Structural Analysis of GFRP and CFRP as Suspension for Automotive Application

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***Abstract*:-** *Suspension system of an automotive is the main important system which takes care of an automotive being safe on roads due to heavy loading by absorbing the shocks in automotive like light weight motor vehicle to heavy trucks and other vehicles etc. The leaf spring suspension system carries lateral loads, torque from drive shaft, brake shocks and in addition the shock due to sudden loads .the main advantage of the leaf spring over helical spring is that the leaf spring absorbs the shock and deflects and slides back to minimize the impact of the sudden shock due to load.*

Material study in the leaf spring research suggests for the material having more strength and minimum young's modulus in the longitudinal direction with minimum possible weight to give sustainable leaf spring. Hence the research work is going on to find the best suitable material for leaf spring over conventional steel leaf spring to reduce the weight of the suspension system which in turn enhances the fuel efficiency and improves the ride

KEY WORDS : Shock absorber, truck, leaf spring, impact and young's modulus.

1. INTRODUCTION

The automobile chassis is mounted on the axles with the help of springs so that the road shocks may be indirectly transferred to the chassis to isolate the vehicle body from the undesired road shocks, road bounces and pitches of the automobile.

The system which isolate the vehicle during road shocks, road bounces and pitches and safeguards the vehicle, occupants and payloads are called as suspension systems. The main important component of the system are the leaf spring which are elastic in nature and absorbs the shocks by deflecting upwards and takes the shock in the form of strain energy and release slowly to give comfort to the occupant, rider and the payload. The leaf springs are arranged one over the above and consist of number of leaves.

Suspension system of an automotive is the main important system which takes care of an automotive being safe on roads due to heavy loading by absorbing the shocks in automotive like light weight motor vehicle to heavy trucks and other vehicles etc...The leaf spring suspension system carries lateral loads, torque from drive shaft, brake shocks and in addition the shock due to sudden loads .the main advantage of the leaf spring over helical spring is that the leaf spring absorbs the shock and deflects and slides back to minimize the impact of the sudden shock due to load.

2. LITURATURE SURVEY

N.LeninRakesh , G R Kaushik2, Dr. J. Hameed Hussain et.al[1] The present work deals with the FE analysis of composite leaf spring which is gaining more importance in the automotive applications.

Jiashi Wang, Zaike Li and QibinJiang [2] the work deals with the FE simulation of the E-glass composite leaf spring as the alternative suspension system over the conventional steel leaf spring.

SyambabuNutalapati [3] in this paper the author has worked on the design and analysis of composite leaf spring made of glass fiber reinforced polymer. For the analysis of leaf spring a rear suspension of MAHINDRA "MODEL-COMMANDER 650 DI" was referred to develop geometry.

Abdul Rahim Abu Talib, Aidy Ali, G. Goudah, NurAzidaCheLah, A.F. Golestanehet.al [4] have researched on the optimization techniques in the material and geometry of the composite leaf spring based on the spring rate of action, log life and shear stress parameters

3. METHODOLOGY

3.1 GEOMETRICAL DEVELOPMENT OF THE SUSPENSION SYSTEM FOR THE CASES 1

This chapter presents the geometrical development of the suspension system with conventional leaf spring to the composite mono leaf spring. Here the conventional steel leaf spring model has been referred from the existing leaf spring model of TATA ACE ET light commercial vehicle and actual dimensions are measured and compared with the literature before proceeding to the geometrical development in the design modeler of ANSYS Work bench.

3.1 GEOMETRICAL DIMENSIONS OF LEAF SPRING

1. Total Length of the spring (Eye to Eye) =900 mm
2 Length of spring considering effective length =830mm
3. Free Camber (At no load condition) =80mm
4. No. of full length leave (Master Leaf) = 4
5. Thickness of leaf =8mm
6. Width of leaf spring =50 mm
7. Maximum Load given on spring=6438N
8. Weight of the leaf spring=4 x 3.13kg=12.5 kg

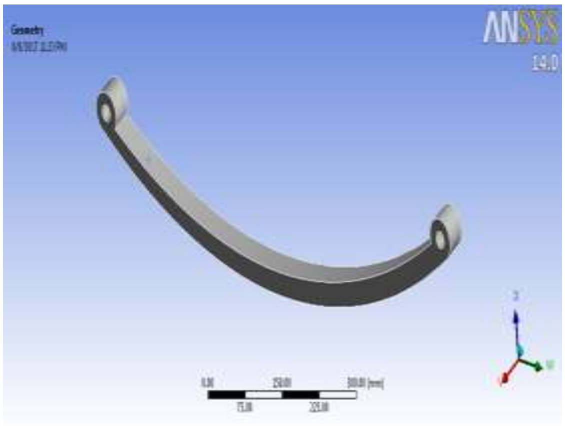

Figure 3.1 shows the geometry of GFRP composite mono leaf spring designed using design modeler

3.2 FE MODELING AND ANALYSIS OF SUSPENSION SYSTEM FOR THE CASES 1

Table 3.1 shows the mesh details of the conventional leaf spring

Mesh details of conventional leaf spring	
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Element type	Hexahedron
Minimum Edge Length	8.34760 mm
Material	Structural steel
Inflation	
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Statistics	
Nodes	7849
Elements	918

Table 3.2 shows the details of structural analysis of the conventional leaf spring

Structural Analysis	
Element type	Hexahedron element
Material	Structural steel
Young's modulus	200Gpa
Poison's ratio	0.3
Weight of leaf spring	9.57kg
Maximum load	6440N
Effective length of the leaf spring	830mm
Thickness of each leaf	8mm
Width of leaf	50mm
NO of Leaves	4

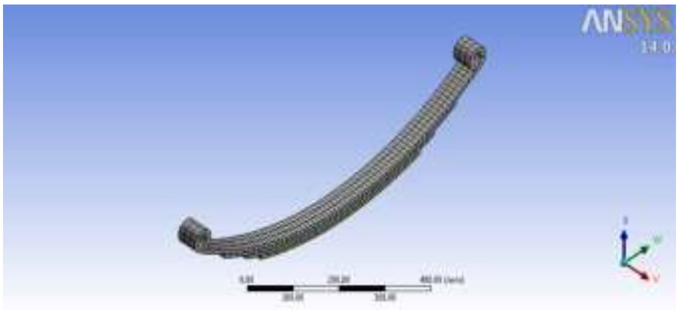

Figure3.2 shows the meshed model of traditional leaf spring made of steel

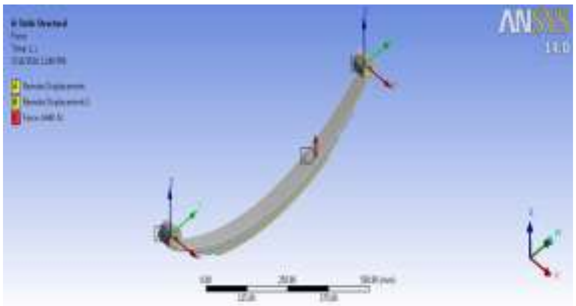

Figure 3.3 shows the boundary conditions assigned to conventional leaf spring

Case1: FE MODELING OF GFRP COMPOSITE WITH MONO LEAF SPRING.

The geometry of the GFRP composite was imported to structural analysis tool and then the mesh has been generated with hexahedron elements. Then the material properties have been assigned as per the GFRP composite in the material library of the ANSYS.

Table 3.3 shows the mesh details of the GFRP composite leaf spring

Mesh details of GFRP composite leaf spring	
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Element type	Hexahedron
Material	GFRP composite
Inflation	
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Statistics	
Nodes	30161
Elements	5852

Figure 3.4 shows the mesh details and boundary conditions for the GFRP composite

CASE1: STRUCTURAL ANALYSIS OF THE GFRP COMPOSITE LEAF SPRING

Table3.4 shows the details structural analysis of the GFRP composite leaf spring

STRUCTURAL ANALYSIS	
Element type	Hexahedron element
Material	GFRP composite
Tensile modulus along X-direction (Ex), MPa	43000
Tensile modulus along Y-direction (Ex), MPa	6530
Tensile modulus along Z-direction (Ex), MPa	6530
Shear modulus along XY-direction (Gxy)in Mpa	2433
Shear modulus along YZ-direction (Gyz)in Mpa	2433
Shear modulus along ZX-direction (Gxz)in Mpa	2433
Poisson ratio along XY-direction (NUxy)	0.27
Poisson ratio along YZ-direction (NUyz)	0.06
Poisson ratio along ZX-direction (NUzx)	0.06
Weight of leaf spring	2.2kg
Maximum load	6440N
Effective length of the leaf spring in mm	830
Thickness of each leaf in mm	25
Width of leaf in mm	50
NO of Leaves	1
Tensile Strength (MPa)	900
Density (kg/m3)	2000

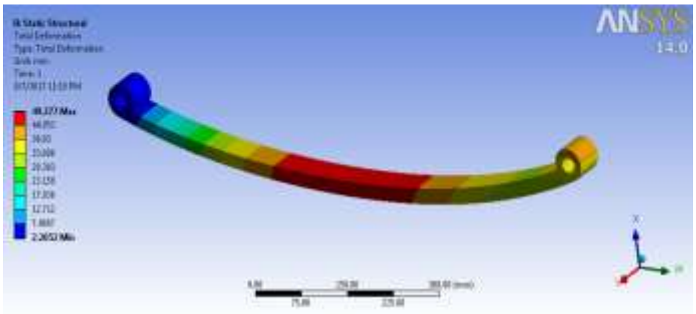

Figure 3.5 shows the maximum deflection for the GFRP composite

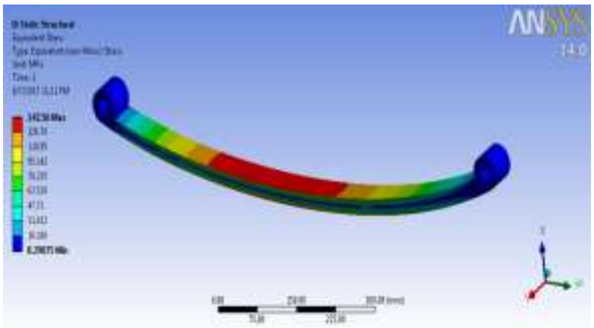

Figure 3.5 shows the maximum stress for the GFRP composite

4. RESULTS AND DISCUSSIONS

	Conventional steel leaf spring	GFRP composite Case-1
Maximum deflection in mm	53.52	49.27
Maximum stress Mpa	489.03	142.56
Structural Analysis-Theoretical calculations		
Maximum deflection in mm	64	51.98
Maximum stress		

Mpa	626	256
Percentage of error in deflection between FE and Theoretical calculations	16%	5%
Weight of leaf suspension system in kg	9.57	2.2
Percentage of weight reduction compared with conventional steel spring	--	77%

5. CONCLUSION

Here in the intended work the research was carried on the alternative material for the suspension system of TATA ACE ET light commercial vehicle to find the best suitable material with maintaining the same strength or more than the existing and more stiffness with reduced weight. And intern this enhances the performance, ride quality, fuel efficiency and safe guards the vehicle and overall decreases the cost of the vehicle.

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