Review On Failure Analysis Of Without Eye leaf Spring Using FEM

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ABSTRACT:

We know that the spring plays very essential part of every automobile for suspension point of view.leaf spring is the main type of suspension system which is used in many light and heavy vehicals. Leaf spring used in many vehicals due to having some main characteristics which are shown bwlow:

1) Uniformaly Load Distribution
2) Lower Cost
3) Rough Used
4) Esiear In Isolation and Tighly attached working frame

Today Every automobile company has been working on increasing the efficiency with reducing the weight without having any load carring capacity. In this paper we would like to review some previous research work performed on the leaf spring by previous researchers for increasing the working condition and capacity with load reduction. In order to analyse the variations in the chemical composition, micro-structural analysis along with material specification has been performed. The failed leaf spring fractured part was analysed by using a visual inspection technique and scanning electron microscope (SEM) analysis. The fatigue life of the proposed leaf spring has increased in comparison with the existing model lifecycles.The paper based on material composition, experimental testing and load (Steady, Dynamic) study etc. Based on the fractography study, it was inferred that the failure of the fractured part was due to the cyclic load. This load lead to fatigue growth on leaf spring of the model truck vehicle. Then finite element analysis of leaf spring was carried out to find out the root cause of the leaf spring suspension system. The failure parameters were also optimised for the truck vehicle during safe operation on the road. The fatigue life of the proposed leaf spring has increased in comparison with the existing model lifecycles.

Keywords :- leaf springs, Material Compositions, fracture mechanics, leaf spring failure, leaf spring stress analysis etc.

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1. INTRODUCTION

A leaf spring is the simple form of spring commonly used for the suspension in wheeled vehicles. Leaf spring is mainly made up of steel, but due to issue of weight today most of the automobile companies used composite materials for the manufacturing of leaf springs. The composite materials used like E-Glass/Epoxy, Graphite/Epoxy, and Carbon/Epoxy etc. The classification of leaf spring included as Elliptical, Semi Elliptical, Three quarter Elliptical, Quarter Elliptical, and Teraservers. The leaf spring mainly consists of different parts like Master leaf, Center bolt, central clamp, Eye, and Rebound clip.
A spring is an elastic body, whose expand in size when load applied and regain its original shape when removed. Leaf spring is the simplest form of spring used in the suspension system of vehicle.It absorbs automobile vibrations, shocks and loads by springing action and to some extend by damping functions.It absorbs energy in the form of potential energy. Springs capacity to absorb and store more strain energy makes the suspension system more comfortable. . The leaf springs always receive a high dynamic load and often experience fatigue failure that occurs after the component is used for a certain period in its operation. Failure due to fatigue is a fracture mechanism that can be identified through 3 stages, the first stage is initiation of crack, then crack propagation and the final stage is fracture. Fatigue failure is the most common failure in

automotive components, particularly those involving spring on trucks. This is due to automotive components often experience excessive load and shocks that occur due to the unevenness of the road through the wheel.
Based on the fractography study, it was inferred that the failure of the fractured part was due to the cyclic load. This load lead to fatigue growth on leaf spring of the model truck vehicle. Then finite element analysis of leaf spring was carried out to find out the root cause of the leaf spring suspension system. The failure parameters were also optimised for the truck vehicle during safe operation on the road. In this project the main objective is to failure analysis of leaf spring of without eye by using finite Element analysis method. (Fem).

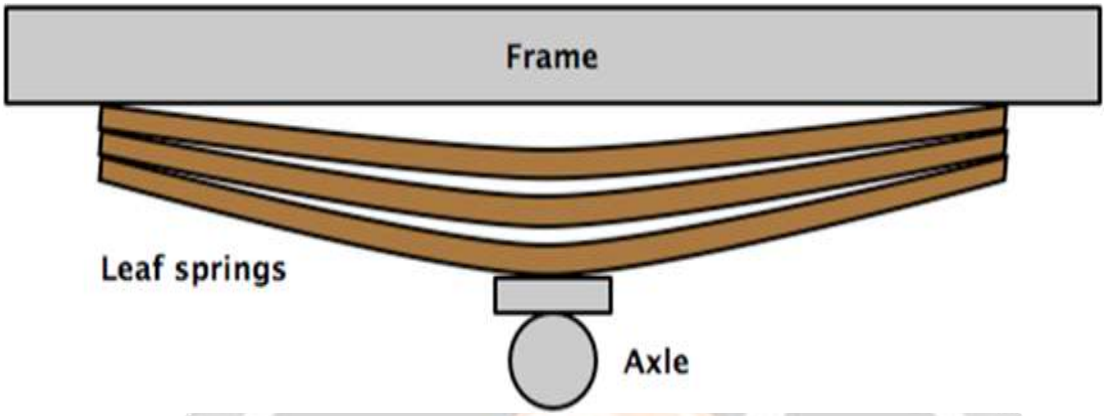

FIG:- Componant Leaf Spring

2. LITERATURE REVIEW

Mahmood M. shokrieh and DavoodRezaei[1] studied design, analysis and optimization of leaf spring. In their study they have replaced a steel leaf spring by a composite one. Primary target of their study was to design a spring that possess least weight and is capable of bearing a given static externalforce without any failure. They conducted work on a four-leaf steel spring which used in back suspension system of light and heavy vehicles. They used ANSYS V5.4 to study the four-leaf steel spring. Theyobtained the deflection and stress results and compared their results with analytical and experimental results available. Utilizing the results obtained for steel leaf spring they designed a composite leaf spring considering spring geometry optimization made of fiberglass with epoxy resin with stress and displacement as design constraints. They analysed this spring utilizing ANSYS and verified their results with experimental results and of finite element solution of same dimensions. They found that composite leaf spring weigh 80% less and stress developed is also less compared to steel leaf spring. The composite leaf spring natural frequency is found to be higher that of steel leaf spring and can avoid the resonance at the road.

M. Nataraj and S. Thillikkani [2] study the failure of leaf spring of the TATA LPT 1613TCIC model truck Thus a root cause analysis of the failure of leaf spring was carried out during this research. Then, based on this analysis report, a method to minimise the fracture growth by modifying the design parameters and material composition was conceived (Guimaraes et al., 2016). This research attempted to increase the safe stress and stiffness, and improve life cycle of the proposed model. The FEM method is an ideal tool, to find the payload and safe stresses for this kind of problem.

Rupesh N. Kalwaghe, K. R. Sontakke[3] conducted study on Design and Analysis of Composite Leaf Spring by Using FEA and ANSYS. They substituted a steel leaf spring by a composite leaf spring.Because for same load carrying capacity composite leaf spring possess high strength to weight proportion for same dimensions. A semi-elliptical composite multi leaf spring made of E-glass/epoxy is designed. Less stresses and deflection has been found for same load carrying capacity. Results compared well with the theoretical results.They had done a comparative study and found that composite leaf spring with E-Glass/Epoxy weighs 67.88% less compared to steel leaf spring. In their study they suggest to use E-glass/epoxy composite leaf spring from stiffness and stress perspective.

Ashish V.Amrute, Edward Nikhil karlus[4] studied design and evaluation of leaf spring. They targeted their study towards the comparison of composite leaf spring and steel leaf spring. Different comparison parameters were stress developed, weighing capacity and load carrying capacity.Tata ace ex vehicle leaf spring has been considered in the present study. In their study they have tried to replace the steel leaf spring by composite leaf spring. Bending stress has been found to be decreased by 25.05% i.e. for the same load carrying capacity less stresses developed in the composite leaf spring. The steel leaf spring weighs around 10.27kg while composite leaf spring with E-glass/Epoxy weighs just 3.26 kg. They concluded that the weight get reduced by 67.88%.

Y. N. V. Santhosh Kumar, M. Vimal Teja[5] Presented work on design and analysis of composite leaf spring . They also discussed the advantages of composite material like higher specific stiffness and strength, higher strength to weight ratio. This work deals with the replacement of conventional steel leaf spring with a Mono Composite leaf spring using E-Glass/Epoxy. For this they selected design parameters and analysis of it. Main objective of this work is minimizing weight of the composite leaf spring as compared to the steel leaf spring. For this they selected the composite material was E-Glass/Epoxy. The leaf spring was modeled in Pro/E and the analysis was done using ANSYS Metaphysics. From results they observed that the composite leaf spring weighed only 39.4% of the steel leaf spring for the analyzed stresses. So from result they proved that weight reduction obtained by using composite leaf spring as compared to steel was 60.48 %, and it was also proved that all the stresses in the leaf spring were well within the allowable limits and with good factor of safety. It was found that the longitudinal orientations of fibers in the laminate offered good strength to the leaf spring.

Malaga. Anil Kuma, T. N. Charyulu,[6] presented work on design optimization of leaf spring. The automobile industry has shown increased interest in the replacement of steel spring with composite leaf spring. Main purpose of this paper is to replace the multi-leaf steel spring by mono composite leaf spring for the same load carrying capacity and stiffness.Composite materials have more elastic strain energy storage capacity and high strength-to-weight ratio as compared to those of steel. It is possible to reduce the weight of the leaf spring without any reduction on load carrying capacity and stiffness. The design constraints were limiting stresses and displacement. Here the dimensions of a leaf spring of a light weight vehicle are chosen and modeled using ANSYS 9.0. As the leaf spring is symmetrical about the axis, only half part of the spring is modeled by considering it as a cantilever beam. Three different composite materials have been used for analysis of mono-composite leaf spring. They are Eglass/epoxy, Graphite/epoxy and carbon/epoxy. Static and model analysis has been performed. From results it is concluded that E-glass/epoxy has lower stresses among using three materials. So they suggested E-glass/epoxy composite material for replacement of steel leaf spring.

H.A.AI-Qureshi [8] studied on automobile leaf spring from composite materials. The aim of this paper is design, analysis & fabrication of composite spring. For this compact car is taken as prototype. A single leaf, variable thickness spring of glass fiber reinforced plastic with similar mechanical and geometrical properties to the multileaf steel spring was designed, fabricated and tested. Here they performed experiment in laboratory & was followed by road test. Field testing to determine ride characteristics were also carried out on a number of GFRP spring which were mounted in place of conventional steel spring on jeep. This test were limited to ride quality and sound observation on different road condition. From result it is observed that GFRP spring were more flexible then steel leaf spring.From test ride they observed that harshness & noise also reduced then steel leaf spring.Compared to the steel spring, the optimized composite spring has stresses that are much lower, the natural frequency is higher and the spring weight without eye units is nearly 80% lower.

Pozhilarasu V. and T ParameshwaranPillai [9] studied analysis of steel and composite leaf spring. They compared the conventional leaf spring and composite (Glass fibre reinforced plastic – GFRP) leaf spring. They used ANSYS software for studying conventional steel leaf spring and composite leaf spring for similar conditions. They fabricated a glass/epoxy composite leaf spring using hand layup method. The universal testing machine has been used to test the results of conventional steel and composite leaf spring. Under the same static loading condition deflection and stress of conventional steel and composite leaf spring has been obtained and results shows a wide difference between the results.

3. PROPOSED SYSTEM

This project is very informative project, in this i am going to study the Failure Analysis Of Without Eye leaf Spring Using FEM. for that I have studied 20 research paper, I have found that every one analysis on eye leaf spring that using in truck suspension. But I am doing analysis on the single eye leaf spring by using Finite Element System.

4. Analysis of Leaf Spring

4.1 Reasons to Perform Failure Analysis Testing

The failure analysis process provides a number of benefits including financial, legal and safety related outcomes:-

1. **Understand Root Cause of Failure**
   Understanding the root cause is often the fundamental part of the failure analysis process. This involves data collection to ascertain whether failure occurred due to manufacturing or material defect or misuse.

2. **Prevent Asset or Product Failues**
   Once the cause of failure has been determined corrective actions can be taken to prevent a recurrence of the problem.

3. **Improve Future Products and Processes**
   Manufacturing processes and product designs can be improved due to an understanding of the failure mode, not only to prevent the problem from happening again but also to prevent costly legal action or replacements as well as protecting a company's reputation.

4. **Meet Standards for Products and Assets**

Failure mode and effects analysis can help to meet standards for manufacturing processes, failed components, products, or assets going forward.

5. Determine Liability for Failure

A failure analysis will not only determine the root cause of the failure, but may also assign liability for the failure. This can be used in legal proceedings to not only apportion blame but also protect yourself from litigation.

4.2 Analytical Analysis

Analytical analysis is performed to obtain the load distribution on each wheel, either the maximum load or minimum load during the operation of the leaf springs. As it is known that the fine crack found in the material that leaded a bending load and resulted the stress intensity factor (K_I) around the crack tip. When the value of $K_I > K_{IC}$ (fracture toughness), the crack propagation will occur, but when $K_I < K_{IC}$, crack does not spread. Based on this understanding, the stress intensity factor was calculated using available data of the failure life spring [11-13]. Further analytical solution is explained in detail in sub sections.

4.3 Numerical Analysis

The simulation of collected data was done on the bolt hole area on leaf springs number eight. The usage of hole area due to the fracture failure is around it. From the result of simulation, the stress distribution known, as well as stress intensity factor and strain also obtained]. The steps and simulation process for numerical analysis were done using FEM software by giving fixed support on the spring eye. The loading type used was centralized load given on th.e bottom of the spring. The truck loading can be calculated by analytical analysis . The meshing steps used the obtained nodes number of 633438 and the number of elements of 5280.

4.4 Load Distribution Analysis.

Loading analysis is one method to determine the cause of damage to leaf springs due to overload, either static or dynamic. In determining the maximum and minimum load received by the spring on each wheel, a calculation was undertaken by applying Eq.1.4mgF×= (1) where F is the force (N) that occurs on the spring, m is the mass (Kg) of the vehicles the weight of, which is divided by the suspension system of the four wheels of the vehicle.

4.5 Stress Analysis

Stress calculations were performed to estimate the reduction in strength in the spring resulting from cracks existing before the accident and the midplane segregation. Exemplar spring test data were also used to provide a basis for estimating the reduction in strength. The reduction-in-strength estimates were then used to determine if normally expected dirt road forces in the absence of a large rock strike were adequate to rupture this spring. Finite-element stress analysis was used to study the existence of transverse tensile stresses at the location of the fracture.

4.6 Hardness of Failure Leaf Spring

The results of hardness test Hardness of Failure Leaf Spring horizontal axis from point A to B and vertical axis from C to D in the sum of 22 points. The distance between point approximately 2 to 5 mm. The hardness in the area close to the bolts whole or in middle of the spring is lower than of the ends of leaf spring. It shows that, the materials toughness on the center of the leaf spring higher than of the spring ends. This result is in agreed well with the result reported by previous researchers.

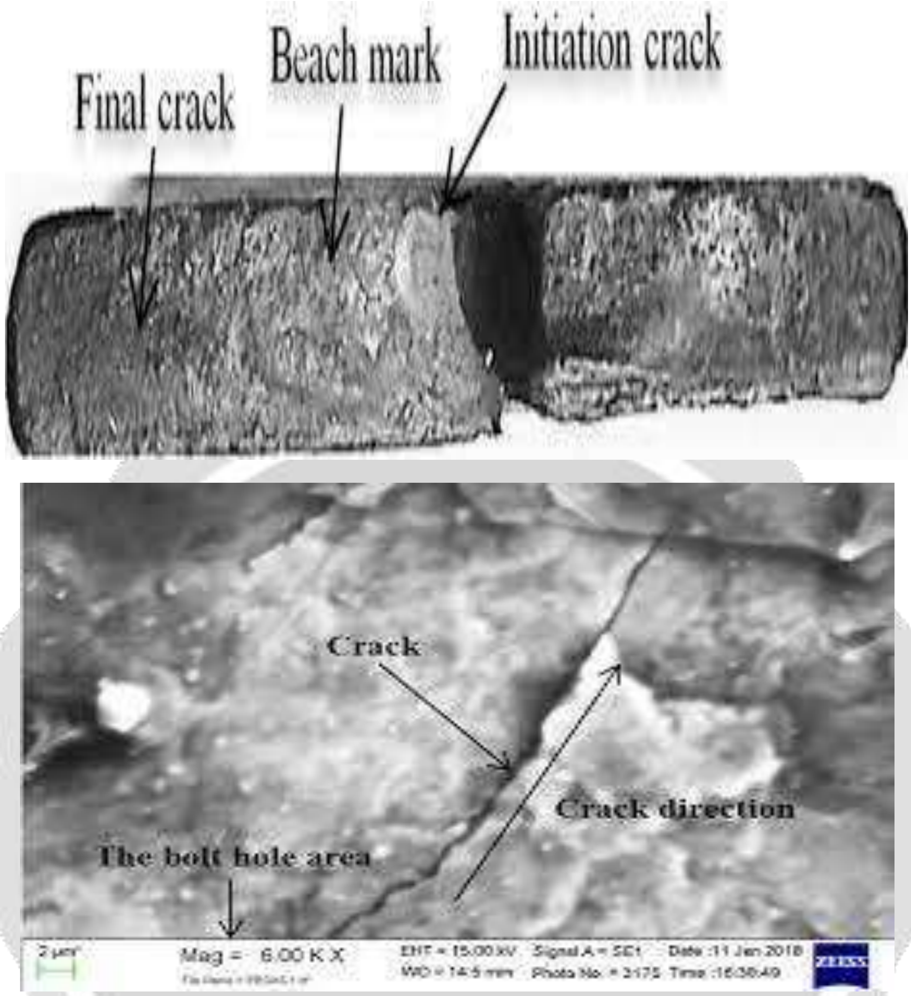

Fig 4.1:- Failure of Leaf Spring

CONCLUSION

The study done by us here gives a review on previous paper and journals based on different ideas and modifications with the help of mathematics, experiments, and computational methods. Now in this portion we concluded here the main parameters analyze by us from the study of these previous papers. The failure analysis yielded the following conclusions:

- The presence of sulfur segregation at the midplane weakened the spring.
- The spring was cracked for some time in advance of the accident
- The prior cracking in the spring was extensive enough to reduce the strength of the spring to the point where normal dirt road forces were adequate to produce rupture.
- Marks in the wheelwells and on the road surfaces were consistent with and support rupture of the spring at the start of the accident sequence.
- The rock strike possibility was ruled out because forces adequate to rupture the spring were present well in advance of the rock strike, and wheelwell marks were not consistent with short-duration forces expected from a rock strike.

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