Design Analysis, Optimization and Testing of Mono Composite Leaf Spring by Varying Thickness using ANSYS

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Abstract— Increasing competition and innovation in automobile sector tends to modify the existing products by new and advanced material products. Conservation of metals is an important issue in these days. A suspension system of vehicle is also an area where these innovations are carried out regularly. Leaf springs are universally accepted suspension components that are being still used widely in automobiles. Weight reduction is also given due importance by automobile manufacturers. The automobile industry has shown keen interest in the use of composite leaf spring in the place of conventional leaf spring due to its high strength to weight ratio. The introduction of composite materials has made it possible to reduce the weight of the leaf spring without any reduction in load carrying capacity and stiffness. The objective of this work is to design and analyze composite leaf spring (Glass Fiber Reinforced Composite),fabrication of GFRC by using hand layup technique, experimental work were done by UTM machine and Static analysis is performed using FEA based software Ansys14.5.

Key words: Mono Composite Leaf Spring, Glass Fiber Reinforced Composite (GFRC), Ansys14.5

I. INTRODUCTION

Automobile components are in great demand these days because of increased use of automobiles.

The increased demand is due to improved performance and reduced cost of these components.

R&D and testing engineers should develop critical components in shortest possible time to minimize launch time for new products. This necessitates understanding of new technologies and quick absorption in the development of new products. Leaf springs are mainly used in suspension systems to absorb shock loads in automobiles like light motor vehicles, heavy duty trucks and in rail systems.

Weight reduction has been the main focus of automobile manufacturers in the present scenario. The replacement of steel with optimally designed composite leaf spring can provide 92% weight reduction. Moreover the composite leaf spring has lower stresses compared to steel spring. Conventional leaf spring are usally manufactured and assembled by using number of leaf made of steel and hence weight is more. Its corrosion resistance is more compared to composite leaf spring, it has less damping capacity. Hence, composite material becomes a very strong candidate for such applications. Finite Element analysis tools offer the tremendous advantage of enabling design teams to consider virtually any molding option without incurring the expense associated with manufacturing and machine time.

II. PROBLEM DEFINITION

The weight of the conventional multi leaf spring is very heavy, i.e. 10 to 20% unsprung weight of vehicle. Due this fuel consumption increases, decreasing the tyre life .Multi leaf structure creates problems such as producing squeaking sound, fretting corrosion thereby decreasing the fatigue life., Sudden spring failure. Composite are the best alternatives to replace the steel leaf spring. The strength to weight ratio of the composite material is high i.e. 3 to 5 times lighter than the Conventional leaf spring. As single leaf eliminates the problems arising due to multi leaf structure. Sudden spring failure does not occur due to laminated structure. Here design and analyze composite leaf spring (Glass Fiber Reinforced Composite),fabrication of GFRC by using hand layup technique, experimental work were done by UTM machine and Static analysis is performed using FEA based software Ansys14.5.

III. SOLID MODELING OF COMPOSITE LEAF SPRING

This geometry has been created Mechanical APDL taking the dimension as per design.

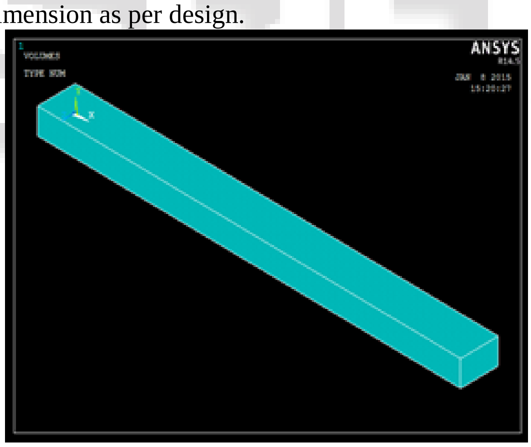

Fig. 1: Geometry of composite leaf spring

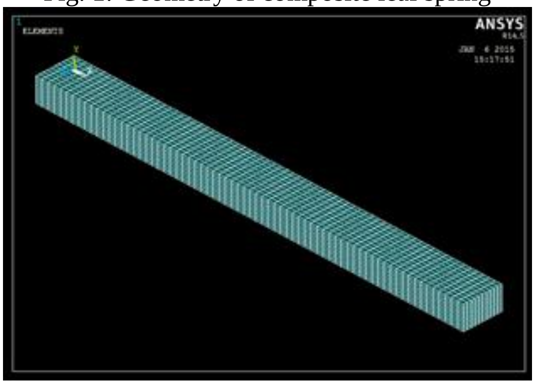

Fig. 2: Meshed model of composite leaf spring

A. Deflection Result of Composite Leaf Spring by varying thickness

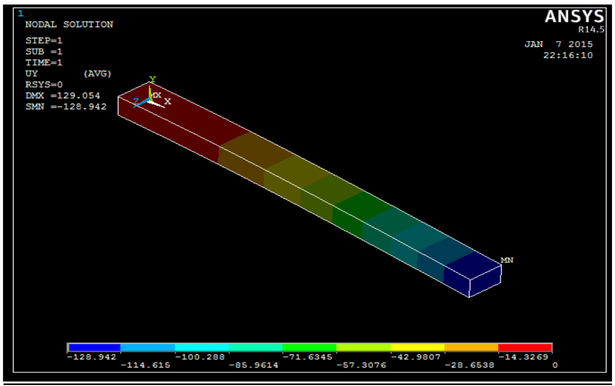

Fig. 2a: at 28mm

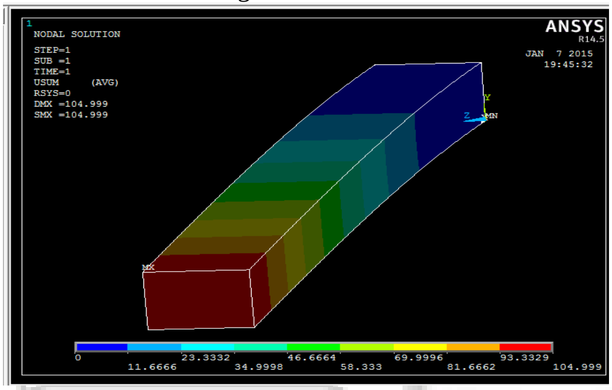

Fig. 2b: at 30mm

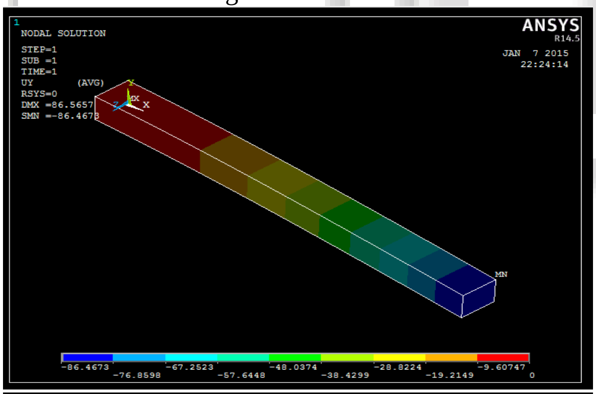

Fig.2b: at 32mm

Fig. 2: Deflection of composite leaf spring at 30mm

B. Stresses result of Composite Leaf Spring by varying thickness

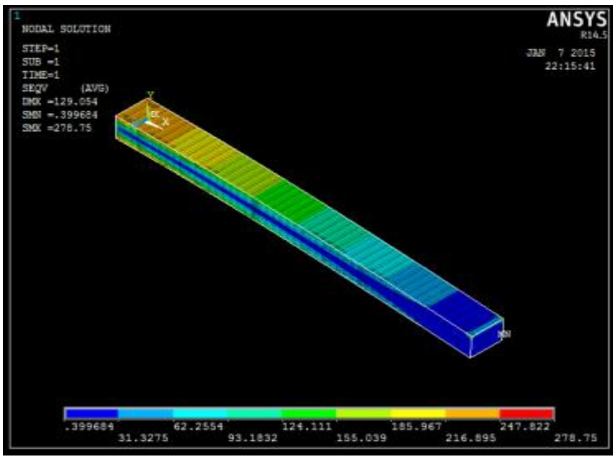

Fig. 3a: Stress at 28mm

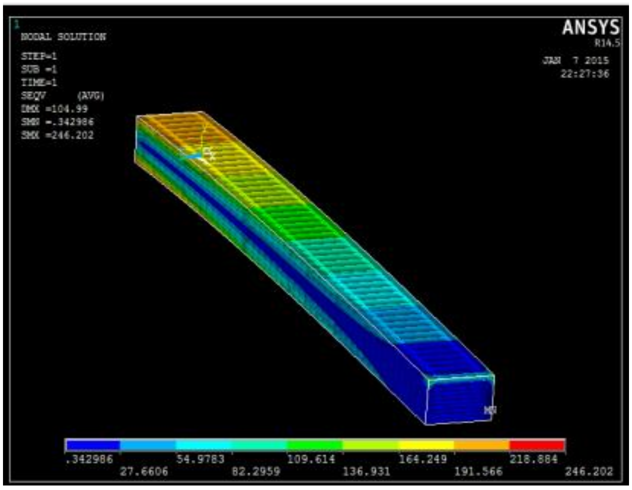

Fig. 3b: Stress at 30mm

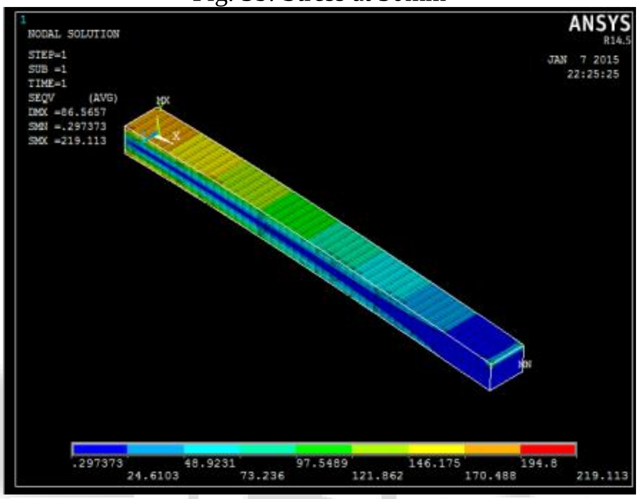

Fig. 3b: at Stress 32mm

Fig. 3: Stress of composite leaf spring

IV. TESTING OF COMPOSITE LEAF SPRING

Testing of GFRCcomposite leaf spring has been carried out on UTM.

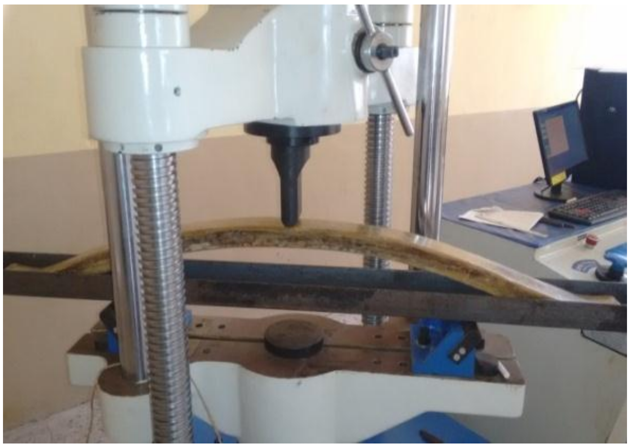

Fig. 4: Load applied on composite leaf spring

V. RESULT AND DISCUSSION

Material	Steel			Composite		
Thickness (mm)	Deformation (mm)	Stresses (N/	Stiffness (N/	Deformation (mm)	Stresses (N/	Stiffness (N/mm)

		mm^2)	mm)		mm^2)	
28	154.52	877.97	19.04	128.97	252.75	22.81
30	120.32	743.10	24.45	104.85	220.18	28.06
32	99.33	653.27	29.62	86.40	193.51	34.06

Table 1:.Analytical Result of Conventional and Composite Leaf Spring

Material	Steel			Composite		
Thickness (mm)	Deformation (mm)	Stresses (N/mm^2)	Stiffness (N/mm)	Deformation (mm)	Stresses (N/mm^2)	Stiffness (N/mm)
28	152.5	875.97	19.29	128.94	278.25	22.82
30	119.49	741.29	24.62	104.99	246.20	28.03
32	96.33	651.27	30.55	86.56	219.11	34.0

Table 2: FEA result of steel and composite leaf spring

Material	Steel			Composite		
Thickness (mm)	Deformation (mm)	Stresses (N/mm^2)	Stiffness (N/mm)	Deformation (mm)	Stresses (N/mm^2)	Stiffness (N/mm)
28	154.52	877.97	19.04	92.37	252.75	31.86
30	120.32	743.10	24.45	75.10	220.18	39.18
32	99.33	653.27	29.62	61.88	193.51	47.55

Table 3: Experimental results of steel and composite leaf spring

Experimental result from testing the leaf spring under static loading condition stress and deflection are calculated the result compared with FEA. Testing has been done for directional GFRC leaf spring by varying thickness. From varying thickness it is observed that as deflection, stresses in composite leaf spring are less as compared to conventional leaf spring and stiffness in composite leaf spring is more as compared to conventional leaf spring by using analytical, FEA and experimentally. Since the composite leaf spring is able to withstand the static load.

VI. Conclusion

The objective was to fabricate and analyze the leaf spring with varying thickness and minimum weight which is capable of carrying given static external forces by constrains limiting stresses and displacement. The weight of leaf spring is reduced considerably about 75% by replacing conventional leaf spring by GFRC with varying thickness. Thus the unsprung mass is achieved to large extent. Stress in composite leaf spring is much lower than that of conventional leaf spring. There is no objection from strength point of view in the process of replacing conventional leaf spring by GFRC. The GFRC leaf spring for designed for same stiffness as that of conventional.

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