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Experimental Investigation of Designed Mono Suspension Spring

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ABSTRACT: Suspension springs are responsible for comfortable ride and the same spring in any another vehicle can be the cause of one's back pain too. The current model installed was very stiff since it was of a different car. The new one was designed as per the calculations done by using the specific values and conditions of a car it is going to be installed in. Fundamentals of vehicle dynamics and machine design were taken into considerations for calculation of ride and roll rates along with various dimensions of the spring. Designing was done on Solid-works and Analysis were carried out on the software named Ansys. The testing on Universal Testing Machine enabled us to rely on our calculated stiffness as more as accurate and sound for the car.

KEYWORDS: experimental investigation, ride comfort.

I. INTRODUCTION

The suspension system is the main part of the vehicle, where the shock absorber is designed mechanically to handle shock impulse and dissipate kinetic energy. In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations. Spring is an elastic body whose function is to store energy when deflected by force and return equivalent amount of energy on being released. Helical compression springs are widely used for suspension in light vehicle and locomotives worldwide. Generally, springs are made of hardened steel are used. Small springs can be wound from pre-hardened stock while larger ones are made from annealed steel and hardened after fabrication. Non-ferrous metals are also used such phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current because of its low electrical resistance. The rate of spring is called the change in the force it exerts, to the change in deflection of the spring. Steel helical coil spring in suspension system is generally used by the automobile manufacturers.

The use of conventional steel in spring increases the weight and with the current scenario the automobile manufacturers are interested in replacing steel springs with light weight composite materials.

Hysteresis is the tendency for otherwise elastic materials to rebound with less force than was required to deform them. Hence, the designing of suspension system is very crucial. In modeling the time is spent in drawing the coil spring model and the front suspension system, where risk involved in design and manufacturing process can be easily minimized. This project focus on optimization of helical spring used in Colleges Solar Electric Vehicle suspension. the modeling of the spring is made by using Solid-works. Later the model can be imported to ANSYS for the analysis work. Today's manufacturers are mainly concentrated on weight optimization of the product. Less weight ultimately results in less material required and less cost of product. Aiming at weight optimization of product, spring being a component of product, the weight reduction of spring can reduce the weight of product. As the weight of the product is reduced material required for product and cost of product will also be reduced.

• OBJECTIVE

- To determine the stress developed due to applied load
- To calculate maximum load acting on shock absorber and study the distribution.
- Experimental investigation of shock absorber to calculate stress developed . .

II. RELATED WORK

Manga Hymanjali and all [1], In this reference, Aluminium alloy, Carbon steel and stainless steel materials are selected for shock absorber components other than spring and for spring material for static structural analysis Beryllium copper, Chromium, vanadium, Inconel 750 and spring steel were selected. Variation of different parameters such as total deformation, von mises strain and von mises stresses has been observed with different material combination at standard design load condition i.e , 5000N.

Lalitkumar Maikulal Jugalkar and all [2], this article variable stiffness system is presented , which comprises of two helical springs and variable fluid damper . Simulation results indicates the proposed system will give 15% improvement in acceleration transmissibility and tyre discomfort in comparison to conventional fluid passive shock absorber.

Rahul Tekade , Chinmay Patil and all [3], Structural analysis will be done to validate the strength. Modal analysis to determine displacement for number of modes. In this project existing spring material (67SiCr5) spring steel was replaced by (ASTMA228) spring steel material and it is observed that the suggested material having less total deflection than the existing material.

Nikhil S. Kothawade, Amol D. Halwar, Ajay I. Chaudhari, Bhushan R. Mahajan [4], This mainly focuses on the measurement of the transmissibility of the shock absorber and its analysis at various loads and speeds . For the measurement of transmissibility of the shock absorber a test rig is designed and developed. As load increases at constant speed the transmissibility of the system goes on decreasing practically. When the speed increases at constant load, the transmissibility of the system goes on increasing.

S.k.v..Mutha, Saurabh Metkar [5] in this paper study of various concepts aimed at designing , fabrication and testing of a multipurpose test rig used by company for corporate presentation. This test rig will be capable of performing tests like vibrational analysis torsional vibration testing, rotational balancing, force transmissibility and noise testing. The paper reviewed provide useful information on design and testing of a beam, rigs for vibration loosening of bolts and easy interchangeability as well as its study, research work done on modelling and fabrication of crankshaft is also considered.

Arif Ahmad Ansari and K. K. Jain [6] in this paper stress analysis of a helical compression spring, which is employed in two-wheeler Automotive front suspension belonging to the medium segment of the Indian automotive market. The structural reliability of the spring must be ensured so for this purpose the static stress analysis using Finite element method has been done in order to find out the detailed stress distribution and deformation of the spring. The structural analysis for modeling the structural behavior of helical compression spring. Stainless steel and chromium vanadium. For this analysis, loads are considered as bike weight, single person, structural analysis is done to validate the strength and an attempts to compare the results for selecting best material for spring.

K. Vinaykumar R. Rudarbhiramu [7] in this paper the front suspension in motorcycle is telescopic forks which are replaced by Mono shocks that gives a superior vehicle handling and provides safety while braking. Mono shocks also allows the rider to fine tune the machine to give better control over the machine when riding The springs in Mono Shock have been designed by taking consideration of many practical condition like dynamic resistance, road tracks and aerodynamic properties. In this design the uneven vibrations in the telescopic forks have been balanced by using the Mass centralization concept in the pivoted center point of the front suspension in the motorcycle using mono shocks. The Mono shock geometry gives a rising rate of damping characteristics to the front suspensions and the designed springs used to restrict a downgraded dynamics when it returns to the immobility state posterior to humps and bumps. This design of front suspension using mass centralization concept many antiquate the present telescopic forks. From results alloy steel material is more stable and gives good efficiency compared to other two material.

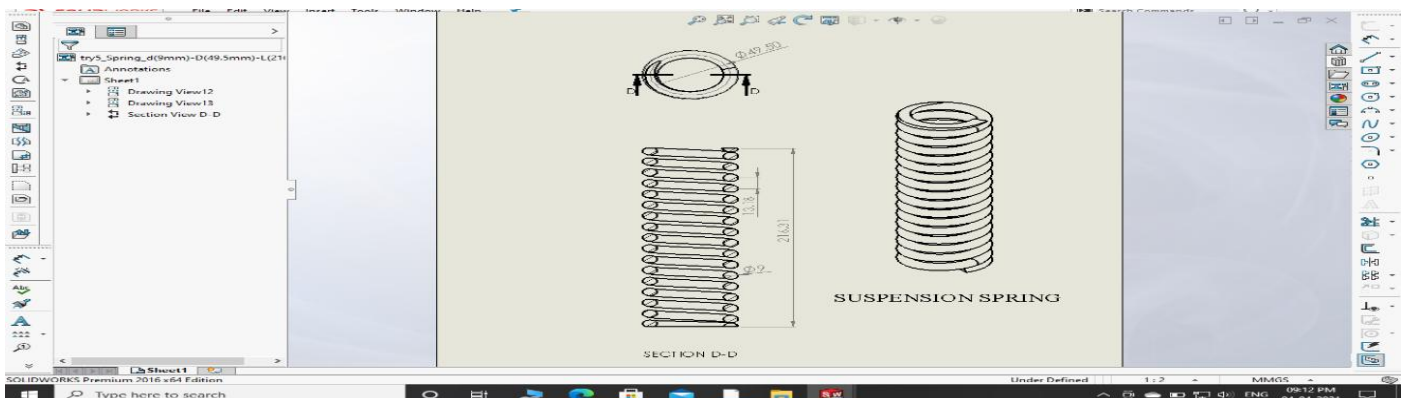
Amol D. Halwar, Bhushan R. Mahajan [8] in this paper mainly focuses on the measurement of transmissibility of shock absorber and its analysis at various at various loads and speeds. Transmissibility is a measure of effectiveness of the vibration isolating material. For measurement of the Transmissibility of the shock absorber a test rig designed and developed. An experiment on the test rig is carried out at different speeds and loads which lead to the output in terms of sinusoidal waveform on strip chart recorder. The waveform is used to find out transmissibility at different load-speed combination. The result obtained are used to find out behavior of transmissibility at different speed and loads from results as load increases at constant speed, the transmissibility of the system goes on decreasing practically. There is increase in transmissibility calculated by theory but it is nearly negligible.

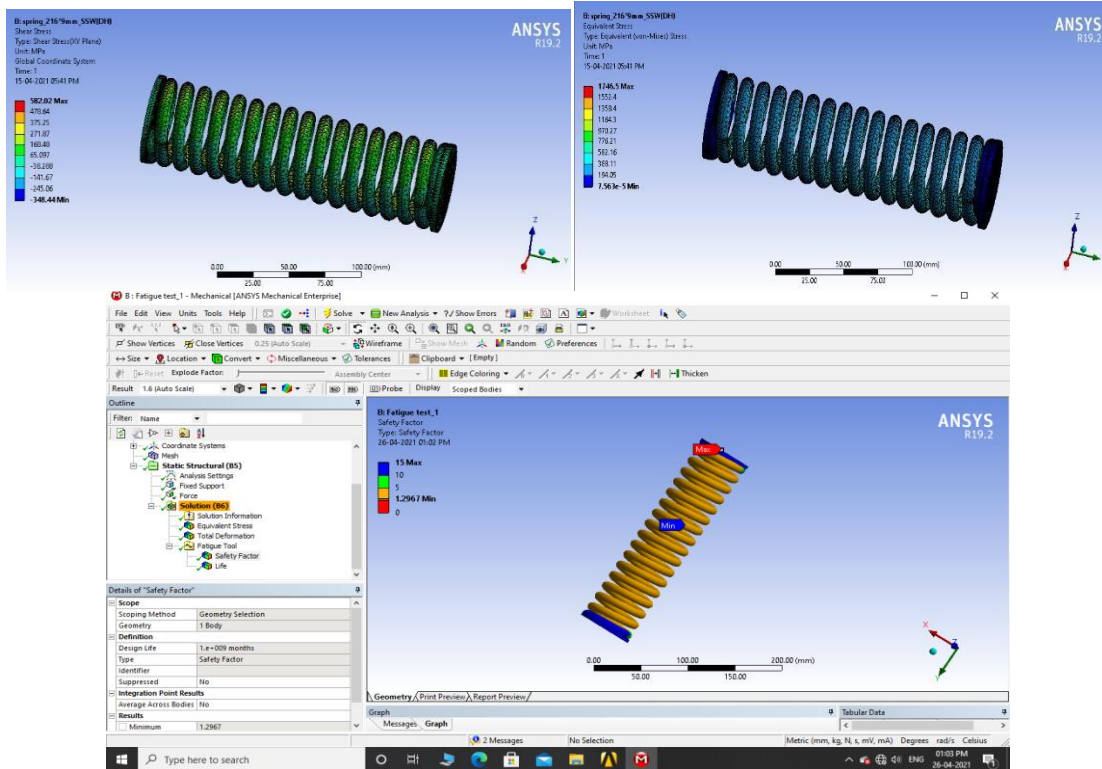
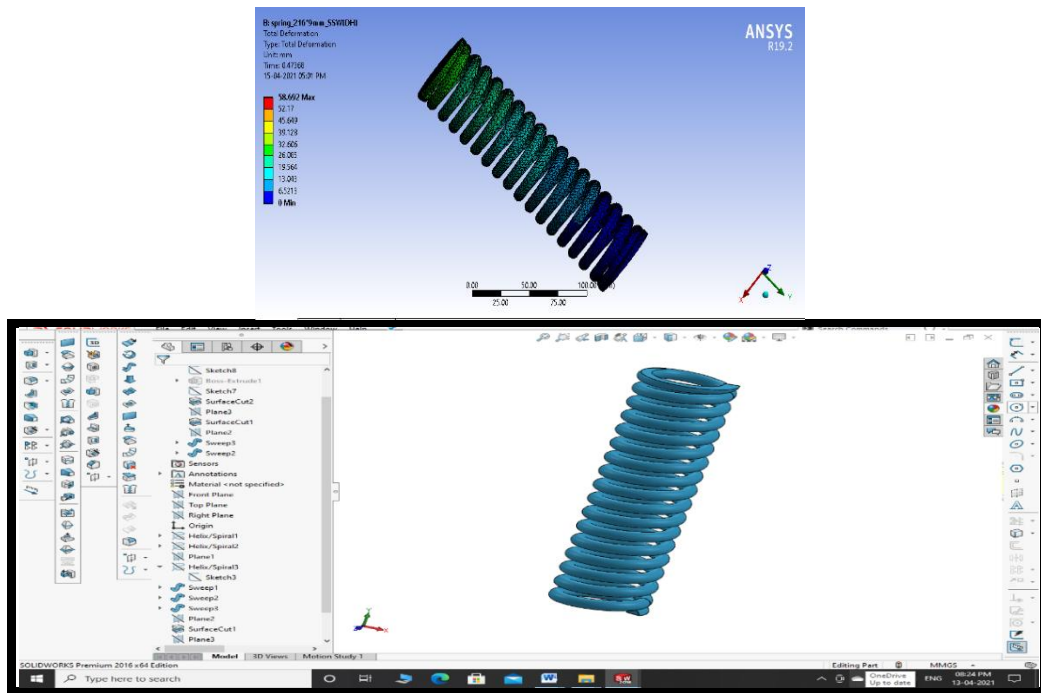
Chaudhari Arati G., Shilawat Pooja S [9].in this paper main purpose is to measure transmissibility of shock absorber and to analyze it for different loads and speeds. Effectiveness of the vibration absorber can be measured by transmissibility. And for measurement of transmissibility shock absorber test rigs designed and developed. An experiment on test rig is carried out at various loads and speeds which results to the output in the form of sinusoidal waveform on the paper by using stylus. The waveform is used to find transmissibility at various load speed combinations. It gives the behavior of shock absorber at various speeds and loads.

III. METHODOLOGY

FEA for spring

- Spring ends - Plain and ground ends
- Material consideration- Spring steel wire (grade - DH)
- Ultimate strength = 1600 N/mm²
- Endurance strength = 518.4 N/mm³
- Yield strength = 672N/mm²
- Maximum load = 2000 N at 40mm deflection
- Minimum load = 491 N at 13mm deflection
- Total deflection required = 54.5 mm
- Type of spring = squared and ground ends
- Free length of spring = 216mm
- Spring wire diameter= 9mm
- Maximum Diameter (D_o)= 58.5 mm
- Mean Diameter (D_m)=49.5mm; $D_m = D_o - d = 58.5 - 9 = 49.5$ mm
- Spring Index= (D_m / d) = (49.5/9) = 5.5
- Total no of turns = 17
- No. of active turns = 15
- Pitch = 13.179 mm







4.1 Determination of stresses at different loads in spring:

- **Shear Stress in Spring:**

$$T = Kw8WDmd^3 = 1.278 \times 8 \times 2700 \times 49.5\pi \times 93$$

$$T = 596.64 \text{ Nmm}^2$$

- **Load Considerations:**

Total weight of vehicle = 230 Kg

Weight of person = 120 Kg

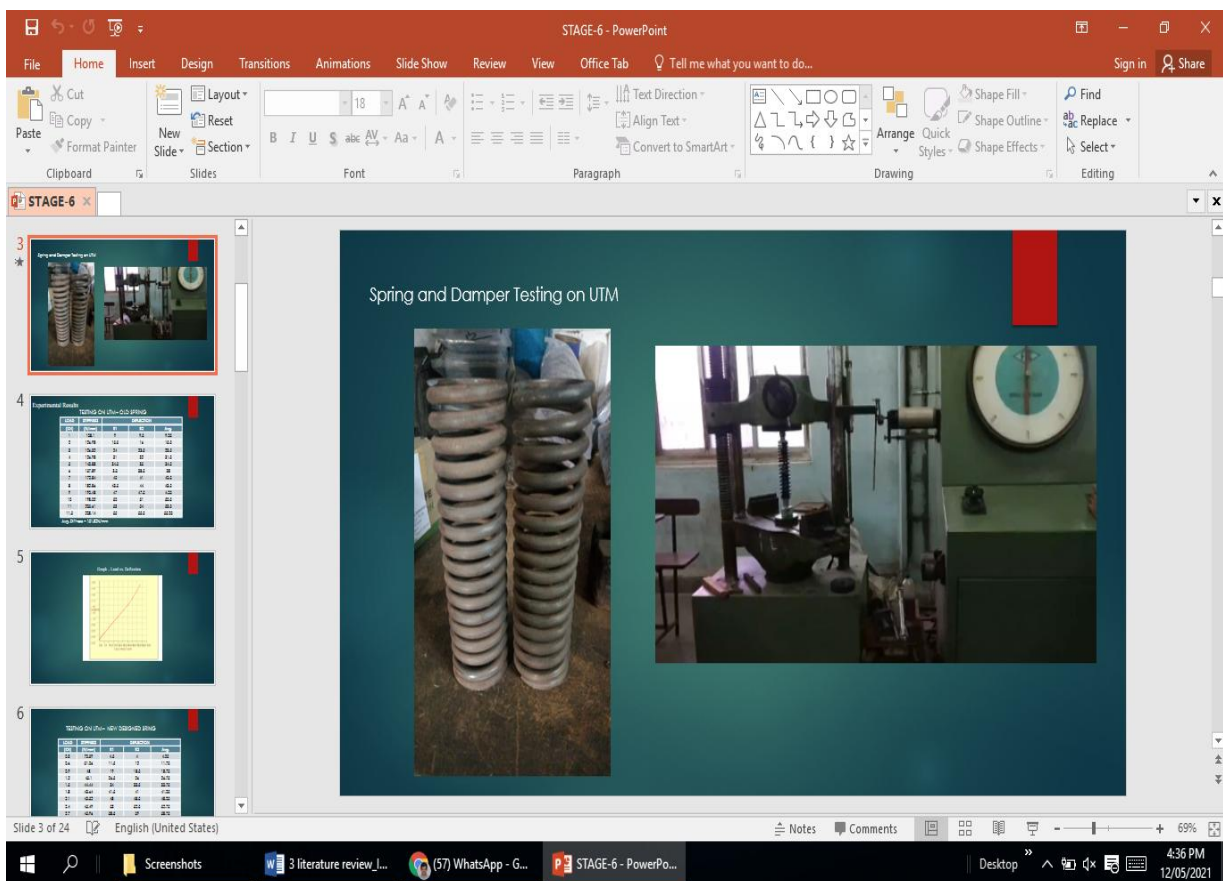
Total Static Load = 350 Kg = 3434 N

- **Variable Load Conditions:**

Initial Load on spring = 491 N

Max load on spring = 2000 N

EXPERIMENTAL SETUP:





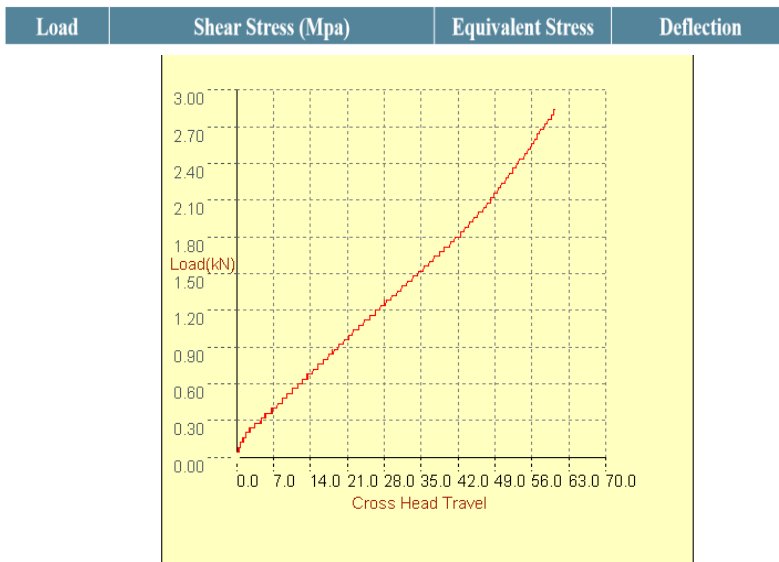
UTM TESTING RESULTS

| LOAD | STIFFNESS | DEFLECTION | | |
|------|-----------|------------|------|-------|
| (KN) | (N/mm) | R1 | R2 | Avg. |
| 0.3 | 70.59 | 4.5 | 4 | 4.25 |
| 0.6 | 51.06 | 11.5 | 12 | 11.75 |
| 0.9 | 48 | 19 | 18.5 | 18.75 |
| 1.2 | 45.1 | 26.5 | 26 | 26.75 |
| 1.5 | 44.44 | 34 | 33.5 | 33.75 |
| 1.8 | 43.64 | 41.5 | 41 | 41.25 |
| 2.1 | 43.52 | 48 | 48.5 | 48.25 |
| 2.4 | 45.49 | 53 | 52.5 | 52.75 |
| 2.7 | 45.96 | 58.5 | 59 | 58.75 |
| 2.84 | 46.5 | 60.6 | 60.9 | 60.75 |



IV. EXPERIMENTAL RESULTS

For spring



| (N) | Theoretical | Analytical | (Mpa) | (mm) |
|------|-------------|------------|---------|-------|
| 300 | 66.31 | 64.28 | 184.49 | 6.20 |
| 600 | 132.63 | 128.56 | 368.98 | 12.4 |
| 900 | 198.94 | 195.84 | 553.47 | 18.6 |
| 1200 | 265.26 | 257.12 | 737.96 | 24.8 |
| 1500 | 331.57 | 321.4 | 922.45 | 31 |
| 1800 | 397.88 | 385.68 | 1106.94 | 37.2 |
| 2100 | 464.20 | 449.96 | 1291.43 | 43.4 |
| 2400 | 530.51 | 514.24 | 1475.92 | 49.6 |
| 2700 | 596.83 | 578.52 | 1660.41 | 55.8 |
| 2840 | 627.77 | 608.52 | 1746.5 | 58.69 |

Fig. Load v/s Deflection

V. CONCLUSIONS

1. The stress analysis of Mono suspension System is carried theoretically for various loading conditions and these results are verified by Finite Element Analysis and Using UTM Testing.
2. As per the calculations performed and loading conditions the theoretical spring stiffness is 37.73 N/mm at deflection of 40 mm and safe frequency for design is around 5 Hz.

From the fatigue analysis we come to know that the FOS calculated theoretical which is 1.34 is appropriate as per loading conditions.



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