Design & Analysis of Mono Composite Leaf Spring

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Abstract— Weight reduction is now the main issue in automobile industries. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The introduction of FRP material has made it possible to reduce the weight of spring without any reduction on load carrying capacity. The automobile industry has shown increased interest in the replacement of steel spring with fiberglass composite leaf spring due to high strength to weight ratio. Therefore, the aim of this project is to present a low cost fabrication of complete mono composite leaf spring. The achievement of weight reduction with adequate improvement of mechanical properties has made composite a very good replacement material for conventional steel. Selection of material is based on cost and strength of material. The composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel, so multi-leaf steel springs are being replaced by mono-leaf composite springs. This project gives the brief look on the suitability of composite leaf spring on vehicles and their advantages. The objective of this work is to present a general study on the Design and Analysis of composite (Glass Fiber Reinforced Composite-GFRC) leaf spring. Static analysis is performed out in FEA based software Ansys14.5 with design constrains as Stress, Deflection with varying thickness.

Key words: Ansys14.5, GFRC

I. INTRODUCTION

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. It carries lateral loads, brake torque, driving torque in addition to shock absorbing. The advantage 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 device. The automotive industry is exploiting composite material technology for structural components construction in order to obtain the reduction of weight without decrease in vehicle quality and reliability. To conserve the natural resources and economize energy, weight reduction has been the main focus of automobile manufacturer in the present scenario. Actually, there is almost a direct proportionality between the weight of the vehicle and its fuel consumption, particularly in city driving. . In composite there are two phases one is the reinforcing phase in which the form of fibers, composite leaf springs weakness lives have five times more solid than steel leaf springs. It's additionally gives a smoother ride than steel leaf springs and likewise gives more quick reaction to stretch bring about by street stun. Additionally, it is offer less risk of cataclysmic disappointment and has superb consumption resistance. Among these, the glass fiber has been selected based on the cost factor and strength. The types of glass fibers are C-glass, S-glass and E-glass. The C-glass fiber is designed to give improved surface finish. S-glass fiber is design to give very high modular, which is used particularly in aeronautic industries. The E-glass fiber is a high quality glass, which is used as standard reinforcement fiber for all the present systems well complying with mechanical property requirements.

II. METHODOLOGY

A. Fabrication of leaf spring:

The Hand layup procedure used to produce mono composite leaf spring. Composite leaf spring prepared by using unidirectional E- glass fiber and epoxy before fabrication of leaf spring design the desired shape of wooden mould. The wooden mould is prepared like 60mm radius in light of the fact that our camber tallness is 60mm.

Fig. 1: Wooden mould for making composite leaf spring

The E-glass fiber sheet cut in to required measurement like 1200mm *100mm length. Resin and hardener are utilized. Epolon 5015 resin and polyoxyalkelenamine hardener are used for preparing of composite leaf spring. The hand layup process was used prepare the composite leaf spring. The desired dimensions cuter E-glass fiber placed on the wooden mould, resin and hardener poured on the fiber placed on wooden mould. The consolidation roller rolls over two layer of the resin and dry reinforcement fabric layer of the given thickness.

Fig. 2: Hand lay-up Process

Fig. 3: Mono Composite Leaf Spring

Two steel eyes with require measurement is joined to the leaf spring. Two holes 10mm diameter is to be made on steel eye and composite leaf spring and using nut and bolt fastener to join the steel eye and mono composite leaf spring.

B. FEA (Finite Element Analysis)

FEA tool is the mathematical idealization of real system. It's a computer based method that breaks geometry into element and link a series of equation to each, which are then solved simultaneously to evaluate the behavior of the entire system. Ansys14.5 software is commercially available software which is capable of analyzing the given part by means of structural, thermal, fluid, harmonic analysis. The finite element analysis (FEA) for steel leaf spring is carried by ANSYS 15.0 Workbench software. The steel leaf spring is design in CATIA V5 part modeling and assembly. Master leaf, full length leaf, graduate leaf, bolt and nut each part is create in part modeling. In assembly section assemble all part in sequences. After assemble model are save file.

This file is import in ANSYS Workbench geometry. Open the ANSYS Workbench application in computer. First window open, selects static structural from toolbox, the static structural analysis is integrated various step.

C. Experimental Method:

Testing of leaf spring is carried out on Universal testing machine (UTM). Composite leaf spring attached in C-channel. In this testing composite leaf spring are free from two sides, means any side is not fixed. Now applying gradually load of 50mm/min speed under testing software.

Fig. 4: Testing of composite leaf spring.

III. RESULTS & DISCUSSION

The finite element analysis (FEA) for steel leaf spring is carried by ANSYS 15.0 Workbench software. The steel leaf spring is design in CATIA V5 part modeling and assembly. Master leaf, full length leaf, graduate leaf, bolt and nut each part is create in part modeling. In assembly section assemble all part in sequences. For the leaf spring analysis one eye end of the leaf spring is fixed to the chassis of the vehicle and the fixed support at another eye end of the leaf spring model and cylindrical support is applied to the other eye end of leaf spring model. The force is acting middle of the leaf spring. Due to the force applied on the middle of the spring deflection take place in the spring and stress is induced on it.

A. Deflection of spring:

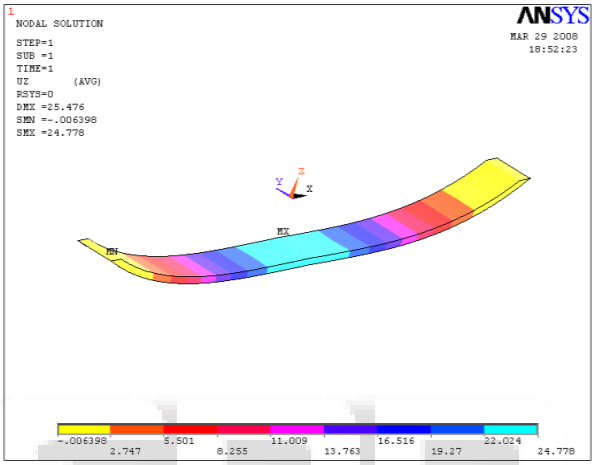

Fig. 5: Deflection of steel spring.

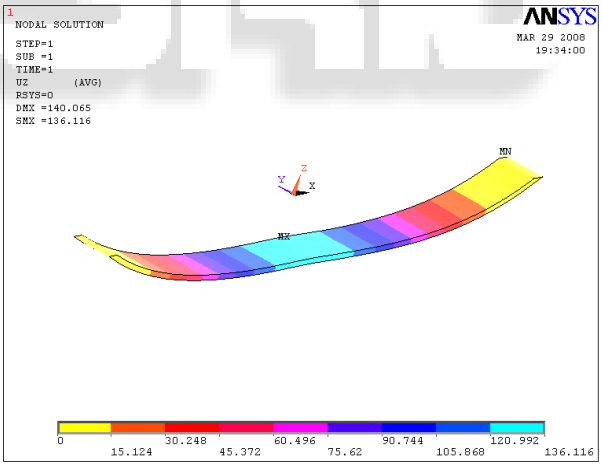

Fig. 6: Deflection of composite spring.

The above FEA results shows that maximum deflection of steel spring is 24.5 mm at the middle of the spring and the maximum deflection of the composite spindle is 140.05 mm. Stresses induced on the both springs and listed below.

Material	Mechanical Property	Allowable Stress (Mpa)	Maximum Stress obtained (Mpa)	Factor of Safety	Design
Steel (55Si2Mn90)	Yield Strength	1470	758.162	1.94	OK
E-Glass/Epoxy	Tensile Strength	900	382.228	2.35	OK
	Compressive Strength	450	382.228	1.18	OK

Table 1: Stress induced on the both springs.

B. Experimental results:

Testing of leaf spring is carried out on Universal testing machine (UTM). Composite leaf spring attached in C-channel. In this testing composite leaf spring are free from two sides, means any side is not fixed. The deflection, stress and stiffness of steel leaf spring and composite leaf spring are listed below with respect to different load condition.

Parameter		Load(N)	Difflection(mm)	Stress(N/mm2)	Stiffness(N/mm
Steel	FEA	1000			
			9.898	109.79	101
Composite	FEA		9.6	52.02	104.16
	Testing		14.9		
Steel	FEA	2000	19.79	219.38	101.06
Composite	FEA		19.2	104.04	104.16
	Testing		29.6		67.56
Steel	FEA		28.41	329.37	105.59
		3000			
Composite	FEA		28.8	156.06	104.16
	Testing		44.5		67.41
Steel	FEA		38.03	439.37	105.18
		4000			
Composite	FEA		38.4	208.06	104.16
	Testing		56.8		70.42
Steel	FEA		47.5	548.75	105.26
		5000			
Composite	FEA		48.04	260.04	104.07
	Testing		66.1		75.64

Table 2: Deflection Stress and stiffness of both springs.

IV. CONCLUSION

In present work at static loading condition by varying load stress and deflection of GFRC is found having difference as compared to conventional leaf spring. The analytical results were compared with FEA of varying loading condition shows good agreement with stress and deflection. Study demonstrated that composite can be used for leaf spring meet the requirements.

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