DEVELOPMENT OF LEAF SPRING DESIGN IN HEAVY LOAD VEHICLES USING 65SI7 MATERIAL

K.Rajesh[1], A. Aryan[2], G.Varun[3] ,S.Vineeth[4],V.Koushik[5]

[1]Assistant Professor, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad, India.

[2,3,4]Student, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad, India.

Abstract

Leaf spring is a simple form of suspension spring used to absorb vibrations induced during the motion of a vehicle. The automobile industry has shown increased interest in the replacement of steel leaf spring (55 Si 7) with composite leaf spring (E-glass/Epoxy) due to high strength to weight ratio, higher stiffness, high impact energy absorption and lesser stresses. This research is aimed to investigate the suitability of natural and synthetic fiber reinforced hybrid composite material in automobile leaf spring application. By using natural fibers efforts have been made to reduce the cost and weight of leaf spring. n this work an attempt is made to develop a natural and synthetic fiber enforced hybrid composite material with optimum properties so that can replace the existing synthetic fiber reinforced composite material n automobile leaf spring. Jute and E-glass woven roving mats are used as reinforcements and epoxy resin LY556 is used as the matrix material. The CAD models of Leaf spring are prepared in CATIA V5 and imported in static structural analysis work bench of Ansys 14.5 where ignite element analysis (FEA) is performed. The design constraints are stresses and deflections. This study gives a comparative analysis between steel leaf spring and Jute/E glass reinforced Epoxy leaf spring. The hybrid composite leaf spring is found to have lesser weight, lesser cost, lesser stresses and higher stiffness.

INTRODUCTION

A leaf spring is one or more narrow, arc-shaped, thin plates which are attached to the axle and Cha leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi- elliptical spring, elliptical spring, or cart spring, it is one of the oldest forms of verses in a way that allows the leaf spring to flex vertically in response to irregularities in the road surface. Lateral leaf springs are the most commonly used arrangement, running the length of the vehicle and mounted perpendicular to the wheel axle, but numerous examples of transverse leaf springs exist as well. Suspension can be considered as a link between the wheels and the body. It absorbs quick loadings and collects the elastic energy. Design fundamentals are based on the strength and comfort. The strength characteristics are usually determined according to the suspension type and loading. The comfort design fundamentals originate from the actuation and vibration point of view. The basic idea for the design is to generate the wanted elasticity and maintain the driving comfort. Suspensions mechanisms also can use different types of springs in the mechanism. The most common are the coil spring, torsion bar, pneumatic, and leaf spring. The choice of spring normally has little effect on suspension performance. Leaf springs were the suspension of choice in the early days of the automobile. They have the advantage of using the same mechanism to control the wheel and provide the necessary spring force. They are simple, inexpensive, and easy to manufacture. Now a days it is widely used in heavy duty vehicles and work machines. The advantages of the leaf spring are based on its simple construction, low costs and easy maintenance. The design also provides the solution for the axle support. Almost all vehicle suspension uses parabolic leaf springs. The difference between the normal leaf spring and the parabolic leaf spring is the total number of leafs. A parabolic leaf does not need of huge amount of leafs because the stress is distributed equally due to its parabolic shape. In terms of function, leaf spring suspensions are much simpler, since the axle is suspended by the spring, and does not require the complicated suspension geometry of the coil-spring set-up. Leaf springs are also much sturdier, and are capable of handling much higher loads with less detection than coils. Trucks with leaf springs are also easier to raise or lower. The leaf springs simplicity is as much a curse as a blessing. Since these springs attach at axed points on the chassis, they give very little room for adjustability of suspension geometry. These springs also a great deal less than coil springs, resulting in a loss of wheel-to-ground contact under extreme conditions. In the present scenario, weight reduction has been the main focus of automobile manufactures. The suspension leaf spring is one of the potential items for weight reduction in automobiles as it accounts for ten to twenty percent of the unsprang weight, which is considered to be the mass not supported by the leaf spring. The introduction of composite materials made it possible to reduce the weight of the leaf spring without any reduction on the load carrying capacity and stiffness. Studies were conducted on the application of composite structures for automobile for automobile suspension system. The leaf spring should absorb the vertical vibrations and impacts due to road irregularities by means of variations in the spring detection so that the potential energy is stored in spring as strain energy and then released slowly. So, increasing the energy storage capability of a leaf spring ensures a more compliant suspension.

ISSN NO: 1001-1749

PERFORMANCEAND PARAMETERS:

Angle	Deformation	Strain		Stress	
		Max	Min	Max	Min
0	0.703	0.00015304	1.528e-15	32.125	1.618
5	0.70913	0.00015193	5.4954e-16	30.032	1.352
10	0.85526	0.00017828	2.0153e-8	38.267	1.3933
15	0.76109	0.00015435	2.4656e-14	32.609	1.3254
20	0.62284	0.0001286	1.098e-6	27.095	1.629

Parameters	Conventional steel leaf	E-GLASS/EPOXY COMPOSITE LEAF SPRING
Total Deformation (maximum)	$1.1353^{e^{-9}}$	$6.5303^{e^{-7}}$
Equivalent stress (maximum)	5.6913	$4.5706^{e^{-5}}$
Directional deformation (maximum)	$1.253^{e^{-10}}$	$1.4879^{e^{-8}}$
Maximum shear stress (maximum)	2.9168	$2.3549^{e^{5}}$
Maximum principal stress (maximum)	0.68649	$1.5615^{e^{5}}$

OBJECTIVES

Objective of the Work In the present scenario, weight reduction has been the main focus of automobile manufactures. The suspension leaf spring is one of the potential items for weight reduction in automobiles as it accounts for ten to twenty percent of the un sprung weight, which is considered to be the mass not supported by the leaf spring. The introduction of composite materials made it possible to reduce the weight of the leaf spring without any reduction on the load carrying capacity and stiffness. Studies were conducted on the application of composite structures for automobile for automobile suspension system. The leaf spring should absorb the vertical vibrations and impacts due to road irregularities by means of variations in the spring deflection so that the potential energy is stored in spring as strain energy and then released slowly. So, increasing the energy storage capability of a leaf spring ensures a more compliant suspension system. According to the studies, a material with maximum strength and minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring. In the present work, a nine-leaf steel spring used in heavy vehicle is replaced with a composite multi leaf spring made of S2 Glass /Epoxy and Kevlar/Epoxy. The dimensions and the number of leaves for both steel leaf spring and composite leaf springs are considered to be the same. The objective is to compare their displacement, frequencies, deflections and weight savings of composite leaf spring.

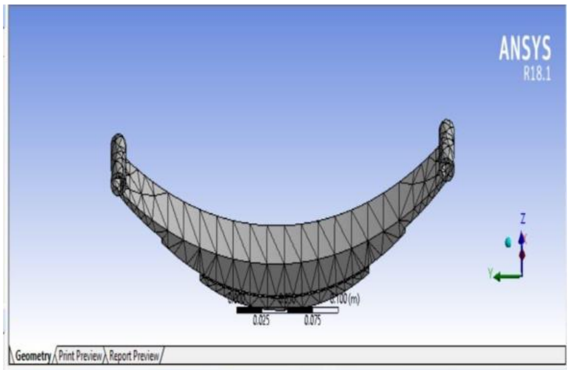

Table 2. Experimental results of loading and unloading of the leaf springs for load rate test

Deflection (mm)	Loading (kg)	Unloading (kg)	Mean (kg)	L/Rate kg/mm	Av. L/Rate kg/mm
0	0	0	0	0	
10	160	80	120	16	
20	340	220	280	16	
30	520	360	440	17	
40	700	520	610	16.5	
50	870	680	775	15.5	
60	1040	820	930	17	
70	1200	1000	1100	16	
80	1370	1150	1260	17	16.26 kg//mm
90	1540	1320	1430	17	
100	1720	1480	1600	17.5	
110	1900	1650	1775	18.5	
120	2100	1820	1960	18	
130	2280	2000	2140	17.5	
140	2480	2150	2315	18.5	
150	2660	2340	2500	21.5	
160	2890	2540	2715	17	
170	3060	2710	2885	17	

EXPECTEDOUTPUT:

The complete design of leaf spring with different cross sections is done using CAD

ISSN NO: 1001-1749

software . Thermal analysis are worked in ANSYS 15.0 and the results obtained are with varying stress and strain according to the angle and deformation using material 65si7(carbon steel). From the experimental results obtained by loading and unloading of the leaf springs for load rate determination, a load –deflection curve is drawn for loading, unloading and mean load as .The mean value of load shows a linear relationship with deflection but for loading and unloading this relationship is not linear. As observed that the relationship between load-deflection is not linear during the loading and unloading of the springs; therefore the mean value of loading and unloading to achieve 10 mm deflection is taken to determine the exact load rate. experimental load deflection curve, obtained by testing the leaf springs on a full scale leaf spring testing machines. The deflection observed under the application of the specified load is plotted. It is observed from this plot that there exist a liner relationship between the load and deflection shows an analytical load deflection curve.

CONCLUSION

The deflection observed under the application of the specified load is plotted. It is observed from this plot that there exist a liner relationship between the analytical load and deflection. To validate the analysis, the CAE results have been compared with the experimental results and analytical results. As the experiments are done on a full scale leaf spring testing machine under the specified loads, therefore the CAE analysis has been carried out for the same loads. The analytical method for determination of deformation and stress is also described. The maximum stress induced in the leaf springs is found to be 941MPa, 989.89 MPaand 969.25MPa using experimental, CAE and analytical approach respectively. The stress is found to be well below the yield stress which is 1081.2 MPa. The total deformation comparison for experimental, CAE and analytical approach also validates the CAE analysis of the leaf springs. The results of the comparison have been depicted in the tabular.

REFERENCES:

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

[2]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.

[3]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)

[4]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.

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

[6]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.

[7]PrahaladSawantBadkar, Prahalad Sawant Badkar " Design Improvements of Leaf Spring of BEML Tatra 815 VVNC 8 X 8 Truck " International Journal of Emerging Technology and Advanced Engineering ,Volume 3, Issue 1, January 2013.

[8]H.A.AI-Qureshi " automobile leaf spring from composite materials " Journal of materials processing technology, 118(2001).

[9]Ashish V. Amrute, Edward Nikhil karlus, R.K.Rathore "design and assessment of mul leaf spring'' International journal of research in aeronautical and mechanical engineering, ISSN :2321-3051. November (2013).

1) Behera, A.K., Panda, M., Nayak, S.C., Dash, C.S.K., 2022, An Artificial Electric Field Algorithm and Artificial Neural Network-Based Hybrid Model for Software Reliability Prediction, Smart Innovation, Systems and Technologies, 10.1007/978-981-16-9447-9_21
2) Lu, Y., Khan, M., Ansari, M.D., 2022, Face recognition algorithm based on stack denoising and self-encoding LBP, Journal of Intelligent Systems, 10.1515/jisys-2022-0011
3) Sudhamani, C., Kumar, K.B., Prasad, G.V.H., Renuka, N., 2022, Classified Authentication System with IoT and Dashboard, Lecture Notes in Electrical Engineering, 10.1007/978-981-16-8550-7_47
4) Shaik, A.S., Ahmed, M., Suresh, M., 2022, Low-Cost Irrigation and Laser Fencing Surveillance System for the Paddy Fields, Lecture Notes in Electrical Engineering, 10.1007/978-981-16-8550-7_49
5) Reddy, G.S., Kalaivanan, R., Kumar, R.U., Krishna Varma, K.P.V., 2022, Convective Heat Transfer in Heat Exchangers Using Nanofluids: A Review, Ecological Engineering and Environmental Technology, 10.12912/27197050/147679