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Design and performance testing of master leaf for Mahindra Pick-up

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Abstract - *The project work deals with optimal design and analysis of composite material leaf spring made up from E-Glass fiber. In this work the four-leaf steel spring used in the rear suspension system of light vehicle having vehicle weight 2.5 to 5 ton is studied. The objective of the present work is weight reduction of the suspension system for prescribed stiffness which results in better fuel economy at present fuel crises environment. For the analysis of the leaf spring performance parameters used are as deflection, stress, strain energy storage capacity and weight. The Ansys13.0 software is used for the structural, optimization and stress analysis. After the structural analysis result of the steel leaf spring, Optimization is done by using design surface optimization for the thickness reduction. The constant cross section mono-composite leaf spring is designed and analyzed for prescribed stiffness. The experimental validation is done by using Universal Testing Machine (UTM).The comparison in between conventional and composite leaf spring shows the 30-50% weight reduction in the suspension system of an vehicle.*

Key Words: **leaf spring, Weight reduction, E-Glass fiber, Structural and stress analysis , UTM**

1.INTRODUCTION

Increasing competition and innovations in automobile sectortends to modify the existing products or replacing old products by new and advanced material products. In order to conserve natural resources and economize energy, weight reduction has been the main focus of automobile manufacturers in the present scenario. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. A suspension system of vehicle is also an area where these innovations are carried out regularly. More efforts are taken in order to increase the comfort of user. Appropriate balance of comfort riding qualities and economy in manufacturing of leaf spring becomes an obvious necessity. To improve the suspension system, many modifications have taken place over the time. The suspension leaf spring is one of the potential items for weight reduction in automobiles as it accounts for 10% - 20% of the unsprung weight. This achieves the vehicle with more fuel efficiency and improved riding qualities. Inventions of parabolic leaf spring, use of composite materials for these springs are some of these latest modifications in suspension systems. This seminar mainly focuses on the implementation of composite materials by replacing steel in conventional leaf springs of suspension system. The introduction of composite materials was made it possible to reduce the weight of leaf spring without any reduction on load carrying capacity and Stiffness. Since, the composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel, multi leaf steel springs are being replaced by mono-leaf composite springs.

1.1 Problem statement

1.2
In case of MAHINDRA PICK-UP we identify some of the problems which generally occurs in case of leaf spring. The usual leaf spring has various problems identified which are listed as follow :
1. Maximum deformation: because of continuous running of the vehicle there is a declination in the level of soothed offered by the spring.

2. Low strength: It is observed that the leaf springs be likely to break and deteriorate at the eye end segment which is extremely near to the shackle and at the middle.

3. High weight: The usual steel leaf spring having more weight, which additionally influences the fuel efficiency.

1.2 Problem Formulation

The problem identification, objective and hypothesis has been prepared in previous sections now to devise the problem the parabolic leaf spring taken into consideration is that of a mini loader truck (MAHINDRA PICKUP) having the following specifications as :

1. Kerb Weight [15] : 815 kg

It is the definite weight of the truck exclusive of any cargo or passengers on it. It's the basic weight that is used in exclusion to estimate the entire weight of the vehicle with cargo and passengers. 2. Loading Capacity [15] : 1 Tons

It is the maximum load, which can be carried by the vehicle. 3. Max Gross Vehicle Weight (GVW) [15] : 1550 kg It is the entire weight of the loaded vehicle. This comprises the vehicle itself and the cargo that is loaded inside that vehicle.4. Load Calculations The parabolic leaf spring taken into consideration is of Mahindra Pickup having a Max Gross Vehicle Weight of 2315 kg. Total weight acting downwards

(i.e at full load) = Gross Vehicle Weight × gravity = 2315 x 9.81 = 22710.15N. There are four suspensions two at the front and two at the back. So, Load on one suspension = 22710.15N/4 = 5677 N approx. For better safety spring should be design for 5700N load. Factor of safety = Ranges (2 - 2.25) for leaf spring.

2. SOFTWARE ANALYSIS OF MASTER LEAF

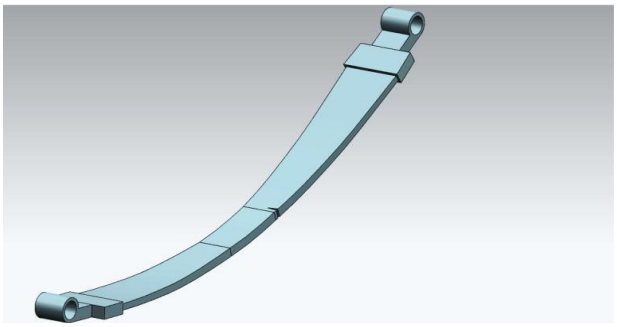

Fig-1: Composite master leaf

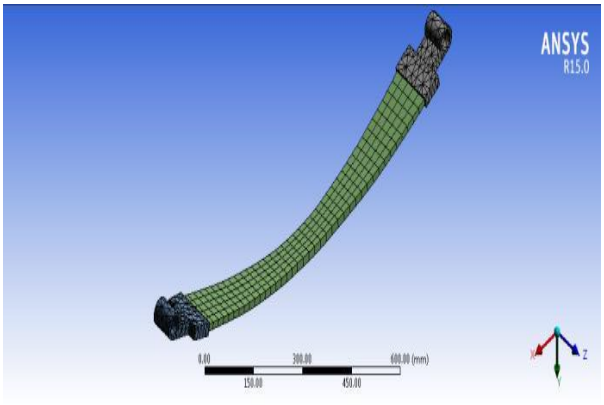

Fig-2: Meshing

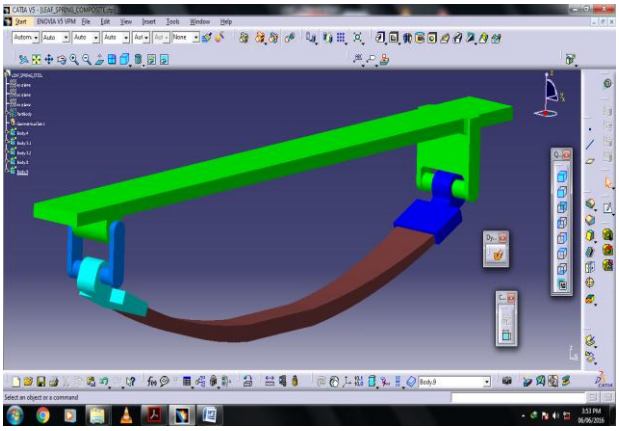

Fig-3: system layout for boundary condition

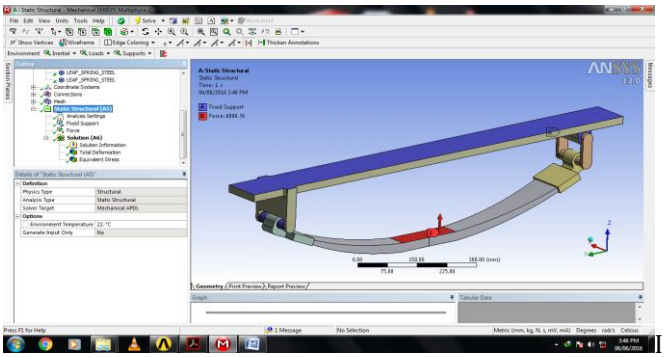

Fig-4 Application of load

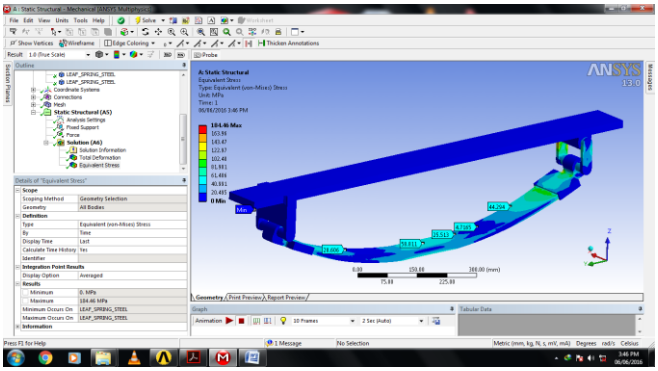

Fig-5: Equivalent von-misses stresses

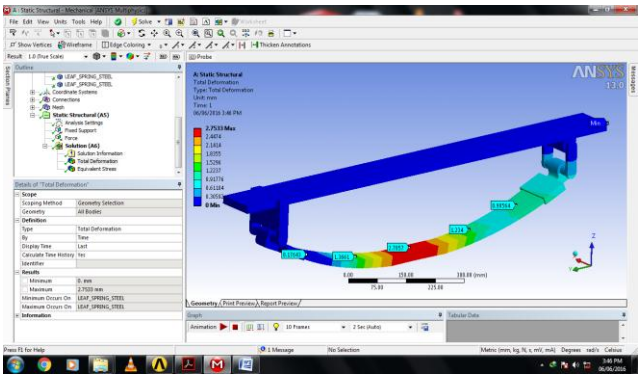

Fig-6: Total Deformation

Table -1: FEA Results of Composite E-glass leaf

Sr.No	Parameter	Deflection	Von-misses stress
	Load(N)	(mm)	(N/mm2)
1	1000	0.45	9.39
2	2000	0.90	16.59
3	3000	0.96	29.07
4	4000	1.80	39.26
5	5000	2.25	49.05
6	6000	2.7	58.81

Table -2: FEA Results of Composite EN-47leaf

Sr.No	parameter	Deflection	Von-misses stress
	Load(N)	(mm)	(N/mm2)
1	1000	1.86	83.60
2	2000	4.19	79.99
3	3000	6.14	107.5
4	4000	8.75	235.75
5	5000	11.75	356
6	6000	13.12	423

3. EXPERIMENTAL TESTING

Fig-7: Experimental testing of composite leaf

Fig-8: Experimental testing of steel leaf

Table -3: Sample Table format

Sr. No	Load (N)	Deflection(mm)		Strain (10^{-4})		Weight(kg)	
		steel	E-glass	Steel	E-glass	Steel	E-glass
1	1000	22	10	55	21	2.25	5.0
2	2000	48	16	61	34	-	-
3	3000	80	28	76	51	-	-
4	4000	112	40	81	57	-	-
5	5000	112	52	N.A.	65	-	-

3.1 Testing Results

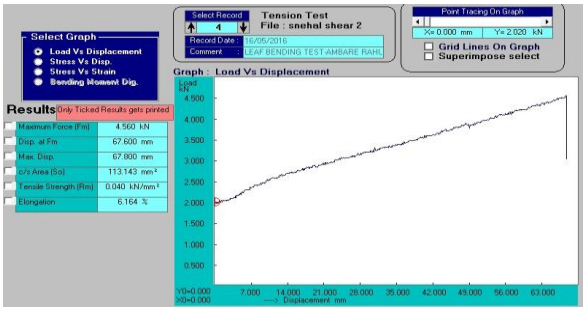

Fig-9: Load VS Deflection for steel

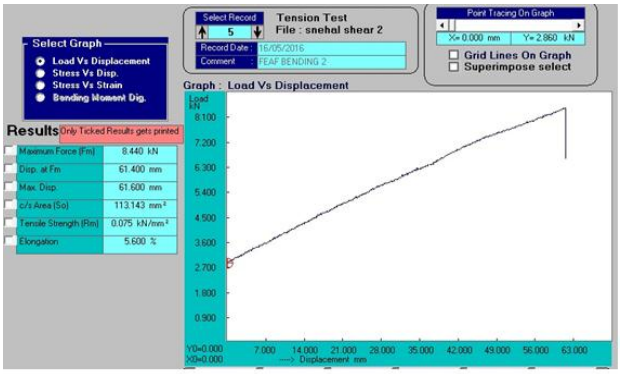

Fig-10: Load VS Deflection for E-glass

4. RESULTS AND DISCUSSION

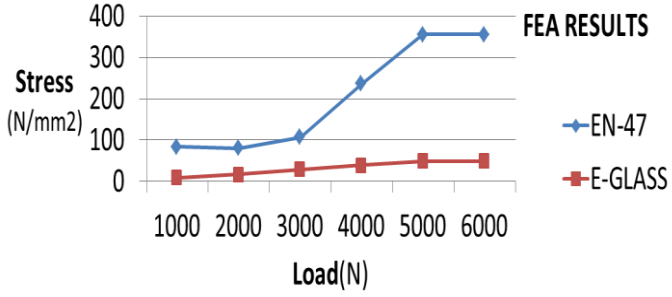

Chart -1: Load Vs. Deflection

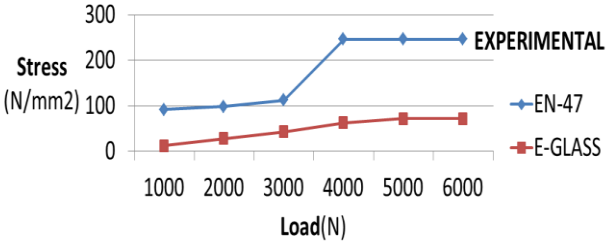

Chart -2: Load Vs. Deflectio

5.CONCLUSION

From the results we can conclude that, reduction in un-sprung weight is possible due to use of composite material for fabrication of leaf spring. Almost 50% weight reduction is done. Composite leaf spring does not gets rusted, so the performance will not get reduced after prolong use. The ultimate tensile strength of the composite leaf spring more than that of conventional leaf spring ensuring good mechanical properties Stresses generated in the composite leaf spring are much lower than that of conventional one.Stiffness of the composite leaf spring is nearly same as that of conventional steel master leaf. So we can replace conventional one by composite.

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BOGRAPHIES

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