Critical Review of Research Paper for Analysis of Multi Leaf Spring

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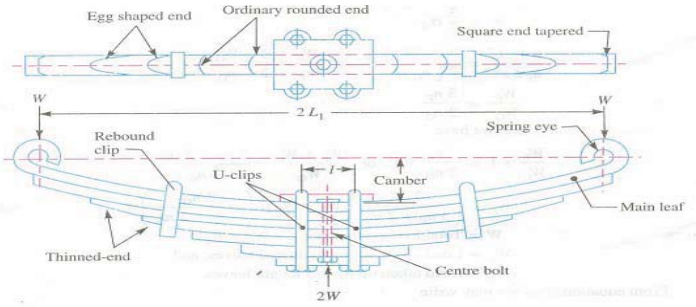
Abstract - The aim of this review paper is to represent a general study on the design, analysis of multi leaf spring. In passenger vehicles ride comfort and load carrying capacity, rigidity is important considerations. Vehicle ride comfort depends upon the suspension system. Suspension system in automobile significantly affects the behavior of vehicle. Leaf springs are perhaps the simplest and are less expensive compared to other suspension. Leaf spring is therefore an important aspect in the suspension system design. . Due to variation of load leaf springs are one of the most dynamically stressed components in automobile therefore quality of vehicle ride depends upon the characteristics of leaf spring used in suspension unit, Performance measures of any leaf springs are its stiffness and fatigue life. This paper present analysis of leaf spring used in light commercial vehicle.

Keywords –Multi Leaf Spring, FEA, Fatigue Life.

I. INTRODUCTION

In the present paper the main focus of automobile manufacturers is to improve life of the automobile. Fatigue failure is the predominant mode in-service failure of many automobile components. This is due to the fact that the automobile components are subjected to several of fatigue loads like shocks caused due to road irregularities traced by the road wheels, the sudden loads due to the wheel traveling over the bumps etc. The leaf springs are more affected due to fatigue loads, as they are a part of the unstrung mass of the automobile. Performance measures of any leaf springs are its stiffness and fatigue life. Life of leaf spring can be achieved mainly by introducing the new material, changing design parameter and manufacturing processes.



Multi Leaf spring details

Kumar Krishan and Aggarwal M.L [1] this work is carried out on a multi leaf spring having nine leaves used by a commercial vehicle. The finite element modeling and analysis of a multi leaf spring has been carried out. It included two full length leaves in which one is with eyed ends and seven graduated length leaves. The FE model of the leaf spring has been generated in CATIA V5 R17 and imported in ANSYS-11 for finite element analysis. Bending stress and deflection are the targeted results. A comparison of both i.e. experimental and FEA results has been done to conclude. When the leaf spring is fully loaded, a variation of 0.632 % in deflection is observed between the experimental and FEA result, and same in case of half load, which validates the model and analysis.

Parameters	Experiment Results	FEA Results	Variation
Normal Static Load	35000N	35000N	Nil
Deflection	158 mm	157 mm	0.632 %
Spring Rate	221.5 N/mm	222.92 N/mm	0.641 %
Bending Stress	101.8 Kgf/mm2	113.25 Kgf/mm2	10.11 %

C.K. Clarke and G.E. Borowski [2] discussed the determination of the point of failure during an accident. Finite-element stress analysis is used to study the existence of tensile stresses at the location of the fracture. A finite-element analysis is carried in finite-element code ALGOR is conducted on the spring eye stress conditions in order to examine the transverse stresses. Residual-strength calculations are made with longitudinal forces. Reduction in strength produced by the old OD crack is also estimated based on published stress-intensity data.

Mouleeswaran Senthil Kumar, Sabapathy Vijayarangan [3], they described in their paper static and fatigue analysis of steel leaf spring and composite multi leaf spring made up of glass fiber reinforced polymer using life data analysis. adopted the analysis model of Hwang and Han.

$$N = \{B (1 - r)\}^{1/c}$$

They found stiffness; natural frequency of composite leaf spring is higher than steel spring It is found that the life of composite leaf spring is much higher than that of steel leaf spring. Also weight of spring is reduced.

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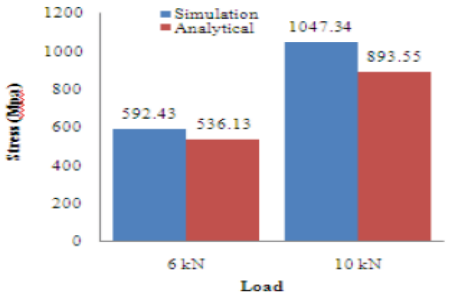
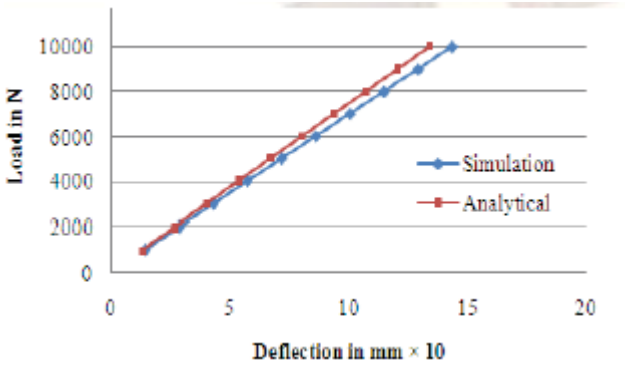
Mr. V. K. Aher, Mr. P. M. Sonawane [4], the purpose of this paper is to predict the fatigue life of semi-elliptical steel leaf spring along with analytical stress and deflection calculations by using CAE tools.

i) From the nonlinear static analysis, it is observed that for the leaf spring at 6 kN. Load, the maximum von-Mises stress is 592.43 MPa and at 10 KN it is 1047.34 MPa.

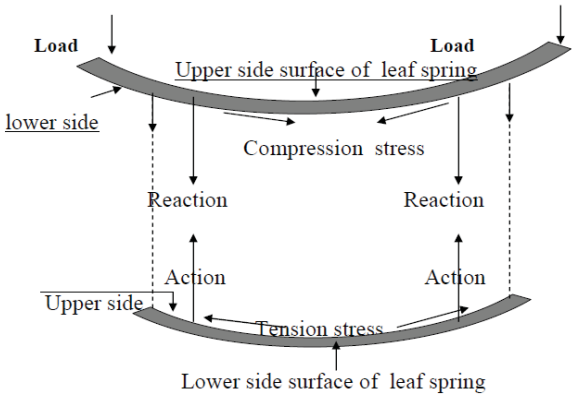
ii) From load Vs deflection curve shows there is linear relationship between the load and deflection. For the validation, the FEA deflections are compared to the analytical. From load Vs deflection curve shows there is linear relationship between the load and deflection





From Modal analysis, the fundamental frequency for the leaf spring is 10.68 Hz observed in vertical bending mode. The subsequent 2nd and 3rd mode shows the lateral and twisting modes. From the fatigue analysis, it is clear that the damage sum is less than 1 hence it is in safe limits and the life predicted for the leaf spring is 1.47×10^7 cycles. This study will help to understand more the behavior of the spring and give information for the manufacturer to improve the fatigue life of the spring using CAE tools. It can help to reduce cost and times in research and development of new product

Abdul Karim Selman Abdul Karim, Arshed Abdul Hamed Mohammed [5] Leaf spring for light truck is investigated. Three groups of light truck are considered Simulation resembles to constrained condition when mounting on the vehicle, where each leaf in the system can be idealized in to a diamond shape. The finite element method was applied as a method of analysis to examine the stress distribution for each leaf. The number of cases studied equal 24 cases. He concluded the magnitude of stress in lower side surface for all leaves of spring is more than stress in upper side surface.



R. B. Charde , Dr. D.V. Bhope[6] found for product quality it is necessary to determine the stresses in various components In first approach the stress analysis is carried out by considering only the graduated leaves and in other approach the stress on master leaf is carried out by considering one extra full length leave. The results of finite element analysis for both approaches are verified experimentally by using strain gauges. The stress are evaluated at varies distances varying from 15mm to 345mm measured from support. So, length of graduated leaves plays a significant role in the stresses on master leaf. It is also observed from table that with the addition of extra full length leaf the stresses are reduced drastically. Thus to strengthen the leaf spring extra full length leave are recommended.

Sr No.	Length mm	Maximum Stress calculated analytically N/mm2	Maximum Stresses By FEM N/mm2	Maximum stress with analysis Experimental Analysis N/mm2
1	15	46.41	50.794	39.48
2	125	35.49	46.59	36.33
3	235	22.38	41.07	32.97
4	345	10.37	27.94	26.25

Prof. N.P.Dhoshi, Prof .N.K.Ingole, Prof .U.D.Gulhane [7]. The paper illustrated the importance of analytical and micro-analysis. FEM analysis is done in ANSYS 11.0 and the project shows the importance of Stress analysis. On reducing the number of leaf spring from 17 to 13 will further reduce the weight by approximately 6kg and the production cost by nearly 20%.

R. A. Claudio, J.M. Silva, C.M. Branco, J. Byrne [8] explained in paper Fatigue life calculated using total fatigue life predictive methods which are normally used for notched geometries, gave conservative results for almost all of the situations herein studied. These are found to be too pessimistic in predicting the shot peening effect. Results are much better if stress or strain energy density is averaged over a critical distance, when shot peening is considered.
Niklas Philipson [9] found the conventional way to model leaf springs is to divide the spring into several rigid links. The models in this paper are designed as generalized force elements where the position, velocity and orientation of the axle mounting gives the reaction forces in the chassis attachment positions. The shape of the Figure leaf spring will be determined by the rotations between each link.

Vinkel arora, Dr. M.l aggarwal, Dr. Gian bhushan [10] the work is carried out on the front end leaf spring of a commercial vehicle. CAE analysis of the leaf spring has been done and the results are compared with the experimental results as follows:-

For Static Load 35 KN

Parameters	Exp.results	CAE Results	Variation
Deflection	158 mm	156.15 mm	1.17%
Bending stress	126 Kgf/mm2	141.56 Kgf/mm2	12.30%
Spring Rate	221.5/mm	224.5N/mm	1.35%

For Static Load 17.5 KN

Parameters	Exp.results	CAE Results	Variation
Deflection	79 mm	78.07 mm	1.1%
Spring Rate	221.5 N/mm	224.5 N/mm	1.35%
Bending stress	48 Kgf/ mm^2	53.77 Kgf/ mm^2	12.02%

When the leaf spring is fully /half loaded, a variation of 1.17% in deflection, time bending stress for fully loaded, is increased by 12.30 %, for half loaded bending stress is increased by 12.02 %. maximum equivalent stress is 172.5 MPa & 86.29 MPa for fully and half loaded leaf spring respectively, which is below the Yield Stress i.e. 250MPa.Therefore the design is safe which is observed among the Experimental & CAE value, which proved the validation of our CAD model and analysis. It is concluded that when CONTA72, TARGET71 type of contact and SOLID 92 mesh element is used for CAE analysis the results are closer to the Experimental results.

Predrag Borkovic, Borivoj Sustarsic, Vojteh Leskovsek, and Borut Zuzek [11] stated that fatigue life of a component is a very important regarding safety and stability of any dynamically loaded systems. On the base of the fatigue simulations it is clear that the longest fatigue life of the mono-leaf spring is obtained by using the largest transition radius of 115 mm. With this transition radius, the mono-leaf spring may be able to endure at least 50 Million cycles, according to the S/N curve of the unnotched longitudinal oriented specimens. Also, by using other S/N curves for the perpendicular specimen orientation as well as for the notched specimens, the fatigue life is longer too.

II.CONCLUSION

In this study general discussion on design, analysis of leaf spring is carried out for enhancement of the fatigue life. The main purpose of doing this work is to increase life of leaf spring i.e. reduction of the stresses at peak loading condition. For improve life of leaf spring and its durability modifications can be implemented by changing the material, changing the physical parameters like Span of the leaf spring, Width of the leaf ,Thickness of the leaf, Number of leaves. This study will help to understand more the behavior of the spring by using CAE and give information for the manufacturer to improve the fatigue life of the spring by changing design parameter. FEA is carried out by changing design parameter with conventional spring and modified spring. The result will compared with experimental result.

REFERENCES

[1] Kumar Krishan and Aggawal M.L "A Finite Element Approach for Analysis of a Multi Leaf Spring using CAE Tools", Department of Mechanical Engineering, YMCA University of Science and Technology,Faridabad, HR, India, Vol.1 (2), 92.

[2] C.K. Clarke and G.E. Borowski "Evaluation of a Leaf Spring Failure" ASM international submitted July 18,2005 In revised from August 31, 2005.

[3] Mouleeswaran Senthil Kumar, Sabapathy Vijayarangan "Analytical and Experimental Studies on Fatigue Life Prediction of Steel and Composite Multi-leaf Spring for Light Passenger Vehicles Using Life Data Analysis" ISSN 1392-1320, material scienceVol.13, No.2, 2007.

[4] Mr. V. K. Aher, Mr. P. M.Sonawane "Static and Fatigue Analysis of Multi Leaf Spring used in the suspension System of LCV" International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622 Vol. 2, Issue4, July-August 2012, pp.1786-1791.

[5] Abdul Karim Selman Abdul Karim, and Arshed Abdul Hamed Mohammed "Studying the stress analysis in leaf spring by finite elements method" Diyala Journal of Engineering Sciences, ISSN 1999-8716, Vol. 03, No.1 June 2010 pp. 47-64.

[6] R. B.Charde, Dr. D.V. Bhope "Investigation of stresses in master leaf of leaf spring by fem and its experimental Verification" International Journal of Engineering Science and Technology (IJEST), Vol. 4, No.02 February 2012, ISSN: 0975-5462. ,

[7] Prof. 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, ISSN: 2249-6645.

[8] R.A. Claudio, J.M. Silva, C.M. Branco, J. Byrne "Fatigue life prediction of shot Peened components" Ciencia e Tecnologia dos Materiais, Vol. 20, n. º 1/2, 2008.

[9] Niklas Philipson, Modelon AB "Leaf spring modeling" Ideon Science Park SE-22370 Lund, Swede, Modelica 20 -06, September 4th – 5th.

[10] Vinkel Arora, Dr. M.L Aggarwal, Dr. Gian Bhushan "A Comparative Study of CAE and Experimental Results Of Leaf Springs in Automotive Vehicles" International Journal of Engineering Science and Technology (IJEST) ISSN: 0975-5462 Vol. 3 No. 9 September 2011.

[11] Predrag Borkovic, Borivoj Sustarsic,Vojteh Leskovsek, Borut Zuzek "Influence of Different stress concentration

[12] Factors in mono-leaf spring on its final fatigue life" Institute of Metals and Technology, Ljubljana, Slovenia.