ABSTRACT
Present time the main issue of automobile industry are weight reduction. The automobile industry has looking for any implementation or modification to reduce the weight of the vehicle. The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for 10% to 20% of the unsprung weight. The introduction of composite leaf spring made of E-glass fiber epoxy resin has made it possible to reduce the weight of spring without any reduction on load carrying capacity and stiffness. The achievement of weight reduction with adequate improvement of mechanical properties has made composite a very good replacement material for conventional steel spring. This work deals with the replacement of multi-leaf steel spring with mono composite leaf spring for the LCV Carrying capacity and stiffness. The design constraints were limiting stresses and displacement. Modeling and analysis of both the steel and composite leaf springs have been done using ANSYS 14.5 software.

Keywords: Composite Materials, Leaf Spring, Material Property, FEA, ANSYS, and CatiaV5.

INTRODUCTION
Ever increasing demands of high performance together with long life and light weight necessitate consistent development of almost every part of automobile. Increasing competition and innovations in automobile sector tends to modify the existing products or replacing old products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. 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 [1].

Leaf spring is a simple form of a spring, commonly used for the suspension in wheeled vehicles. It is also one of the oldest forms of springing, dating back to medieval times. Just for the common form of its conception in Italian language a leaf spring suspension is called “balestra” (cross bow). an advantages of a leaf spring over a helical spring is that the end of the leaf spring may be guided along a definite path. 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.

Composite materials consist of two or more physically dissimilar and instinctively separable components called reinforcement and matrix. These two components can be mixed in a restricted way to achieve optimum properties, which are superior to the properties of each individual component. The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the unsprung weight. This helps in achieving the vehicle with improved riding qualities. Since the strain energy in the spring is inversely proportional to density and young's modulus of the material, it is always suggested that the material for leaf spring must have low density and modulus of elasticity.

METHODOLOGY
Design Parameter
Dimensions of TATA ACE leaf spring
Table no.1 Design Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Length in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Length of the spring (Eye to Eye) 2L</td>
<td>860mm</td>
</tr>
<tr>
<td>Free Camber (At no load condition)</td>
<td>90 mm</td>
</tr>
<tr>
<td>No. of leaves including master leaf</td>
<td>04</td>
</tr>
<tr>
<td>Thickness of leaf</td>
<td>08 mm</td>
</tr>
<tr>
<td>Width of leaf spring</td>
<td>60 mm</td>
</tr>
<tr>
<td>Modulus of elasticity for steel leaf spring</td>
<td>2 X 10^11 Pa</td>
</tr>
</tbody>
</table>

Modelling of spring

Steel leaf spring

Meshing of steel leaf spring

Composite leaf spring

Meshing of composite leaf spring

Boundary conditions.

Boundary conditions for steel and composite material are same one end has given degree of translation and other end fixed. At the midpoint vertically upward force applied because in TATA ACE there is support at midpoint, acceleration due gravity in downward direction.

Simulation case (1)
Kerb weight = 925 kg
Driver weight = 75 kg
Therefore, Total weight = 925 + 75 = 1000 kg
                           = 1000 X 9.81 N
                           = 9810 N

Weight 9810N is on 4 wheels therefore,
Weight on one wheel is = 9810/4 = 2452.5N
When 2452.5 N net force applied.

Simulation case (2)
Kerb weight      = 925 kg
Driver + 1 (weight) = 150 kg
Luggage weight  = 250 kg
Therefore, Total weight = 925 + 150 + 250 = 1325 kg
                           = 1325 X 9.81 N
                           = 12998.25 N

Weight 12998.25N is on 4 wheels therefore,
Weight on one wheel is = 12998.25/4 = 3249.56N
When 3249.506 N net force applied.

Simulation case (3)
Maximum load carrying capacity of TATA ACE = 1550 kg
Therefore, Total weight  = 1550 X 9.81 N
                           = 15205.5 N

Weight 15205.5N is on 4 wheels, therefore
Weight on one wheel is = 15205.5/4 = 3801.375N
When 3801.375N net force applied.

RESULTS
Analytical analysis
For analytically calculation following formula is used by
Assuming leaf spring as a cantilever beam
Max. Stress = 6WL/nb t^2
Max. Deflection = 4WL^3/nEbt^3
Results at 2452.5 N Force
CONCLUSION

Analytical results of the leaf spring under static loading containing the stresses and deflection are listed in the Table. These results are compared with FEA in Table. Since the composite leaf spring is able to withstand the static load, it is concluded that there is no objection from strength point of view also, in the process of replacing the conventional leaf spring of TATA ACE by mono composite leaf spring. Since, the composite spring is designed for same stiffness as that of steel leaf spring. The major disadvantages of composite leaf spring are chipping resistance.

The weight of the leaf spring is reduced considerably about 50% by replacing steel leaf spring with composite leaf spring. Thus, the objective of the unsprung mass is achieved to a larger extent.

The stresses and deflections in the composite leaf spring are much equivalent (equal strength) to steel but weight reduced.

From the results, it is observed that the composite leaf spring is lighter and more economical than the conventional steel spring with similar design specifications.

FUTURE SCOPE

The future work can be performed as
(a) Experimental work.
(b) Harmonic analysis with finding and compression of first five natural frequencies.
(c) Analysis leaf spring by varying thickness

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REFERENCES
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