Design and Analysis of Leaf Spring Used In Heavy Truck

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***Abstract*- this study presents a fatigue life prediction based on finite element analysis under non constant amplitude proportional loading. Parabolic spring is the vital component in a vehicle suspension system, commonly used in trucks. It needs to have excellent fatigue life and recently, manufacturers rely on constant loading fatigue data. The objective of this study is to simulate the non-constant amplitude proportional loading for the fatigue life analysis. The finite element method (FEM) was performed on the spring model to observe the distribution of stress and damage. The fatigue life simulation was performed and analyzed for materials SAE1045-450-QT, SAE1045-595-QT, and SAE5160-825-QT. when using the loading sequences is predominantly tensile in the nature; the life of mounting in Goodman approach is more conservative.**

Index Terms- fatigue life of leaf spring, leaf spring, fatigue life analysis, stress distribution.

I. INTRODUCTION

A spring is defined as an elastic body, whose function is to distort when loaded and to recover its original shape when the load is removed. Leaf springs absorb the vehicle vibrations, shocks and bump loads (induced due to road irregularities) by means of spring deflections, so that the potential energy is stored in the leaf spring and then relieved slowly. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system. Semi-elliptic leaf springs are almost universally used for suspension in light and heavy commercial vehicles. For cars also, these are widely used in rear suspension. The spring consists of a number of leaves called blades. The blades are varying in length. The blades are us usually given an initial curvature or cambered so that they will tend to straighten under the load. The leaf spring is based upon the theory of a beam of uniform strength. The lengthiest blade has eyes on its ends. This blade is called main or master leaf, the remaining blades are called graduated leaves. All the blades are bound together by means of steel straps.

II. LITERATURE SURVEY

A. Review on Leaf Spring Type Suspension System by Prasanna D. Dhumal, Mayur S. Jadhav, Rushabh S. Tawar, Sameer A. Agrawal

Today suspension system is an integral part of the automotive functioning. This review observes the key areas of designing the suspension system from the aspect of durability, failure analysis and some novel methodology adopted for quick and effective design. Low cost and high reliability of the leaf springs makes them suitable for commercial vehicles even today. Fatigue analysis of the springs to the increased load and its failure at certain cycles is an assessment of the current design process. Along with vertical static loads, a number of loads are analysed and taken into consideration.

B. Fatigue Failure Analysis & Validation of Mono Leaf Spring Design by Ajinkya Mahadev Mahajan, 2A. P. Shrotri, 3Swapnil Kulkarni

Leaf spring is widely used in automotive and one of the components of suspension system. It consists of one or more leaves. As a general rule, the leaf spring must be regarded as a safety component as failure could lead to severe accidents. The leaf springs may carry loads, brake torque, driving torque, etc. In addition to shocks the multi-leaf spring is made of several steel plates of different lengths stacked together as shown in figure 1. During normal operation, the spring compresses to absorb road shock. The leaf springs bend and slide on each other allowing suspension movement. Fatigue failure is the predominant mode of in-service failure of many automobile components. This is due to the fact that the automobile components are subjected to variety 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.

C. Design of Experiments For Optimization Of Automotive Suspension System Using Quarter Car Test Rig by Anirban C. Mitraa*, Kiranchand G. R.b, Tanushri Sonic, Nilotpal Banerjeed

The recent years have witnessed an accelerated invention and innovation in suspension design. This project aims at finding the ideal combination of suspension and steering geometry parameters viz. tire pressure (typ), damping coefficient (cs), spring stiffness (ks), sprung mass (m), camber (cma), toe (toe) and wheel speed (N), so that the Ride Comfort (RC) is increased while maintaining an optimal degree of Road Holding (RH) using Design of Experiments. The high R-sq value of 97.70%, R-sq (pred) value of 91.85% and the R-sq (adj) value of 95.81% for RC and the corresponding values of 97.99%, 92.98% and 96.33% respectively for RH show the high reliability and predictability of the experimental models. The experimental models were then validated by executing the optimized set on the test rig with an average accuracy of 80%.

D. Fatigue life prediction: A comparative study for a three layer EN45A parabolic leaf spring by Krishan Kumar* and M. L. Aggarwal

There are literally several studies accomplished to predict the fatigue life of leaf springs but estimation of fatigue life of a parabolic leaf spring by using CAE tools has not yet been executed in the past. Parabolic spring is an important component in a vehicle suspension system. It needs to have excellent fatigue life and in today's scenario manufacturers rely on constant loading fatigue analysis. The objective of this work is to perform the fatigue analysis of parabolic leaf spring by three different methods where CAE analysis is performed to observe the distribution of stress fatigue life and damage using Goodman approach. In this work, fatigue life of the parabolic leaf spring is determined as per SAE spring design manual and experimentally by testing on full scale fatigue testing machine. ANSYS is used for CAE solution for the prediction of leaf springs fatigue life considering stress theory. The fatigue life estimated by all three modes is then compared for the purpose of validation. The methodology used in this paper brings a practical approach to the professionals in the industries who are engaged for design of mechanical components.

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