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Review Over A Leaf Spring for Automobile Suspension System

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ABSTRACT

The aim of this paper is to represent general study of design & analysis of leaf spring. Leaf springs are normally used in the vehicle suspension system . Many research paper has been done for improving the performance of leaf spring. The automobile industry has shown interest in the replacement of steel spring with composite leaf spring. In this paper is also analysis of failure in leaf spring. The automakers can reduce product development cost and time. The predictive capability of computer aided engineering tool has progressed to point where much of the design verification is now using computer simulation rather than physical prototype testing.

Keyword- Leaf spring; CAE tool.

1. INTRODUCTION

A leaf spring is a simple form of spring, commonly used for the suspension of wheeled vehicles. Originally called a laminated or carriage spring and sometime referred to as a semi-elliptical or cart spring.The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the unstrung weight. The introduction of composite materials have made it possible to reduce the weight of leaf spring without any reduction on load carrying.CAE has become an important technology with benefits such as lower costs and a shortened design cycle.

2. LITERATURE REVIEW

Rajendran , S.Vijayarangan[1]has presented an artificial genetics approach for the design optimization of composite leaf spring. The design Va variable (thickness and width) of steel and composite leaf springs are optimized by making use of GA (Genetic Algorithm). Optimization using GA has contributed to a reduction of 8% of the steel spring weight and 23.4% of the composite spring weight.

H.A. Al Qureshihas described a single leaf, variable thickness spring of glass fiver reinforced plastic (GFRP) with similar mechanical and geometrical properties to the multi-leaf steel spring was designed, fabricated and tested.

M.L Aggarwal, V.P. Agrawal, R.A. Khan[5]has calculated fatigue strength of shot peening leaf spring from laboratory samples of EN45A spring steel specimen. A lot of research has been done to improve fatigue strength of material by creating compressive residual stress field in their surface layers through shot peening.

W. Hufenbach & F. Adamhas presented a method to adjust the spring rate of an leaf spring element. For dimensioning of this system a strategy was developed and validated. The tests of manufactured leaf spring elements with different reinforcements show a good agreement between the calculation and themeasured characteristic.

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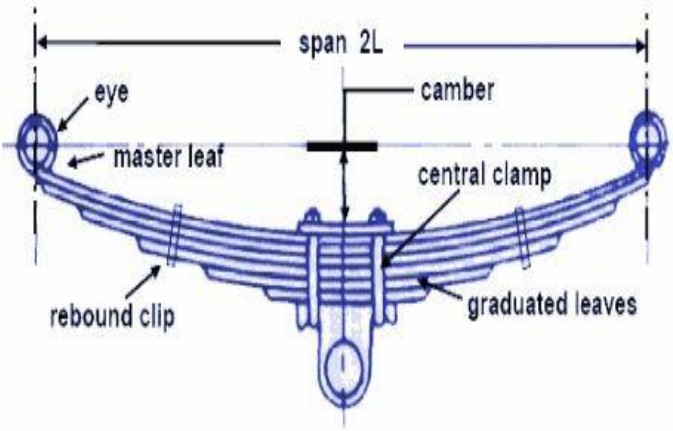
V. B.Vijaya Lakshmihas presented the static analysis on 8-leafs we can concluded that E-glass epoxy is better than using Mild-steel as though stresses are little bit higher than mild steel, E-glass epoxy is having goodyield strength value (5e+008N/m 2) and also epoxy.

3. LAMINATED SEMI-ELLIPTICAL SPRING

The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the un-sprung weight.

This helps in achieving the vehicle with improved reading qualities. It is well known that springs, are designed to absorb & store energy and then release it. Hence, the coefficient of friction and frictional losses between the leaves, the load carrying capacity can be increased and weight of the assembly can be reduced further without any modification in stiffness. The advantages of leaf spring is that it carriage lateral loads, braking torque, driving torque in addition to shock absorbing.

The ends of the spring may be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing capability. Generally conventional leaf springs are stacked & clamped together with pins and clips. The stacked leaf spring generally has high inter leaf frictional losses at varies vehicle dynamic load conditions.



Fig(1). laminated semi-elliptic leaf spring

As an additional aspect a lubricating substance of graphite grease or graphite primer is coated on the tension side of the leafs to reduce interleaf friction. But due to the operation conditions and weather the coating materials degrade leading to the increased friction between the spring leafs.

3.1 LEAF SPRING FAILURE

The fracture of spring occurred at the formed forward eye,as Fig.1 showing. in comparison of the eye with unbroken springs revealed that it had somewhat unwrapped prior to the failure.The position of the two broken ends in Fig.1 exaggerates the prior deformation.Striking features of the fracture were the presence of extensive secondary cracking at the mid-plane,the stepped nature of the fracture,and "woody fracture "on the stepped surface parallel to the spring surface.

Fig(2). The broken halves of the spring have been placed in a manner exaggerating the opening of the eye before rupture.

The determination of the failure during an accident sequence of a rear leaf spring in a sport utility vehicle is presented in terms of fracture surface analysis and residual-strength estimates. Marks at the scene of the accident pointed to two possibilities for the point of failure: marks in the roadway at the start of the accident sequence and a rock strike near the end of the sequence.

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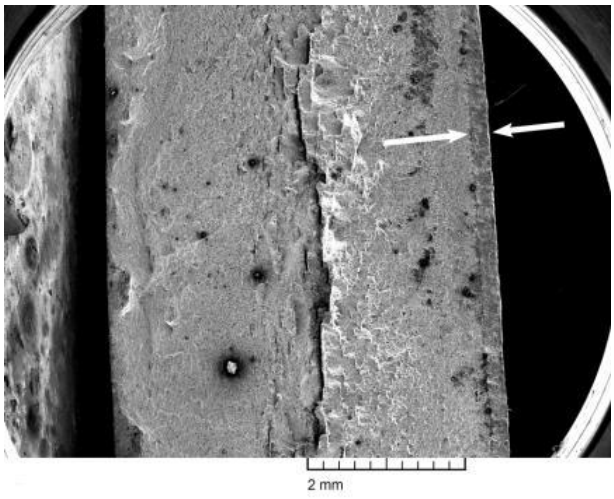

Fig.(3) A Secondary cracks at the mid-plat

The point of failure of the spring was placed at the start of the accident sequence. A scanning electron microscope (SEM) was used to examine the fracture on the eye at higher magnifications. Examination of the mid-plane fracture was difficult because the mid-plane fracture surface faced the surface of the spring itself. Such a geometry creates single detection problem, practically for X-ray analysis. However significant result were achieved by repeated repositioning of the spring eye.

The SEM fractograph of the spring eye fracture in fig. a clearly shows the mid-place cracking and Old crack along the outside diameter (OD) surface.

3.2 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. A limited finite-element analysis using the commercial finite-element code ALGOR (ALGOR, Inc.) was conducted on the spring eye stress conditions in order to examine the transverse stresses. The leaf spring was secured directly to the vehicle frame at the forward and through a shackle assembly at the after end. This arrangement in fig. 4.

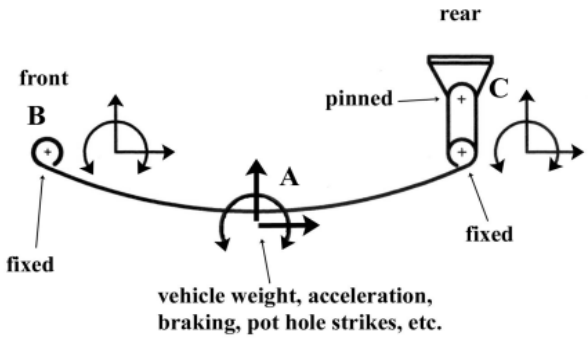

Fig. 4 Reaction forces on the spring eye in the vehicle.

These crack depth measurement for the old OD crack, produce as estimate of 1460 MPa for as outer fiber bending stress required for spring fracture.

CONCLUSION

The composite leaf spring is lighter than conventional steel leaf spring with similar design specifications but not always is cost- effective overtheir steel counterparts. Composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel. Therefore, it is concluded that composite leafspring is an effective replacement for the existing steel leaf spring in automobile.

- E-glass epoxy is better than using Mild-steel as though stresses are little bit higher than mild steel, E-glass epoxy is having good yield strength value.
- 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.

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