ISSN : 2455-9679
Impact Factor : 3.805

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"OPTIMAL DESIGN OF A AUTOMOTIVE LEAF SPRING USING ANSYS"

Sujoy Banerjee [1], Shantanu Roy [2]

[1, 2] *Department of Mechanical Engineering, Indore Institute of Science and Technology, Indore, India*

ABSTRACT

The automotive suspension device is the one of the crucial unit in vehicle design, specifically leaf spring design. It absorbs payload and street load to provide the consolation trip to a passengers withinside the car. In the prevailing trend peoples are involved bought a car with excellent mileage for that reason the automobile industry display an hobby to lessen the burden of an car components. The weight of automobile and mileage are inversely proportional because the weight will increase the mileage decreases. We found that the load of the composite parabolic leaf spring made from Kevlar/epoxy fibre, is decreased through 82.18% as in comparison to spring made from metal EN45, through the usage of fabric E-glass/epoxy Fibre it's miles decreased through 71.87% as in comparison to spring made from steelEN45.through the usage of fabric carbon/epoxy fibre it's miles decreased through 78.14% as in comparison to spring made from steelEN45. Without any discount on load sporting capability and stiffness the load of the parabolic spring became being decreased due to creation of composite fabric. Since the composite substances have extra elastic pressure strength garage capability and excessive energy-to-weight ratio in comparison to the ones of metal EN45. It is being found that the composite fabric indicates extra deflection and pressure strength than that of metal. In this much less weight of the parabolic leaf spring mechanical performance can be increased. By staring at the static evaluation result, E-glass/epoxy Fibre is higher than carbon/epoxy and Kevlar/epoxy due to the fact its stresses are much less than other.

Key Words: *Automotive suspension , vehicle design leaf spring , EN45, composite leaf spring..*

I. INTRODUCTION

Vehicle dynamics, a discipline of broader significance, is area wherever the fundamentals of analyses on vehicles are restrained. Forces/loads engaged on vehicles will be classified as road and gravity masses of these forces and moments generated by tires at the bottom area unit vital in dominant motion of the vehicle. The response of the vehicle structures to those masses area unit restrained in vehicle dynamics. The responses of a vehicle area unit outlined in terms of deflections, strains, and stresses, natural frequencies, random response functions, and fatigue life then on Analysis of the higher than is what puts the premise on that lustiness of a vehicle system or style is observed in terms of its mechanical behaviour. Simulation of auto responses for the most part concentrates on determination of the higher than. Different researches are administered relating to the performance, the response of parts to static and dynamic masses, crashworthiness, safety by completely different establishments and automotive corporations.

Significantly, with the growing simulation capability victimisation computers, researches area unit expedited that area unit aimed to achieving higher quality merchandise.

The application of prototype model-assisted engineering (CAE) analysis to issues of this kind, together with paradigm development and testing, permits to realize structures having longer fatigue life, reduced price, lightweight weight and

ISSN : 2455-9679
Impact Factor : 3.805

improved comfort. In lightweight of this purpose, as explicit earlier, advancements within the space area unit growing further. The parts of the mechanical system are parabolic spring. Here they perform isolation task in transferring vibration because of road irregularities to driver's body.

Increasing competition and innovations in automobile sector, tends to switch the present product and replacement recent product by new and advanced material product, additional efforts are taken so as to extend the comfort of user, to enhance the mechanical system and thus several modifications have taken place over the time. Inventions of parabolic spring and use of composite materials, for these springs are a number of the newest modifications in mechanical system.

II. DESIGN SPECIFICATION

Here Weight and initial measurements of a Tata 1109 HEx2 Heavy commercial vehicle is taken-

Maximum permissible Gross Vehicle Weight= 12990 kg (including Driver)

Taking factor of safety (FS) = 2

Acceleration due to gravity (g) = 9.81 m/s^2

Therefore; Total Weight = 12990 × 9.81 = 127431.9 N

Since the vehicle is 4-wheeler, a single leaf spring corresponding to one of the wheels takes up one 4th of the total weight.

$$\frac{127431.9}{4} = 31858\ N$$

Load acted on the leaf spring is divided by the two because of consideration of the cantilever beam.

But 2F = 31858 N, F = 15929 N

Span length, 2L = 1372 mm, L= 686 mm.

Now the Maximum Bending stress of a leaf spring is given by the formula-

$$\sigma = \frac{6 \times f \times l}{n \times b \times t^2}$$

$$\sigma = \frac{6 \times 31858 \times 686}{7 \times 80 \times 11.3^2}$$

$$\sigma = 1833.79\ \mathrm{N/mm^2}$$

The Total Deflection of the leaf spring is given by -

ISSN : 2455-9679
Impact Factor : 3.805

$$\delta = \frac{6 \times f \times l^3}{E \times n \times b \times t^3}$$

$$\delta = \frac{6 \times 31858 \times 686^3}{2.1 \times 10^5 \times 7 \times 80 \times 11.3^3}$$

$$\delta = 363.66\ mm$$

Data of the above stated light weight four wheeler vehicle.

Straight length of the parabolic leaf spring (L) =1372 mm

The ratio of camber length of parabolic leaf spring is given by manaspatnaik et al (2012)

$$\frac{C}{L} = 0.089$$

$$C = 0.089 \times 1372$$

$$C = 122.108\ mm$$

By analyzing half of the leaf spring is enough. The half of the applied force would have been taken, but here we took as it is to account over loadings of the vehicle and flexures of the leaf spring.

Hence,

$$\frac{L}{2} = 686\ mm$$

F=31858 N t=? b=?

Calculation for "t" and "b" dimensions which are capable of withstanding the loading behaviour of the conventional and composite parabolic leaf spring is the result of this design. From elementary equation we can find out thickness and width of the spring.

Now to find out bending stress we use the formulae,

$$\sigma = \frac{6 \times f \times l}{n \times b \times t^2}$$

Now the total deflection of the leaf spring is being given by,

$$\delta = \frac{6 \times f \times l^3}{E \times n \times b \times t^3}$$

b= 80 mm

Hence the thickness of the leaf spring is obtained by putting total deflection with stress:

t=11.3mm

ISSN : 2455-9679
Impact Factor : 3.805

At no load, Partial load, Full load, over load and at level of FOS condition are considered in the analysis.

III. DATA FOR PARABOLIC LEAF SPRING

Length of the main leaf (L)	1372 mm
Length of the second leaf(L)	1340 mm
Length of the third leaf(L)	1280 mm
Length of the fourth leaf(L)	1080
Length of the fifth leaf(L)	868
Length of the six leaf(L)	580
Length of the seven leaf(L)	390
Width of leaf (b)	80 mm
Camber height (C)	75.828 mm
Tip inserts	30 mm dia.
Thickness of leaves (t)	11.3mm

IV. MODELLING OF PARABOLIC LEAF SPRING

CREO is a feature-based, parametric stable modelling machine with many prolonged layout and production applications. Three dimensional version of parabolic leaf spring are organized through the use of three-D modelling software CREO 3.0 after layout and path of load implemented is offered in contour plot.

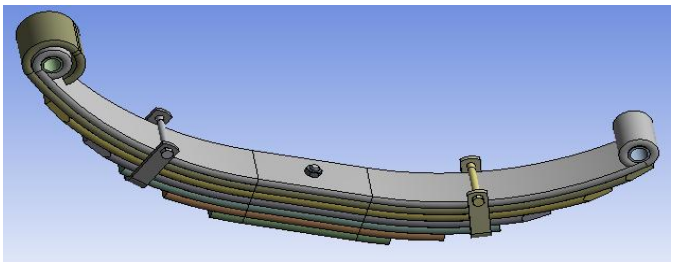


Fig-1 (CAD model of parabolic Leaf spring

V. FATIGUE ANALYSIS OF PARABOLIC LEAF SPRING

5.1.1 Introduction

In this simulation, the Goodman approach, Soderberg's principle, Gerber's principle and imply stress curves has been used. The material that has been used for the simulation of the parabolic leaf spring is traditional metallic EN45 and composite fabric (E-glass/epoxy, carbon/epoxy, Kevlar/epoxy). The consequences received usingANSYS -16.1 software. The consequences are as compared and the principle which offers the bottom fee of existence and the very best fee ischosen to be high-quality withinside the evaluation of metallic EN45 and composite parabolic leaf springs Loading statistics is selected as records statistics of SAE transmission and it's miles applied. Life statistics evaluation: This is done via way of means of making use of a load of 2500 to 4856 N and the evaluation is done via way of means of the above noted 4 approaches. Goodman's and Gerber's approach: Using the Gerber's principle the existence statistics received is just like the Goodman's principle. Mean pressure principle approach: Using imply pressure curves, this principle isn't always desired for the existence statistics evaluation of the parabolic leaf springs.

ISSN : 2455-9679
Impact Factor : 3.805

ASSUMPTIONS

EN45 parabolic leaf spring and other composite parabolic leaf spring (like E-glass/epoxy, carbon/epoxy, Kevlar/epoxy) are simulalted with fixed width and different thickness design.

1. The constraints parameter i.e. dimensions and boundary status of EN45 parabolic leaf spring is same as that of composite parabolic leaf spring.
2. Fatigue life predication of said material with help of FEM using Stress life approach.

VI. POST PROCESSING

A fatigue analysis can be categorised into 2 areas:

(1) Materials

(2) Analysis

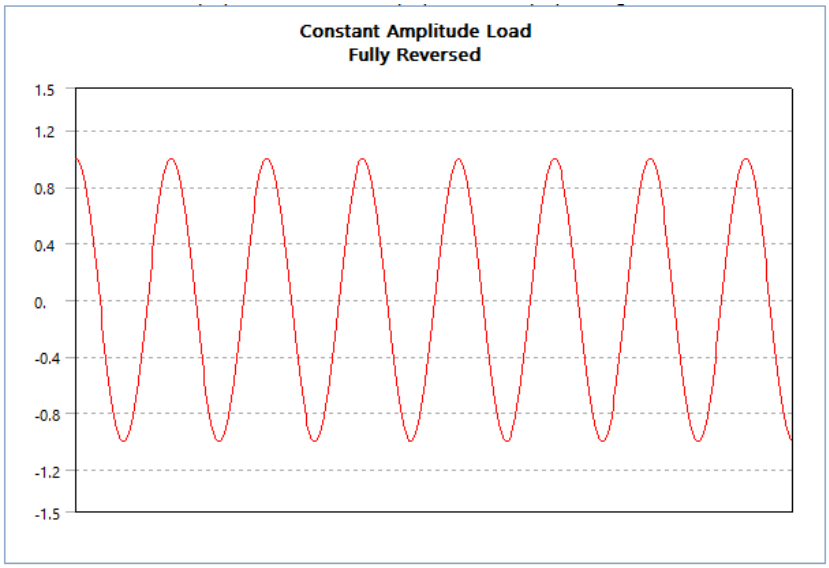
Each of the topic will be discussed in more detail below.

Materials

A massive a part of a fatigue evaluation is getting a correct description of the fatigue fabric residences. Since fatigue is so empirical, pattern fatigue evaluation curves can blanketed simplest for structural metallic material. These residences are blanketed as a manual simplest with purpose for the consumer to offer his very own fatigue records for greater correct evaluation. In case of various stuff is assembled in assembly, every component will use its very own fatigue fabric residences equal because it makes use of its very own static residence.

Analysis

Fatigue consequences may be brought to a strain solution has been performed. It need to be brought earlier than or after. A fatigue device need to first be inserted into the tree to create fatigue consequences. This can be finished thru answer toolbar or thru context menu. To outline the diverse components of a fatigue evaluation the info view of the fatigue device are used. It is which include loading type, managing of imply pressure outcomes and more. As visible in Figure 5.85, a graphical illustration of the loading and imply pressure outcomes is displayed after the fatigue device is selected. This may be very beneficial to assist a novice. Also, it allows to apprehend the fatigue loading. With this we also can apprehend the feasible outcomes of a median pressure.



ISSN : 2455-9679
Impact Factor : 3.805

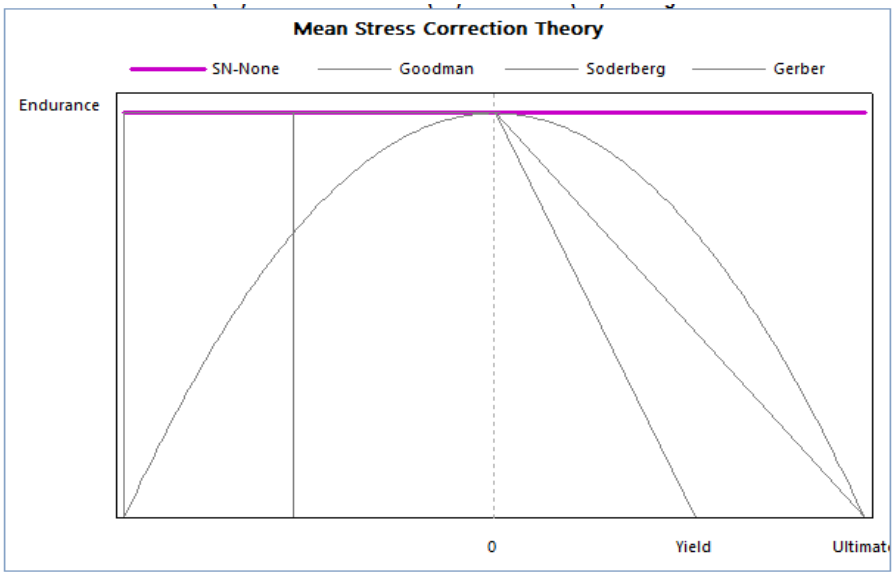


Figure 2 show loading type and handling of mean stress effects

VII. CONCLUSION

In this paper, a parabolic leaf spring is designed and examine for a positive automobile. The parabolic leaf spring is designed for the burden of 15929N. Theoretical calculations had been calculated for parabolic leaf spring dimensions at one-of-a-kind instances like various thickness, camber, span and no. of leaves through mathematical technique. In this thesis, evaluation has been carried out through taking substances Steel EN45, E-glass/epoxy, carbon/epoxy, and Kevlar/epoxy. Static and fatigue evaluation are performed on general meeting of parabolic leaf spring. The outcomes show: The stresses withinside the composite parabolic leaf spring of layout are a whole lot decrease than that of the allowable pressure We found that the load of the composite parabolic leaf spring made from Kevlar/epoxy fibre, is decreased through 82.18% as in comparison to spring made from metal EN45, through the usage of fabric E-glass/epoxy Fibre it's miles decreased through 71.87% as in comparison to spring made from steelEN45.through the usage of fabric carbon/epoxy fibre it's miles decreased through 78.14% as in comparison to spring made from steel EN45.

REFERENCES

[1] K. K. Jadhao, DR. R. S. Dalu, “Experimental investigation & numerical analysis of composite leaf spring”, International Journal of Engineering Science and Technology, Vol. 3, No. 6, 2011.

[2] Kumar Krishan, Aggarwal M.L, “Computer aided FEA comparison of mono steel and mono GRP leaf spring”, International Journal of Advanced Engineering Research and Studies, Vol. I, Issue II, 2012, pp 155-158.

[3] Joo-teck Jeffrey, Tarlochan Faris, “Finite element analysis on the static and fatigue characteristics of composite multi-leaf spring”, Journal of Zhejiang University- Science, Vol. 13, 2012, pp 195-164.

[4] N. P. Dhoshi, Prof. N. K. Ingole, Prof. U. D. Gulhane, “Analysis and modification of leaf spring of tractor trailer using analytical and finite element method”, International Journal of Modern Engineering Research, Vol.1, Issue.2, pp 719-722.

[5] M. M. Patunkar, D. R. Dolas, "Modelling and Analysis of Composite Leaf Spring under the Static Load Condition by using FEA", International Journal of Mechanical & Industrial Engineering, Volume 1, Issue 1, 2011.

[6] M Senthil Kumar, S Vijayarangan, "Static analysis and fatigue life prediction of steel and composite leaf spring for light passenger vehicles", Journal of Scientific & Industrial Research, Vol. 66, 2007, pp 128-134.

[7] Abdul Rahim Abu Talib, Aidy Ali, G. Goudah, Nur Azida Che Lah, A.F. Golestaneh, "Developing a composite based elliptic spring for automotive applications", Materials and Design, 31, 2010, 475–484.

[8] Malaga. Anilkumar, T. N. Charyulu, Ch. Ramesh, "Design Optimization Of Leaf Spring", International Journal of Engineering Research and Applications, Vol. 2,Issue 6, 2012, pp.759-765.

[9] Mahmood M. Shokrieh, Davood Rezaei "Analysis and optimization of a composite leaf spring" Composite Structures, 60 (2003) 317–325.

[10] E. Mahdi a, O.M.S. Alkoles a, A.M.S. Hamouda b, B.B. Sahari b, R. Yonus c, G. Goudah"Light composite elliptic springs for vehicle suspension " Composite Structures, 75 (2006) 24–28.

[11] Y. N. V. Santhosh Kumar, M. Vimal Teja "Design and Analysis of Composite Leaf Spring" Dept. of Mechanical Engineering, Nimra College of Engineering & Technology, Ibrahimpatnam, Vijayawada. (2012).

[12] Pankaj Saini, Ashish Goel, Dushyant Kumar " Design and analysis of composite leaf spring for light vehicles " International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 5, May 2013.

[13] Manas Patnaik, Narendra Yadav, Ritesh Dewangan" Study of a Parabolic Leaf Spring by Finite Element Method & Design of Experiments "International Journal of Modern Engineering ResearchVol.2, Issue 4, July-Aug 2012 pp-1920-1922.

[14] Malaga. Anil Kumar ,T.N.Charyulu, Ch.Ramesh" Design Optimization Of Leaf Spring " International Journal of Engineering Research and Applications Vol. 2, Issue 6, November- December 2012, pp.759-765.

[15] Vijayarangan, "Analytical andExperimental Studies on Fatigue Life Prediction of Steel and Composite Multi-leaf.