Design and Analysis of Molybdenum Disulphide Coated Leaf Spring

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Abstract— The auto mobile industry has shown in interest in the replacement of steel spring with composites for the purpose of high strength to weight ratio. The composite material like fiber glass, fiber, polymers were leads to high production cost and requires design modification. But in existing leaf spring are made by materials like carbon steel (C, Si, Mn etc.) and alloy steels (Cr,V,S,Ph etc.) which has the spring material have problem in deflection and can't withstand high load. So this paper deals to avoid the above problems by using surface coating on leaf spring and also changing the shape of the spring from hyperbola into parabola which helps to increases the deflection of the spring for high loads. Because of above reliability of the spring also increased with low fabrication cost.

Key words: Leaf spring, Molybdenum disulfide (MoS2), dry film coating, NASTRAN

I. INTRODUCTION

Limitations to the further advance of manufacturing industry in the 21st century are most likely to be surface-related. Many mechanical systems will operate under ever more severe application conditions, such as intensive loads, high speeds and harsh environments, in order to achieve high productivity, high power efficiency and low energy consumption. Consequently, many challenging complex design situations have emerged where the combination of several properties (such as wear resistance, load bearing capacity, and fatigue performance) are required. Poor design and improper service conditions are the cause of 15% of down time, while improper selection and poor manufactures of surface layers are responsible for as much as 85% of failures. It is an urgent topic to get the understanding of coating deposited on substrate with different surface and mechanical properties. Dry film coating is a popular low friction coating used widely in machinery equipment to release various wears damages. The difference in surface roughness of the substrate induced by different pre-treatment may result in different adhesion strength of the coatings deposited. Hence this paper selected is to make the investigations on surface modified laminated leaf spring.

A Shankara,Pradeep L Menezes, the addition of zirconia and graphite into the MoS2 lubricant has improved its properties in terms of both friction and wear.

Vivek Rai , Gaurav Saxena, the composite materials have more elastic strain energy storage capacity and high strength-to-weight ratio as compared to those of steel.

Shishay Amare Gebremeskel, The constant cross section design of leaf springs is employed to take advantages of ease of design analysis and its manufacturing process. And it is shown that the resulting design and simulation stresses are much below the strength properties of the material, satisfying the maximum stress failure criterion.

Filip I. ILIE, investigated the tribological properties of solid lubricant coatings from MoS2 nanoparticles. The MoS2 were deposited on alloy substrate by magnetron sputtering. The MoS2 /Ti nanocomposite coating showed lower frictions coefficient and higher wear resistance as compared to the pure MoS2 coating,

II. MODEL DECRYPTION

The leaf spring or laminated leaf spring consists of a couple of full-length leaf and a number of graduated leaves. The thickness of the whole spring is maximum at the centre and is gradually decreases towards the ends.

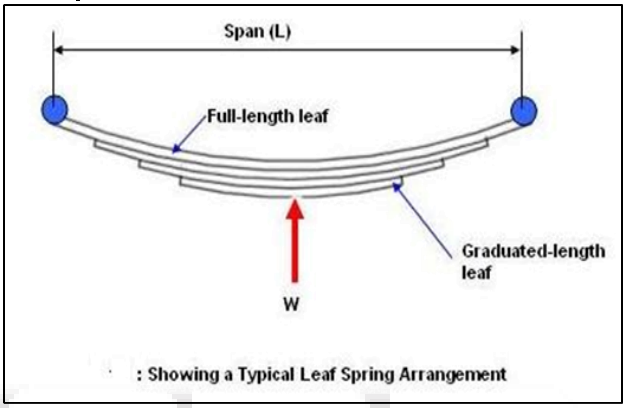

Fig. 1: Showing a typical leaf spring

A. Design of Leaf Springs

Leaf spring design is based on the fundamental beam theory. The following two formulas for the leaf spring design process

– Bending stress produced in the whole spring:
  σb= (3*W*L)/ (b*N*t^2)
– Maximum deflection in the whole spring:
  δ= (6*W*L^3)/[{(2+(n/N)}*E*N*b*t^3]

Parameters	Value
Total Length of the spring (Eye to Eye)	1540 mm
Free Camber (At no load condition)	136 mm
No. of full length leave (Master Leaf)	01
Thickness of leaf	13 mm
Width of leaf spring	70 mm
Max^m Load given on spring	25 Kg

Table – 1 Specification of Existing Leaf Spring

Fig. 3: Modified cad model

Parameters	Value
Total Length of the spring (Eye to Eye)	1550 mm
Free Camber	130 mm

(At no load condition)	
No. of full length leave (Master Leaf)	01
Thickness of leaf	15 mm
Width of leaf spring	65 mm
Max^{m} Load given on spring	35 Kg

Table – 2: Specification of Existing Leaf Spring

III. DRY FILM COATING

Dry film coatings are solid materials that provide low frictional resistance between surfaces when applied directly to interacting surfaces. Each material has different properties. Crystalline lattice (lamella) structure materials, such as molybdenum disulfide, tungsten disulfide and graphite are widely used ... Lamella powders have low shear forces between their crystalline lattice layers that minimize resistance between sliding surfaces.

IV. MOLYBDENUM DISULPHIDE

MoS2 occurs naturally in the form of thin solid veins within granite. It is mined and highly refined to achieve purity suitable for lubricants. MoS2 has a hexagonal crystalline structure. operty of easy shear occurs at the interface between the sulfur molecules

V. MODELING AND MESHING

The modeling was done using the CAD software SOLID WORKS, the data for designing was collected from the existing leaf spring. The model was then imported to a meshing tool surface mesh was generated and volume mesh was created. The meshing details and the boundary conditions are as follows.

FEA Elements details

- CQUAD4 -16122
- CTRIA3 - 36
- RBE2 - 02
- RBE3 - 01
- Total - 16161

A. STATIC/Dynamic Analysis

Vertical LOAD 1000N applied @ Node ID 1000.
Fixed at Node ID 1001, and 1002.
Strain Energy Plot
Displacement Plot (Z Axis Translation).
Rigid Body Modes + Flexible modes up to 1500Hz

VI. ANALYSIS

After the model design it has been meshed and coating properties are applied for the analysis. The results are listed below.

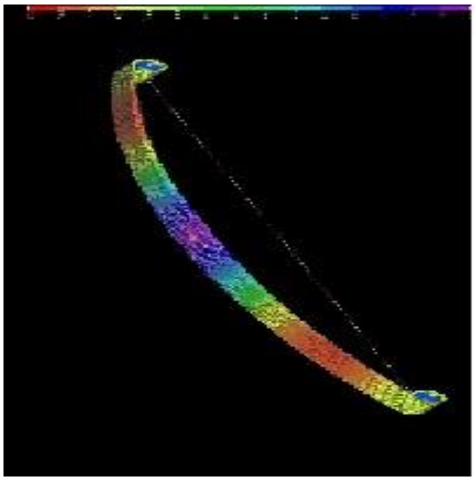

Fig. 4: FEA Model of Leaf spring

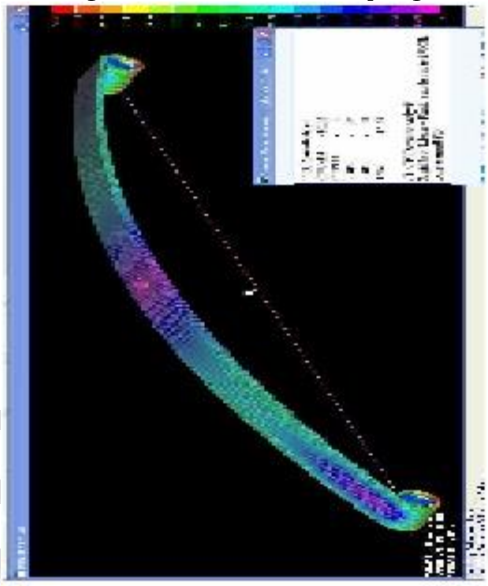

Fig. 5: Static Analysis of Displacement Plot

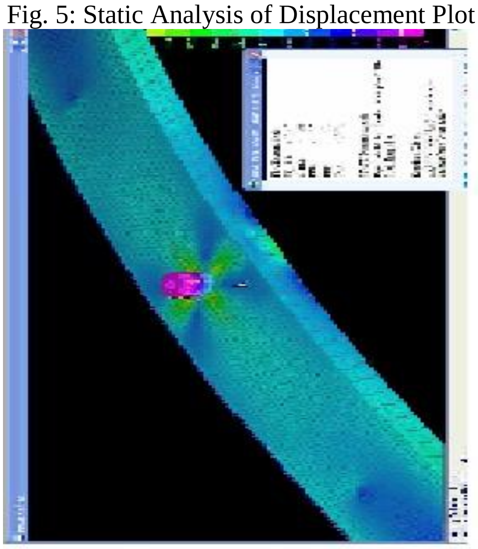

Fig. 6: Static - Dynamic Analysis of Strain Energy Plot

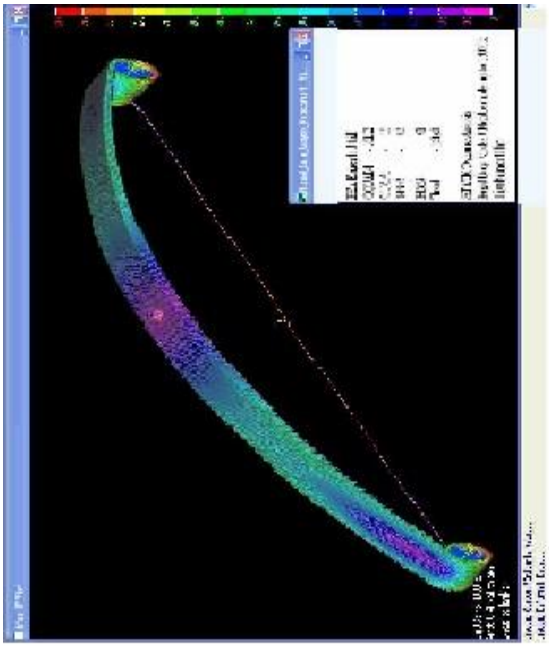

Fig. 7: Static - Dynamic Analysis of Displacement Plot

VII. CONCLUSION

The Graphs reveals that the leaf spring after MoS2 coating has the better stiffness than before MoS2 coating. The CAE results are inline with testing result of before and after coating. The Analysis carried out on linear basis, but testing has considered bon linear effect, (ex: - Prestressed) Due to the non linear testing it exhibits more deflection than CAE results.

The importance of the tribological design of the frictional components of the automotive elements has been emphasized from the point of importance of improved modeling behavior and to the enormous prospect for optimized design based on surface profiles and surface finish considerations.

The thin film MoS2 coating have the improved mechanical properties including life, no contamination and usage in harsh environments, especially nanosized MoS2, presents considerable applications in fields.

In addition to new lightweight vehicle bodies, a new weight saving design is through a spring design that optimizes the use of the properties of the steel from which it is made available for commercial vehicles.

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