ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DESIGN AND ANALYSIS OF COMPOSITE LEAF SPRING FOR LIGHT COMMERCIAL VEHICLE (TATA ACE)

Miss. Gulshad Karim Pathan*, Prof. R.K.Kawade, Prof. N.Jamadar
M.E. Mech. Design Engineering Pad .Dr.D.Y.Patil, Institute of Engineering & Tech.Pimpri Pune, India
Professor Mech. Engineering Dept.Pad.Dr.D.Y.Patil, Institute of Engineering & Tech.Pimpri Pune, India
Professor Mech. Engineering Dept.Pad.Dr.D.Y.Patil, Institute of Engineering & Tech.Pimpri Pune, India

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 to 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

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

Table no.1 Design Parameter

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

Modelling of spring
Steel leaf spring

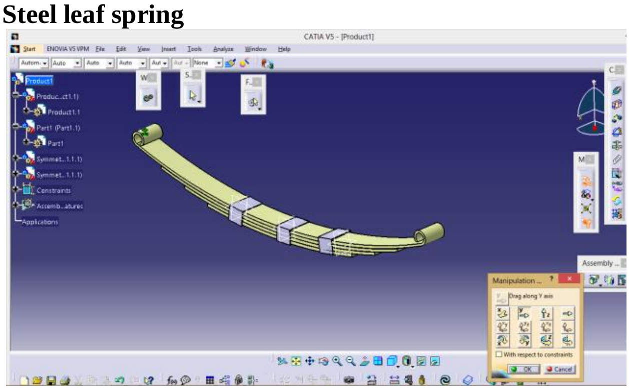

Fig.1 Modelling in catia part modeler

Meshing

Composite leaf spring

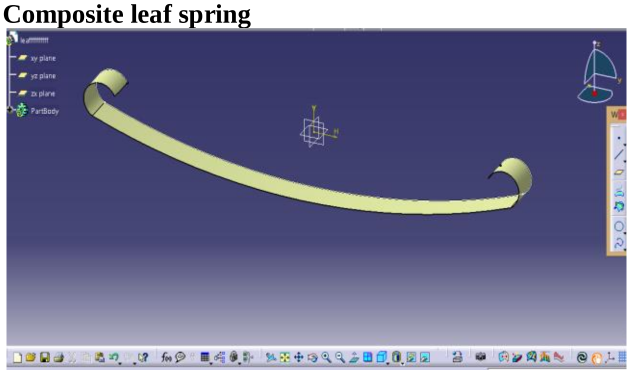

Fig.2 Modelling of composite leaf spring

Meshing of steel leaf spring

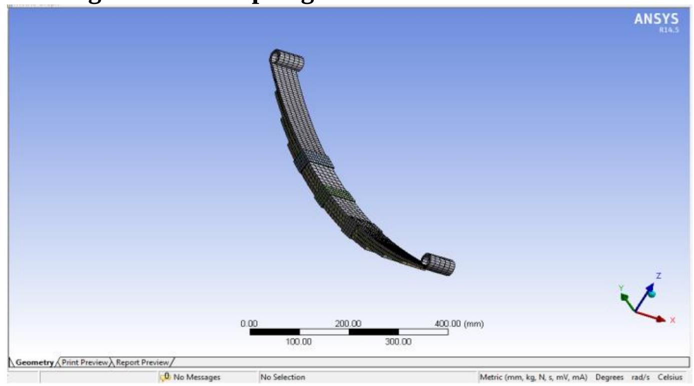

Fig.3 Meshing of steel leaf spring

Meshing of steel leaf spring

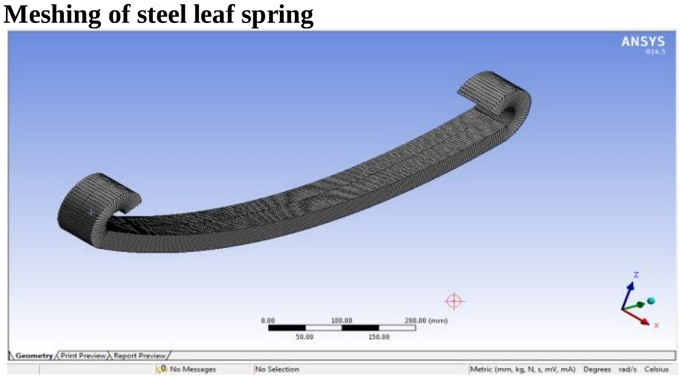

Fig.4 Meshing of steel leaf spring

Boundary conditions.

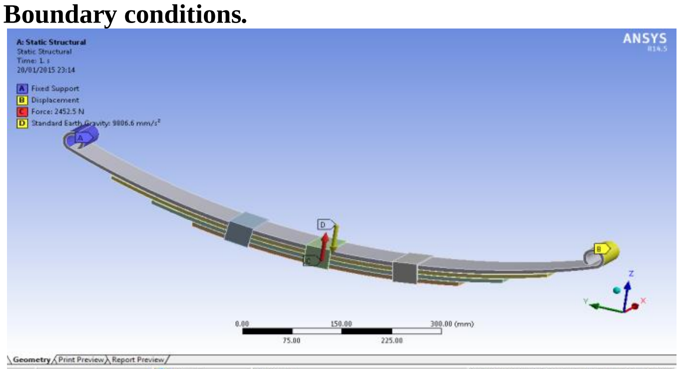

Fig.5 Boundary condition for steel leaf spring

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

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

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

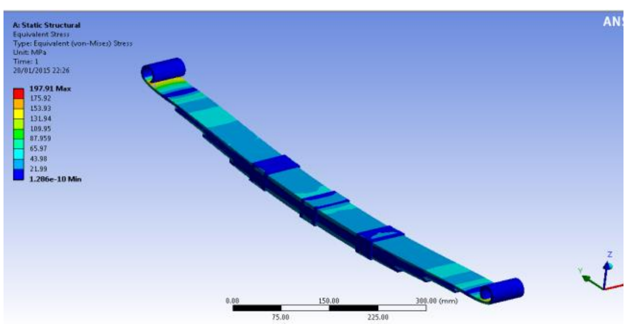

Fig. 6 Stresses in steel leaf spring on F=2452.5N

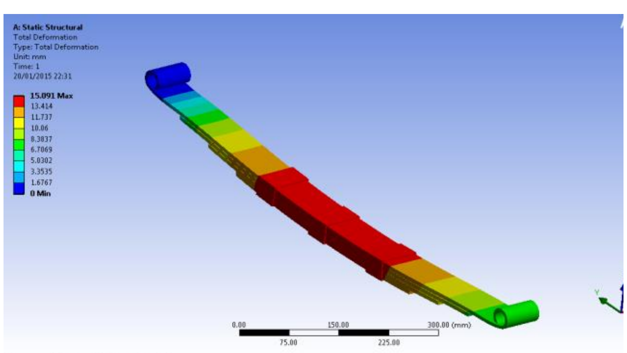

Fig.7 Deformation analysis of steel leaf spring on F=2452.5N

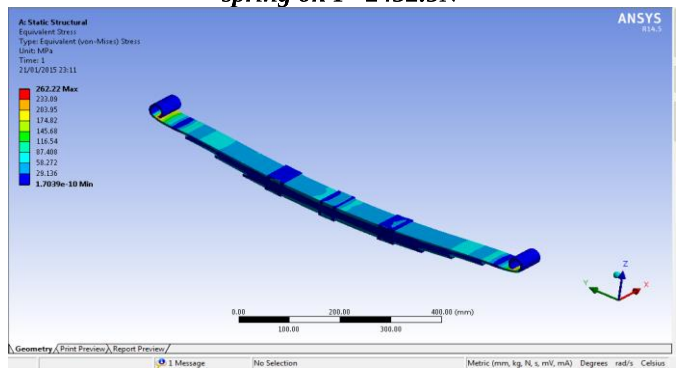

Fig. 8 Stresses in steel leaf spring on F= 3249.506 N

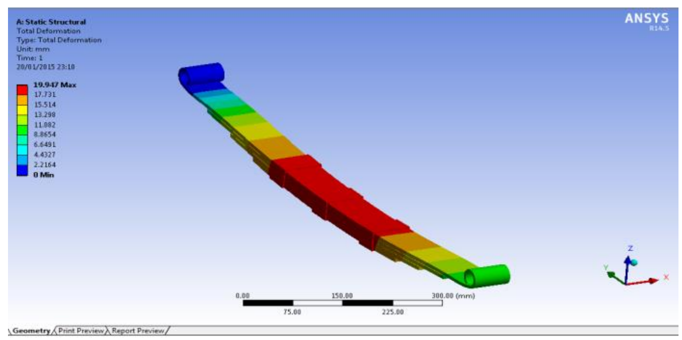

Fig.9 Deformation analysis of steel leaf spring on F=3249.506 N

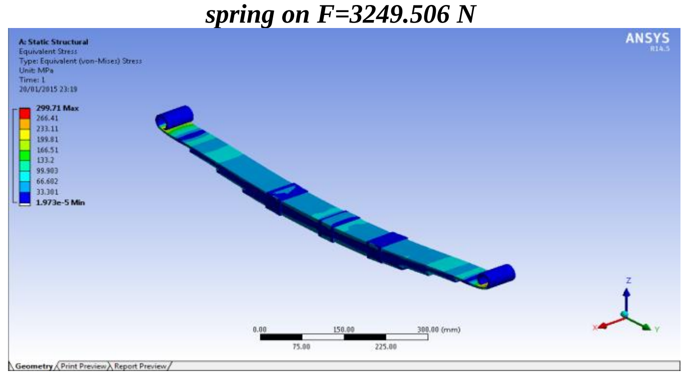

Fig.10 Stresses in steel leaf spring on F=3801.375 N

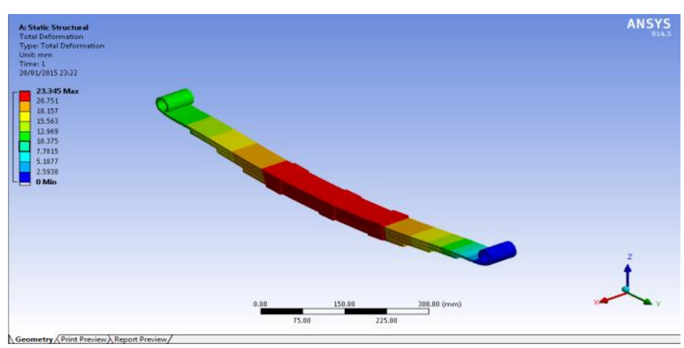

Fig.11 Deformation analysis of steel leaf spring on F=3801.375 N

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

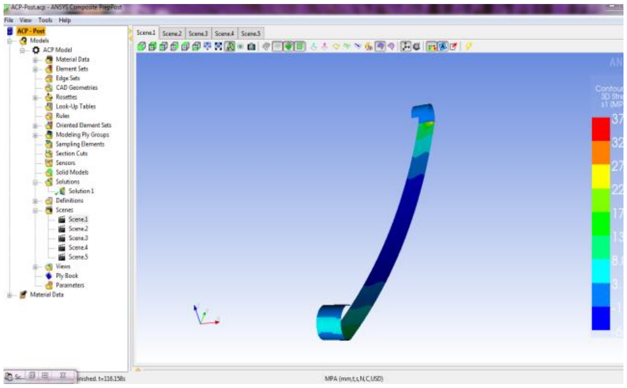

Fig.12 Stresses in composite leaf spring on F=2452.5 N

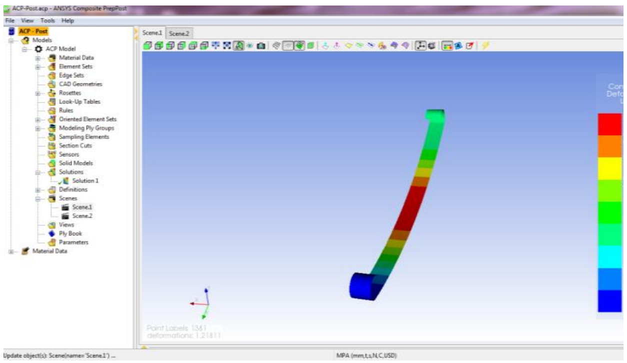

Fig.13 Deformation in composite leaf spring on F=2452.5 N

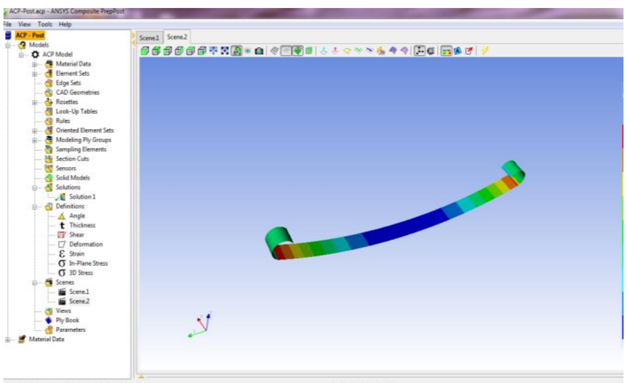

Fig.14 Stresses in composite leaf spring on F=3249.506 N

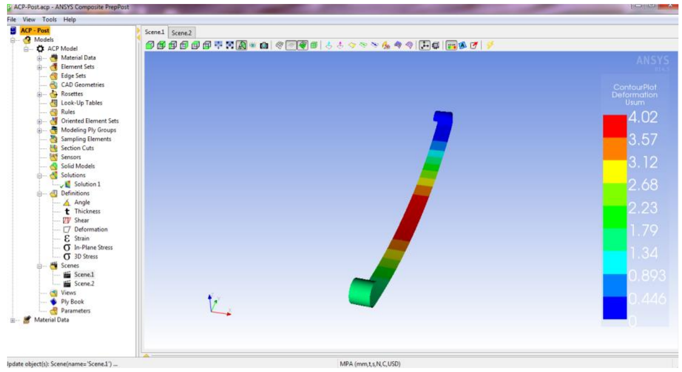

Fig.15 Deformation in composite leaf spring on F=3249.506 N

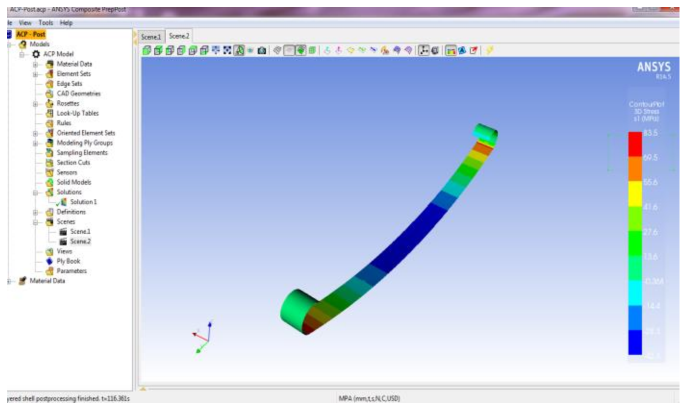

Fig.16 Stresses in composite leaf spring on F=3801.375 N

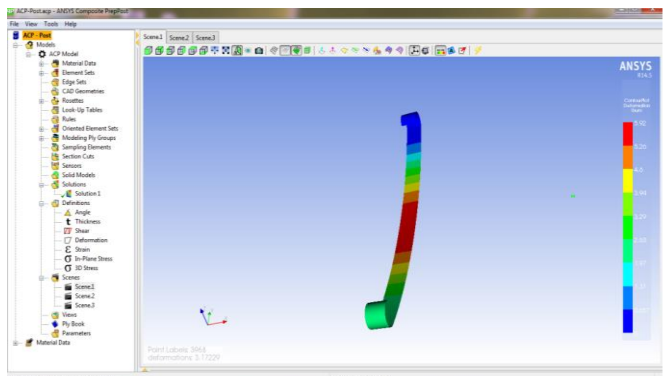

Fig.17 Deformation in composite leaf spring on F=3801.375

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

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

Material	Stresses by FEA	Stresses by Analytical	Deflection by FEA	Deflection by Analytical	Mass	Material cost (appx.)
steel(conventional) leaf spring	197.91 MPa	197.66 MPa	15.091MPa	15.23 mm	10.04kg	Rs. 800
Mono composite leaf spring	37.6 MPa	50.30 MPa	3.23 MPa	4.3 mm	5.628 Kg	Rs. 1200

Results at 3249.506 N Force

Material	Stresses by FEA	Stresses by analytical	Deflection by FEA	Deflection by Analytical	Mass	Material cost (appx.)
steel(conventional) leaf spring	262.22 MPa	264.62 MPa	19.947 mm	20.38 mm	10.04kg	Rs. 800
composite leaf spring	71.5MPa	67.068 MPa	4.02 mm	5.74 mm	5.628kg	Rs. 1200

Results at 3801.375 N Force

Material	.Stresses by FEA	Stresses by analytical	Deflection by FEA	Deflection by Analytical	Mass	Materia l cost (appx.)
steel(conventional) leaf spring	299.71 MPa	310.97 MPa	23.345 mm	23.95 mm	10.04 kg	Rs. 800
composite leaf spring	83.5 MPa	78.65 MPa	5.92 mm	6.733 mm	5.628 kg	Rs. 1200

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.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

(b) Harmonic analysis with finding and compression of first five natural frequencies.
(c) Analysis leaf spring by varying thickness

ACKNOWLEDGMENT

We would like to thanks to Department of mechanical engineering Pad..Dr.D.Y.P.I.E.T Pimpri Pune for valuable guidance.

REFERENCES

[1] Modelling and Analysis of Composite Leaf Spring under the Static Load Condition by using FEA by M.M.Patunkar,D.R.Dolas International Journal of Mechanical & Industrial Engineering, Volume 1 Issue 1-2011
[2] Static Analysis of Composite Semi – Elliptical Leaf Spring by D. Helmen Devaraj, M. Venkatesan IOSR Journal of Engineering Apr. 2012, Vol. 2(4) pp: 598-603
[3] Design and Analysis Of Mono Composite Leaf Spring For Suspension in Automobiles by Mr.V.Lakshmi Narayana International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 6, August - 2012 ISSN: 2278-0181
[4] Optimization of mono leaf spring by parabolic variation of thickness along the length by M.P.Palaskar International Journal of Scientific and Research Publications, Volume 4, Issue 5, May 2014 1 ISSN 2250-3153
[5] Structural Health Monitoring of Fibre Reinforced Polymer Composite Leaf Spring by
[6] Ashoka H.K, Channakeshava K.R, Dr.T.Rangaswamy International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME) Vol. 1, Issue 1, pp: (24-30), Month: April 2014 - September 2014
[7] Vibration Analysis of Composite Leaf Spring for a Light Commercial Vehicle (TATA ACE) by Manjunath H.N, Manjunath.K, T.Rangaswamy International Journal of Scientific Engineering and Technology (ISSN: 2277-1581) Volume No.3 Issue No.7, pp : 871-875 1 July 2014
[8] Experimental Investigation on Laminated Composite Leaf springs Subjected to Cyclic Loading by S.Rajesh and G.B.Bhaskar International Journal of Engineering and Technology (IJET) ISSN: 0975-4024 Vol 6 No 1 Feb-Mar 2014
[9] Performance comparison of conventional and composite leaf spring by V.Pozhilarasu international journal of engineering science and technology (ijest) ISSN: 0975-5462 vol. 4 no.12 December 2012
[10] Development of a Composite Leaf Spring for a Light Commercial Vehicle (Tata Magic) by Vivek Rai , Gaurav Saxena, Vivek Rai et al. Int. Journal of Engineering Research and Applications Vol. 3, Issue 5, Sep-Oct 2013, pp.110-114
[11] Design and assessment of multi leaf spring by Ashish V. Amrute, Edward Nikhil karlus, R.K.Rathore International journal of research in aeronautical and mechanical engineering issn (online): 2321-3051 vol 1 issue. 7, November2013.pgs.115-124