

Leaf Spring Testing Machine: A Review

Mr. Satish Chandbodhale¹ Prof. C.C Handa²

¹M.Tech Student ²Professor

^{1,2}Department of Mechanical Engineering

^{1,2}KDK College of Engineering Nagpur, Maharashtra, India

Abstract— Spring is basically an elastic body whose purpose is to distort under loading conditions and consequently store energy and releases it slowly or rapidly depending on the particular application. The spring needs to be tested before its final assembly. For automotive springs, the most relevant performance characteristic is stiffness under load.. Stiffness of the spring means load required for unit deflection, it is also known as spring index and is main parameter for specification of springs. Springs like Compression helical spring, Tension helical spring, Leaf spring of various sizes and shapes are designed and manufactured. But to check their stiffness is very difficult unless we have such machine. Leaf spring Stiffness checking machine is useful for spring manufacturer as well as spring purchasers for checking the stiffness. It involves the designing and analyzing of leaf spring testing machine. The suspension mechanism in a automobile significantly affects the behavior of vehicle. Leaf springs are subjected to millions of varying stress cycles loading to fatigue failure. So, it becomes mandatory to check for the spring stiffness and its strength before it is installed to perform for any applications.

Key words: Leaf Spring, Spring Testing, CAD, Hypermesh

I. INTRODUCTION

A spring is an elastic member, whose function is to change its shape when loaded and to recover its original shape when the load is removed. The suspension leaf spring is one of the potential and most critical components of automobile vehicle which is helping for improving of riding quality of automobile vehicle. The main purpose of springs is to absorb, store and release energy. Leaf plays a vital role in supporting lateral loads, shock loads, brake torque and driving torque.

Leaf springs are almost widely used for suspension system in light and heavy automobiles. For cars also, these are universally used in rear suspension. The leaf spring consists of a number of leaves called blades. The blades are varying in different lengths. The blades are generally provided an initial curvature or cambered so that they will tend to straighten under the load. The leaf spring is based upon the beam theory. The lengthiest blade has circular ends basically known as parent or master leaf, the remaining blades are called graduated leaves. All the blades are bound together by means of steel straps.

Leaf spring ends are guided along a definite path so as to act as a structural member in addition to shock absorbing device, this is the main advantage of leaf spring over helical. This is the reason why leaf springs are still used widely in a variety of automobiles.

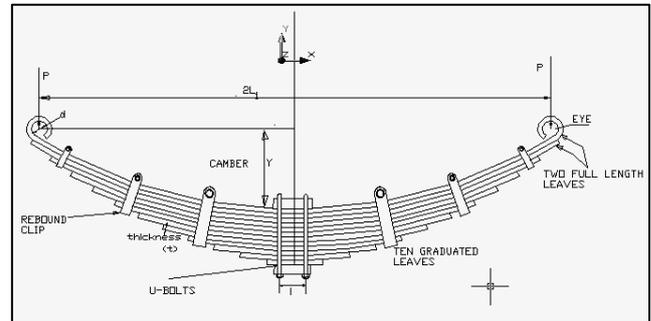


Fig. 1: leaf spring nomenclature

II. OBJECTIVES

To design a machine that performs the given functions, such as:

- To study the existing spring testing machine available
- The mechanism used to test the important parameters/properties of leaf spring
- For the predefined force value, what is the displacement of spring.
- For the predefined displacement, what is the force on spring.
- To determine the strength of the spring under given load.

This project is an industrial project for Dulocos Conveyors And Moulds Private Limited . It involves the designing and analyzing of leaf spring testing machine.

The Dulocos Conveyors and Moulds Private limited manufacture the special purpose machines, Jig fixture, Press tools etc. as per the specifications and requirements of the client.

III. LITERATURE REVIEW

The purpose of a literature review is to establish a theoretical framework for the subject area. To ensure you have a thorough understanding of the topic. To identify potential areas for research. To identify similar work done within the area. Identifying knowledge gaps that demand further investigation. Thus a comprehensive review of the literature is important because it provides an up-to-date understanding of the subject and its significance to practice, identifies the methods used in previous research on the topic, provides comparisons for own research findings.

A. Pratiksha Padmakar Shahane [1]

A leaf spring is a simple form of spring, commonly used for the suspension in wheeled vehicles.

Leaf Springs are long and narrow plates attached to the frame of a trailer that rest above or below the trailer's axle. For safe and comfortable riding, to prevent the road shocks from being transmitted to the vehicle components and to safeguard the occupants from road shocks it is necessary to determine the maximum safe stress and

deflection. The objective is to find the stresses and deformation in the leaf spring by applying static load on it. These values are calculated analytically, by using finite element analysis and experimentation. Therefore in the present work, leaf spring is designed by considering static load on vehicle. The model of leaf spring is created in CATIA V5 and analysis is done using ANSYS 14.5 workbench. The experimental result for stress and deformation is in close agreement with FEA and analysis result.

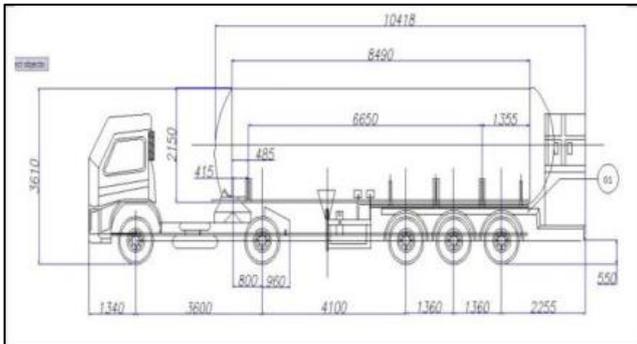


Fig. 2: Vehicle specification

From the study of this literature we obtained Maximum load acting on single spring for Tata LPS 4018 Tanker trailer.

B. Matthew Sunday Abolarin [2]

A spring stiffness testing machine was produced which differentiates a good spring from bad one using hydraulic principle and locally sourced materials were used to produce at relative low cost and high efficiency. It also categories each spring by stiffness into one of several distinct categories based on its performance under test. This is to ensure that in the final assembly process, springs with similar performance characteristics are mated to ensure a better ride, more précised handling and improved overall vehicle or equipment performance. The construction of the machine involves basically the fabrication process which includes such operation as cutting, benching, welding, grinding, drilling, machining, casting and screw fastening. Taken into consideration under test, were types of compression springs with varying spring loading and their different displacement recorded at different pressures to compare their stiffness.

C. Mr. Ajay D. Dighe [3]

This study gives a brief idea about fabrication and testing procedure of steel leaf spring. The efforts have been taken for sequential analysis of leaf spring. It includes static test, fatigue test, macroscopic inspection and metallographic analysis of leaf spring. For the static test, specimens are tested on Universal testing machine (UTM) and numerical analysis is done via (FEA) using ANSYS software. Stresses and deflection results are verified for analytical and experimental results. The fatigue tests are conducted on hydraulic-fatigue testing machine under fluctuating loads. Generally, the origin of premature fracture in leaf springs is at the hole region where there is a high stress concentration. The stress concentrators included the complex geometry of the hole, its sharp corners, notches caused by the bolt thread and various surface defects such as scabs and rolling lines in the starting sheets of unclean steel. For the detail analysis of

causes of failures, the fracture surface must be inspected for Macroscopic Inspection test, Chemical analysis and Metallographic Analysis. These tests give detail idea about causes of failure from metallurgical and morphological point of view. Generally there is a steel decarburization on fracture surface during the manufacturing process, which led to inadequate hardness in the springs and the local presence of soft products (ferrite) in the material structure.



Important observation is, It includes static test, fatigue test, macroscopic inspection and metallographic analysis of leaf spring. For the static test, specimens are tested on Universal testing machine (UTM) and numerical analysis is done via (FEA) using ANSYS software.

D. Hareesh K & Thillikkani S [4]

The aim of this paper is to represent a general study the design and analysis of leaf spring. The suspension system in a vehicle significantly affects the behavior of vehicle. Leaf springs are subjected to millions of varying stress cycles loading to fatigue failure.

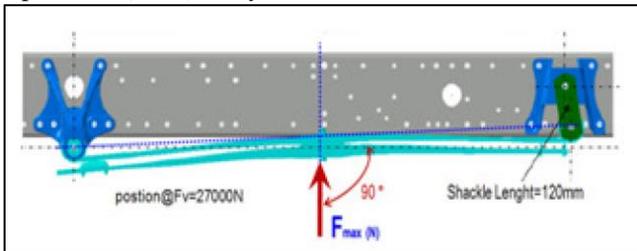
The main function of leaf spring is not only to support vertical load but also to isolate road induced vibrations. The present work attempts to linear Static analysis determines the safe stress and corresponding pay load of the leaf spring and analyze the safe load of the leaf spring. Which will indicate the speed at which a comfortable speed and safe drive is possible. A typical leaf spring configuration of TATA-407 light commercial vehicle is chosen for study. Finite element analysis has been carried out to determine the safe stresses and pay loads and done the simulation also.



From the above literature it is observed that leaf springs are subjected to millions of varying stress cycles loading to fatigue failure.

Ahmet Kanbolat , Murathan Soner [5] This paper presents a more precise method based on non-linear finite element solutions by evaluating the effects of the production parameters, the geometrical tolerances and the variations in the characteristics of the material. In other words, it is a hybrid method, between the traditional and the recent ones, which correlates the real life conditions and the results of computer aided engineering. The leaf springs in different characteristics have been produced and tested in the plant of Olgun Celik plant.

The design methodology of this paper brings also a practical approach to the professionals in the industry. It aims to create a design tool with 2D FEA which is well correlated with 3D. The correlation of 3D and simple 2D methods with experiments are validated through a design of experiment (DOE) study.



From this article it is concluded that Load is gradually increased from 0 to maximum load which describes the fully loaded vehicle condition. Design load F_v is less than maximum load and describes normal loaded vehicle condition

E. Ruchik Tank , Srinivas Kurna [6]

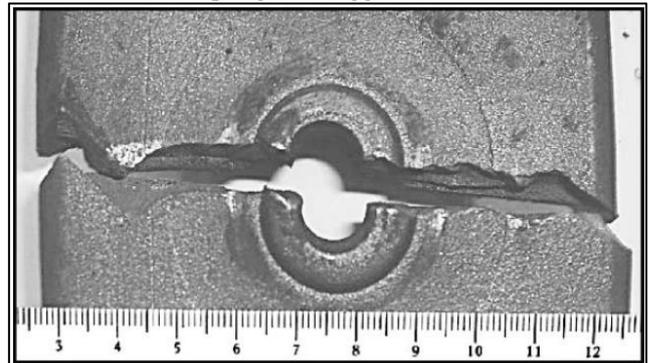
A study has been done in Volvo-Eicher Commercial Vehicles to correlate Rig result with Finite Element Analysis (FEA) simulation result of Multi-stage Suspension Leaf Spring, entirely through Finite Element Analysis route. Correlations have been achieved in both Stiffness and Stress at strain gauge locations between the Rig test and Computer Aided Engineering (CAE) results. Correlation has helped in reducing product design time and cost of running the rig for failure prediction. Thus, this process has indirectly reduced the cost by using soft validation.



From this literature we studied the boundary conditions for testing machine are In rig test, Leaf spring suspension bracket were considered rigidly connected to the test bed with rotational bushes at leaf end & shackle. Therefore in simulation, the ends are fixed in all degrees of freedom except rotation about X-Axis. After the bolt

preload, test actuator displacement is applied to the centre of the leaf spring and ramped up to sufficient duration.

J.J. Fuentes a, H.J. Aguilar [7] In this work, the origin of premature fracture in leaf springs, used in Venezuelan buses, is studied. To this end, common failure analysis procedures, including examining the leaf spring history, visual inspection of fractured specimens, characterization of various properties and simulation tests on real components, were used. It is concluded that fracture occurred by a mechanism of mechanical fatigue, initiated at the region of the central hole, which suffered the highest tensile stress levels. Several factors (poor design, low quality material and defected fabrication) have combined to facilitate failure. Preventive measures to lengthen the service life of leaf springs are suggested.



It is concluded that fracture occurred by a mechanism of mechanical fatigue, initiated at the region of the central hole, which suffered the highest tensile stress levels. Several factors (poor design, low quality material and defected fabrication) have combined to facilitate failure.

F. M. M. Patunkar, D. R. Dolas [8]

Leaf springs are one of the oldest suspension components they are still frequently used, especially in commercial vehicles. This part is focused on is the automobile industry has shown increased interest in the replacement of steel spring with composite leaf spring due to high strength to weight ratio. Therefore, analysis of the composite material becomes equally important to study the behavior of Composite Leaf Spring. The objective of this paper is to present modeling and analysis of composite mono leaf spring (GFRP) and compare its results. Modelling is done using Pro-E (Wild Fire) 5.0 and Analysis is carried out by using ANSYS 10.0 software for better understanding.

Conventional Leaf spring show failure at eye end only. At maximum load condition also Composite Leaf Spring shows the minimum deflection as compared to Steel Leaf Spring.

IV. CONCLUSION

The paper covers study of design and analysis of spring testing machine for leaf type springs. In this article we have studied and presented the previous research literatures in detail. The study will help in design and analysis of the Leaf spring testing machine based on the literature concepts. This can help fulfilling the industry testing requirement.

REFERENCES

- [1] DESIGN AND ANALYSIS OF LEAF SPRING FOR TANKER TRAILER SUSPENSION SYSTEM by Pratiksha Padmakar Shahane, Global Journal of Advanced Engineering Technologies Volume 4, Issue 3- 2015
- [2] American Journal of Engineering Research Design and Construction of a Spring Stiffness Testing Machine by Olugboji Oluwafemi Ayodeji, Matthew Sunday Abolarin , Jiya JonathanYisa ,Alaya Garba Muftau, Ajani Clement Kehinde (Mechanical Engineering Department, Federal University of Technology, Minna, Niger State, Nigeria.
- [3] International Research Journal of Engineering and Technology "A REVIEW ON TESTING OF STEEL LEAF SPRING" by Mr. Ajay D. Dighe, Mechanical Engineering Department, Pravara Engineering College, Loni, Maharashtra, India.
- [4] Design and analysis of leaf springs using the FEA approach by Hareesh and Thillikkani, Mechanical Engineering, Vidya Academy of Science and Technology Thrissur - 680501, India.
- [5] Parabolic leaf spring optimization and fatigue strength evaluation on the base of road load data, endurance rig tests and non linear finite element analysis by Ahmet Kanbolat , Murathan Soner, Mustafa Karaagaç, Tolga Erdogus
- [6] "Investigation of Stresses and Deflection in Multi Stage Leaf Spring of Heavy Duty Vehicle by FEM and Its Experimental Verification" by Ruchik Tank, Srinivas Kurna .
- [7] "Premature fracture in automobile leaf springs" by J.J. Fuentes, H.J. Aguilar a, J.A. Rodríguez b, E.J. Herrera, Engineering Failure Analysis 16 (2009) 648–655
- [8] "Modelling and Analysis of Composite Leaf Spring under the Static Load Condition by using FEA" by M. M. Patunkar¹, D. R. Dolas, International Journal of Mechanical & Industrial Engineering, Volume 1 Issue 1-2011
- [9] "Different types of spring testing machines" research paper presented at National conference SPARK event at KDK college of engineering Nagpur on 16/03/2018".