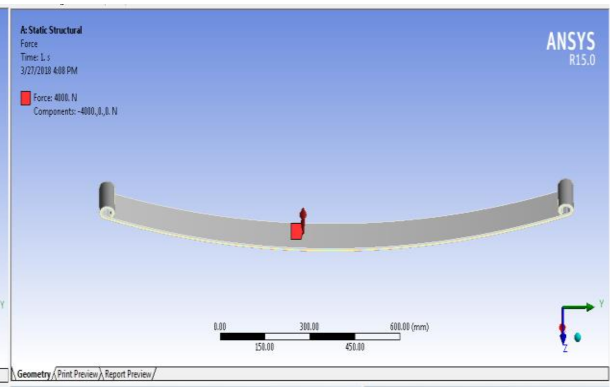


Figure 6. 3000 N **Figure 7. 4000 N**

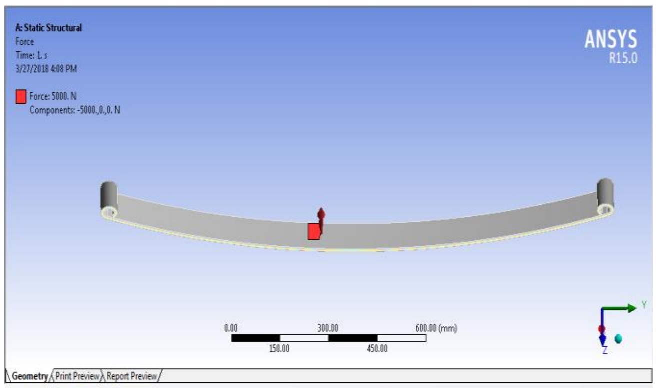


Figure 8. 5000N

3. RESULTS AND DISCUSSION

In this chapter discussed with various results from analyzing ANSYS for Leaf spring in various materials.

3.1. Deformation Result of Leaf Spring Using Steel Material

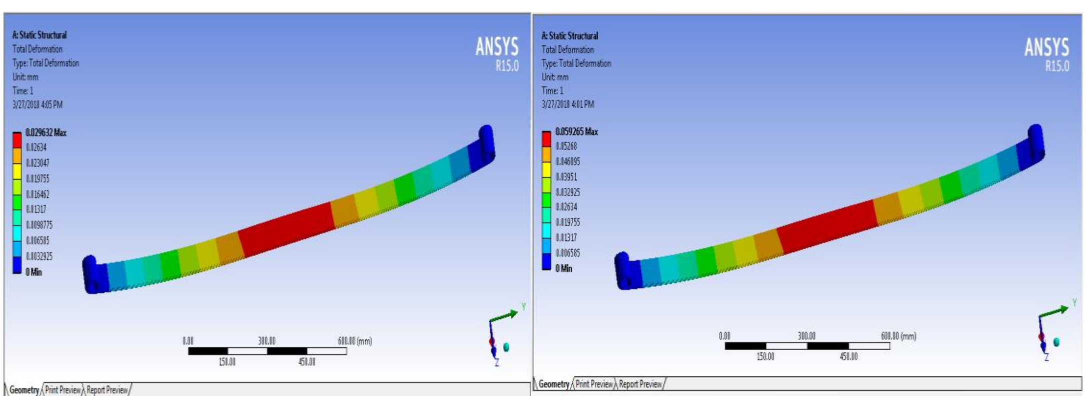


Figure 9. Deformation Result for Steel in 1000 N & 200n Load Condition

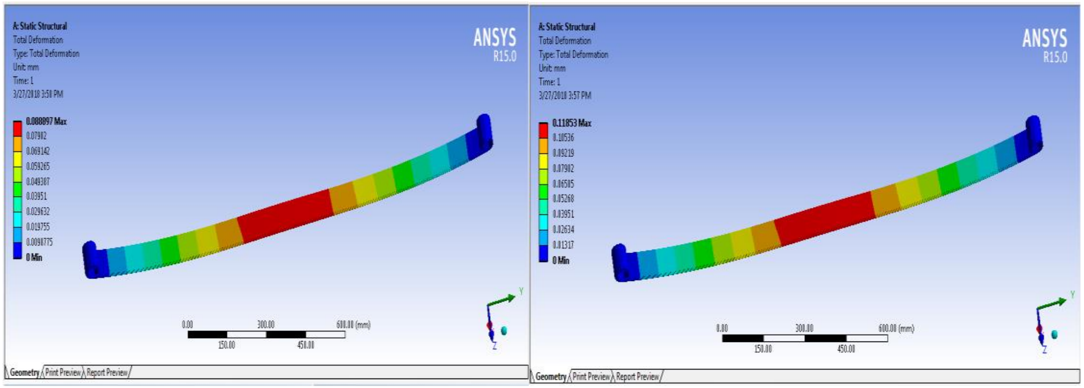


Figure 10. Deformation Result for Steel in 3000 N & 4000 N Load Condition

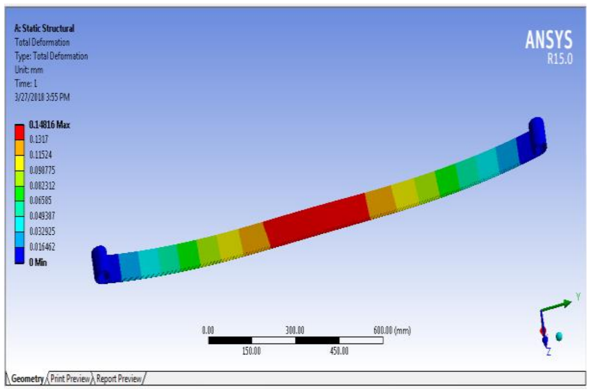


Figure 11. Deformation Result for Steel in 5000 N Load Condition

3.2. Deformation Result of Leaf Spring Using Hybrid Composite Material

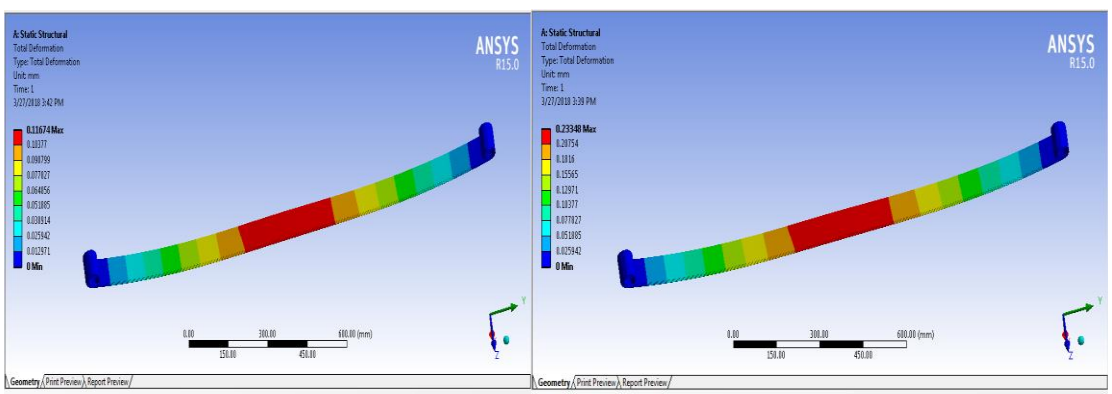


Figure 12. Deformation Result for Hybrid Composite Material in 1000 N & 2000 N Load Condition

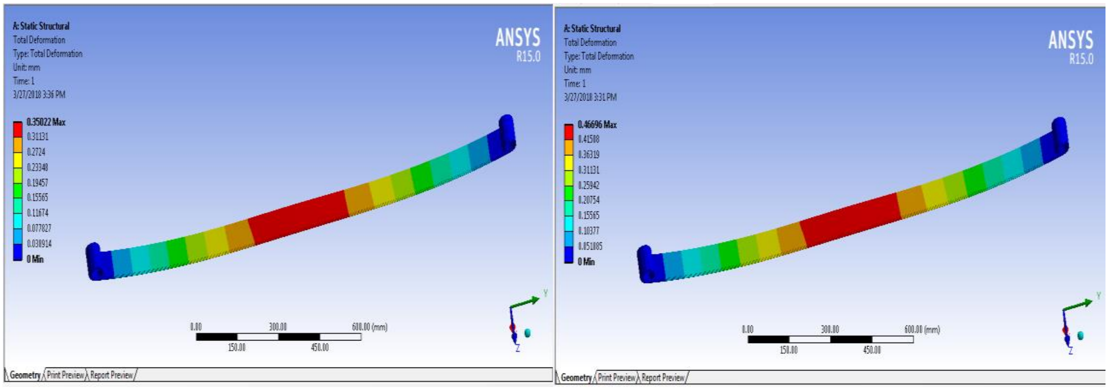


Figure 13. Deformation Result for Hybrid Composite Material in 3000 N & 4000 N Load Condition

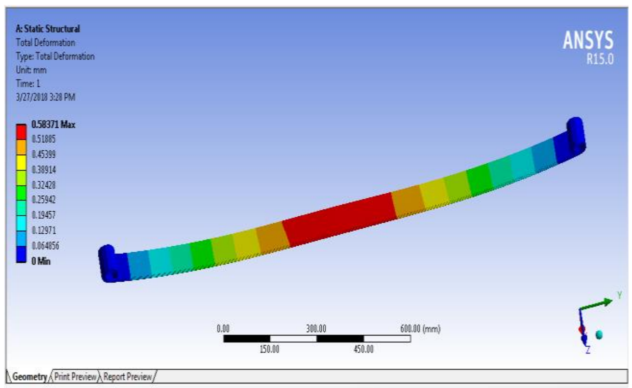


Figure 14. Deformation Result for Hybrid Composite Material in 5000 N Load Condition

3.3. Deformation Result of Leaf Spring Using Hybrid Composite Material 2

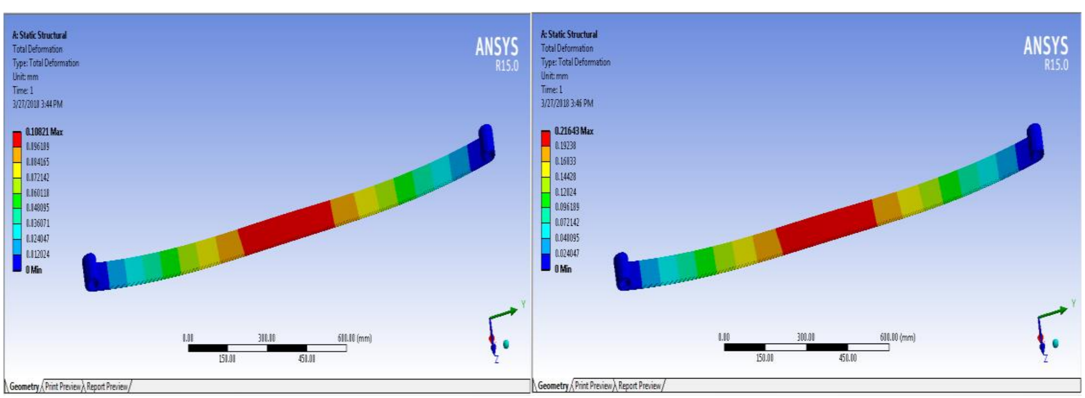


Figure 15. Deformation Result for Hybrid Composite Material in 1000 N&2000 N Load Condition

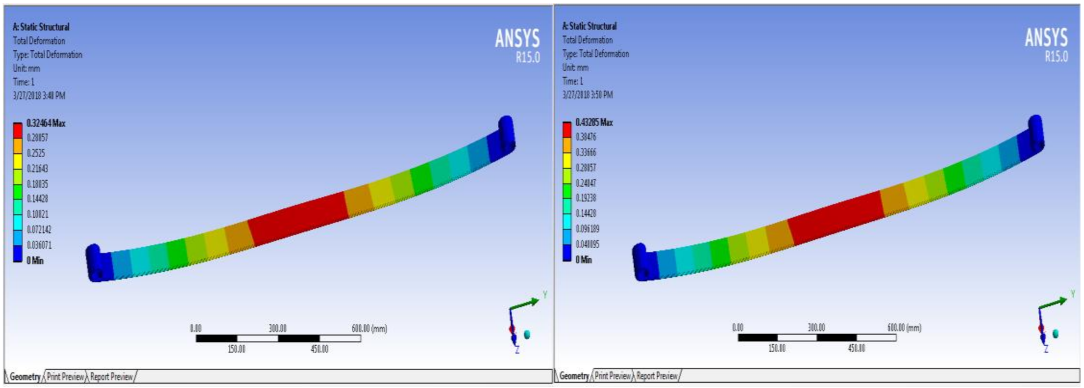


Figure 16. Deformation Result for Hybrid Composite Material in 3000 N 4000 N Load Condition

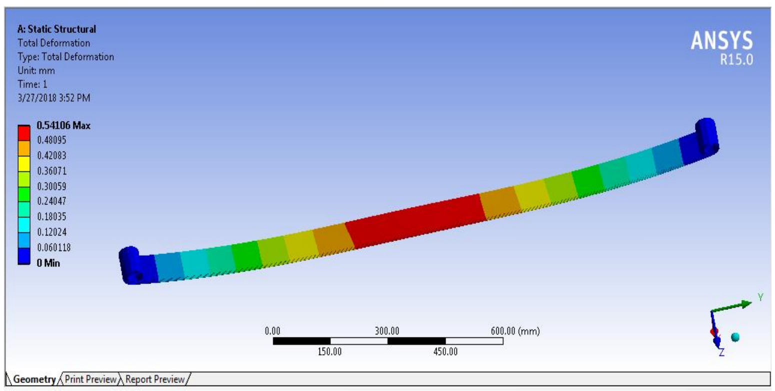


Figure 17. Deformation Result for Hybrid Composite Material in 5000 N Load Condition

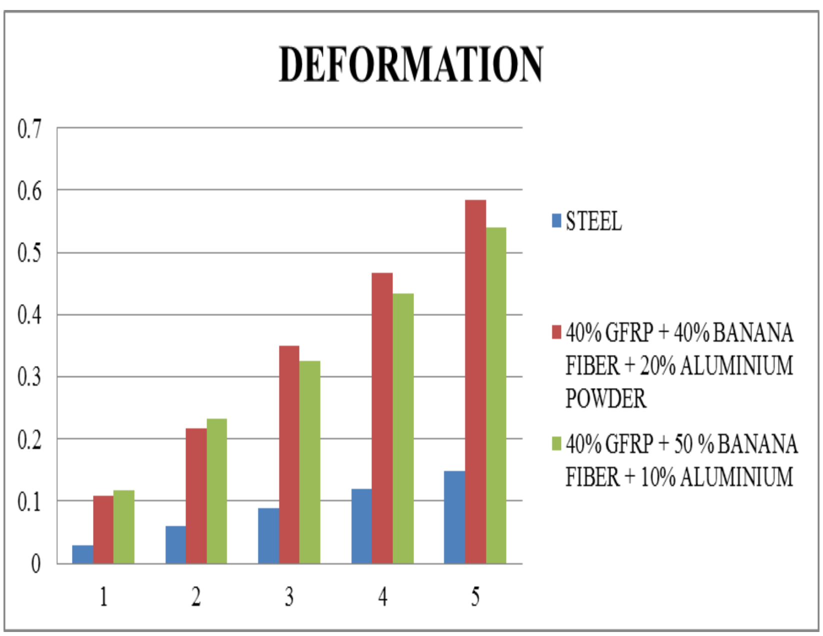


Figure 18 Deformation result for leaf spring with various materials

Table 2. Deformation result for leaf spring with various materials

LOAD	HYBRID 2	HYBRID 1	STEEL
1000	0.11674	0.10821	0.029632
2000	0.23348	0.21643	0.059265
3000	0.32464	0.35022	0.088897
4000	0.43285	0.46696	0.11853
5000	0.54106	0.58371	0.14816

4. CONCLUSION

From the ansys structural analysis getting the result of stress, strain and deformation Comparison of stress result for various materials e-glass fiber 40%, banana fiber 40%, 20% aluminium powder combination get the low stress value So that combination is

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