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Experimental analysis of molybdenum disulphide coating leaf spring

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Abstract - *The main focus of automobile manufacture industry is the replacement of steel leaf spring with Molybdenum disulphide surface coating for the purpose of high strength, impact strength and bear high load. The composite material like fiber, fiber glass, polymers, were leads to high production cost and also it needs some design change. But in present leaf spring are made by alloy steels (Cr, V, S, Ph etc.) And carbon steel (C, Si, Mn etc.) which has deflection problem in spring material (fail from fatigue caused by the repeated flexing of the spring) cannot bear high loads. Corrosion is one of the major factors in reducing spring life. So this paper deals to rectify the above problems by using surface coating on leaf spring, which helps to increases the life time of the spring and also spring bears for high loads. Because of above reliability of the spring also increased with low fabrication cost. The objective of this paper is to replace the original leaf spring of TATA ACE vehicles by molybdenum disulphide surface coating leaf spring. Analysis is done experimentally we can observe that the surface coated leaf spring have improved the load carrying capacity, high strength and the life time.*

***Key Words*: molybdenum disulphide, high strength, impact strength, bear high load, carbon steel, alloy steel , surface coating, Analysis.**

1. INTRODUCTION

Leaf spring should absorb impact loads and vertical vibrations due to road abnormalities by means of spring deflection variation, the potential energy is stored as strain energy and then slowly released in leaf spring. Recent day's many automobile manufacturing industries using surface coating process. Many mechanical methods will function under ever more severe application conditions, such as high speeds, heavy loads, and harsh environments, in order to achieve high productivity and low energy consumption. Consequently, many exciting complex design situations have developed where the combination of several properties such as load bearing capacity, fatigue performance and wear resistance are required. Poor design and improper service conditions are the cause of 25% of down time, while improper selection and poor manufactures of surface layers are responsible for 75% of failures. It is a vital topic to get the understanding of coating deposited on different surfaces and mechanical properties. Dry film coating reduces friction, which widely used in machinery equipment to release various wears damages. The difference in surface roughness of the substrate induced by different pre-treatment process which may result in different adhesion strength of the coatings deposited. Hence this paper selected is to make the investigations on surface modified molybdenum disulphide coated leaf spring. The coating materials have more elastic strain energy storage capacity and high strength-to-weight ratio as compared to those of steel.

2 LITERATURE REVIEW

Mr.Sethu Ramalingam,C.Murugan,G.suresh,S.Bharanikumar [13]had done design and analysis of molybdenum disulphide coated leaf spring. The spring material have problem in deflection and high load. To avoid this they used surface coating on leaf springs and also changing the shape of the spring from hyperbola to parabola.

A Shankara,Pradeep L Menezes,[14] says that by adding graphite and zirconium into the MoS_2 lubricant has improved its properties in terms of both friction and wear.

Vivek Rai , Gaurav Saxena,[21] says that the coating materials have high strength-to-weight ratio and more elastic strain energy storage capacity as compared to those of steel.

3 PROBLEM DEFINITIONS

The leaf spring is one of the potential items to improve the, durability and weight reduction and increase load capacity of the automobile. For reduction of weight in automobile as it accounts for ten to twenty percent of the un-sprung weight. The introduction of surface coating and composites helps in designing a better suspension system with better ride quality. It can be achieved without much increase in cost and decrease in quality and reliability. The relationship of the specific strain energy can be expressed as it is well known that springs, are designed to absorb and store energy and then release it slowly. Capability to store and absorb more amount of strain energy ensures the comfortable suspension system. It can be easily observed that material having lower modulus and density will have a greater specific strain energy capacity. The introduction of molybdenum disulphide coating on leaf spring made it possible to reduction of weight of the leaf spring without reduction of load carrying capacity and stiffness due to more elastic strain energy storage capacity and high strength to weight ratio.

4. METHODOLOGY

- The used conventional leaf spring was taken.
- The hardness test was done in conventional leaf spring by using Rockwell hardness testing machine.

- The load test was done in conventional leaf spring by using universal testing machine.(UTM).For 25mm deflection the maximum load was tested.
- The weight of the conventional leaf spring was noted by digital weighing scale.
- conventional leaf spring was exposed to phosphate process
- Molybdenum disulphide surface coating is applied on the surface of the conventional leaf spring by spraying process.
- The coated leaf spring is kept inside the heating oven Temperature is about 300 degree Celsius for two hours.
- The hardness test was done in molybdenum disulphide surface coating leaf spring by using Rockwell hardness testing machine
- The load test was done in molybdenum disulphide surface coating leaf spring by using universal testing machine (UTM).For 25mm deflection the maximum load was tested.
- The weight of the molybdenum disulphide surface coating leaf spring was noted by digital weighing scale.

4. EXPERIMENTAL ANALYSIS

4.1 Deflection test before molybdenum disulphide surface coating process

Table -1: Load vs. Deflection before coating

SL.NO	DEFLECTION (in mm)	LOAD (in Newton)
1	5	500
2	10	1100
3	15	1700
4	20	2200
5	25	2780

4.2 Basic preparation manganese phosphate coating

Manganese phosphate coatings are the pre treatment process. It is conferment of good corrosion résistance it is applied by the immersion method. The degreasing and cleaning are usually done with strongly alkaline cleaners at concentrations of 1-4% and temperatures 60-95°C. Treatment times range from 5-15 minutes. Then activating pre-rinse has done for manganese which permits alkaline cleaning and pickling of the work, without the penalty of coarse-crystalline phosphate formation. This is based on a finely-dispersed manganese phosphate at concentrations 1-2 g/l .minutes.

Manganese phosphate coating is mainly by immersion. Treatment times range from 10-20 minutes, the optimum time depending on the surface condition. The bath operating temperature is around90 to 95°C and only in special cases can satisfactory coatings be formed at temperature around 75 to 80°C.The phosphate coat components, after drying, are immersed in the oil or lubricant baths for 1-2 minutes, allowed to drain. The thickness of the resulting oil film depends on the oil used and its concentration.

4.3 Molybdenum disulphide surface coating process

Manganese phosphate coated leaf spring is exposed to Molybdenum disulphide surface coating by spraying process. The Molybdenum disulphide surface coated leaf spring is kept inside the heating oven, it is allow to reach the temperature is about 300 degree Celsius, and it is kept for two hours

Molybdenum Disulphide Coatings (MoS_2 coatings) commonly used in applications where load carrying capacity, operating temperature and coefficient of friction. This coating provides effective lubrication in a wide range of loads. These coatings lubricate sacrificially by transferring lubricant between the two mating surfaces, which helps to reduce wear and coefficient of friction. Molybdenum Disulphide (MoS_2) coatings are a dry film lubricant.

4.4 Deflection test after molybdenum disulphide surface coating process

Fig -1: UTM Load Test

Table -2: Load vs. Deflection after coating

SL.NO	DEFLECTION (in mm)	LOAD (in Newton)
1	5	700
2	10	1300
3	15	1900
4	20	2500
5	25	3120

Fig -2: Molybdenum disulphide coating leaf spring

Table -3: Comparison of load capacity before and after molybdenum disulphide coating

Sl. no	Deflection (in mm)	Before coating (load withstand in Newton)	After coating (load withstand in Newton)
1	5	500	700
2	10	1100	1300
3	15	1700	1900
4	20	2200	2500
5	25	2780	3120

This table shows the deflection of varying load in before and after molybdenum disulphide coatings. From the readings we can observe that the molybdenum disulphide coatings leaf spring has the high load capacity than that of the non coated leaf springs

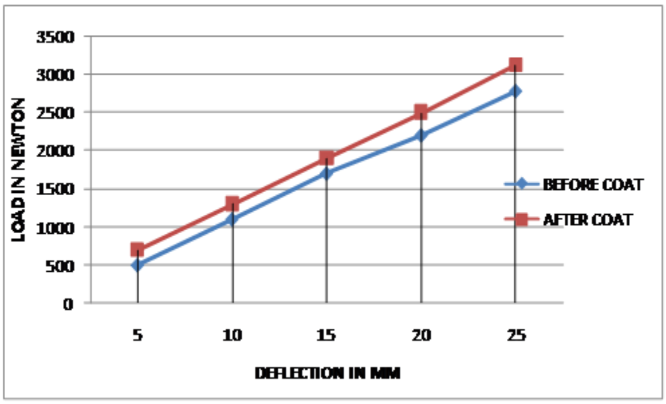

Chart -1: Load vs. Deflection

4.4 Load capacity calculation

Before coating

At 25 mm deflection point the load is = 2.78 KN (2780 N)

1 Kilogram is equal to 9.81 Newton

Therefore 2780 N = **283.384 Kg**

After coating

At 25 mm deflection point the load is = 3.12 KN (3120 N)

Therefore 3120 N = **318.043 Kg**

Before coating load capacity = 283.384 Kg

After coating load capacity = 318.043 Kg

Difference in load capacity = *34.659 Kg (Nearly 35 Kg)*

From this calculation we observed that the molybdenum disulphide coating leaf spring has better load capacity.

The above calculation is for single leaf spring for single wheel

Since it is four wheels 35 X 4 = *140 Kg.*

This is for single leaf for each wheel. TATA ACE vehicle consists of

Front; 2 leaves of each wheel

Rear; 3 leaves of each wheel

If the leaf springs are increased the load capacity of the vehicle also increased. We confirmed that load capacity of the vehicle will increase the double times. (Approx say 250 Kg)

Maximum load capacity of TATA ACE vehicle is *750 Kg*

Increase of load capacity of vehicle after molybdenum disulphide leaf spring coating is 250 Kg.

Maximum load capacity of TATA ACE vehicle after molybdenum disulphide leaf spring coating

= 750 Kg + 250 Kg = *1000 Kg (1 ton)*

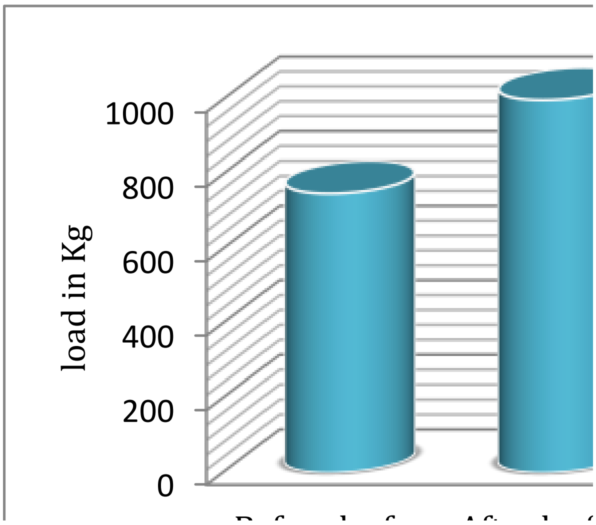

Chart -2: Comparison load before and after coat

4.4 Weight reduction calculation

Table -4: Specification of leaf spring

Length of the main leaf (L)	1072 mm
Length of the second leaf (L)	1072 mm
Length of the third leaf (L)	1072 mm
Width of the leaf (b)	60 mm
Chamber height (C)	95.4 mm
Thickness of the leaf	8 mm
Young modulus (E)	2×10^5 N/mm^2
Density	7850 Kg/m^3

Weight of leaf spring

= volume× density × acceleration due to gravity

Weight of leaf spring 1

= 1072 x 60 x 8 x .00000786 x 9.81

= 39.68 N

Weight of leaf spring 2

= 1072 x 60 x 8 x .00000786 x 9.81

= 39.68 N

Weight of leaf spring 3

= 1072 x 60 x 8 x .00000786 x 9.81

= 39.68 N

Total weight of the leaf spring =119.04 N **(119 N)**

The molybdenum disulphide coating leaf springs has high load carrying capacity. Due to high capacity we can reduce the size of the spring or reduced the number of leaves. It will lead reducing the weight of the vehicle.

Reduce the sizes of leaf spring.

Weight of leaf spring 1

= 722 x 60 x 8 x .00000786 x 9.81

= 26.72 N

Weight of leaf spring 2

= 722 x 60 x 8 x .00000786 x 9.81

= 26.72 N

Weight of leaf spring 3

= 722 x 60 x 8 x .00000786 x 9.81

= 26.72 N

Total weight of the leaf spring =80.16 N *(80 N)*

33% of weight is reduced

Reduce the numbers of leaf spring.

Three leaf springs is reduced I to two leaf springs

Then the weight is = 39.68 + 39.68 = *79.36 N*

33% of weight is reduced

3. CONCLUSIONS

As reducing weight and increasing strength of leaf spring are high research demands in the world, Molybdenum disulphide coated leaf spring materials are getting to be up to the mark of satisfying these demands. In this paper reducing weight of vehicles and increasing the strength of the leaf spring is considered. As leaf spring contributes considerable amount of weight to the vehicle and needs to be strong enough, a single coated Molybdenum disulphide leaf spring is used. The Graphs reveals that the leaf spring after Molybdenum disulphide coating has the better stiffness than before Molybdenum disulphide coating. From the experimental analysis results it is found that the load capacity of the Molybdenum disulphide coated leaf spring is more than before Molybdenum disulphide coating. No contamination and usage in harsh environments, especially Nana sized Molybdenum disulphide 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.

A comparative study has been made between steel and coated composite leaf spring with respect to strength and weight. Molybdenum disulphide coated Composite leaf spring reduces the friction co efficient and wear rate and increase the strength, fatigue life by over conventional leaf spring.

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