EXPERIMENTAL INVESTIGATION OF MONO SUSPENSION SPRING

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Abstract - *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. The objective of this work is to carryout out experimental investigation of mono helical spring. In this work the compression test is conducted on the helical spring for 50 kg to 400 kg to find the deflection. The analytical analysis is carried out with the Ansys. The theoretical analysis is also carried out. The research aims to suggest better material by satisfying desired constraints.*

Keywords- experimental investigation, ride quality.

1. 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 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 focuses on the optimization of helical spring used in Honda unicorn the modeling of the spring is made by using Creo. 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.

1.1. OBJECTIVE

i) To determine the stresses developed due to applied load
ii) To calculate maximum load acting on shock absorber and study the distribution.
iii) Experimental investigation of shock absorber to calculate stresses developed and transmissibility.

2. LITERATURE SURVEY

Budan & Manjunathatheer al. [1] checked feasibility of replacing the metal coil spring with the composite coil spring. Three different types of springs were made using glass fiber, carbon fiber and combination of glass fiber and carbon fibre. The objective of the study was to reduce the weight of the spring. According to the experimental results the spring rate of the carbon fiber spring is34% more than the glass fiber spring and 45% more than the glass fiber/carbon fiber spring. It was concluded that, the weight of the springs manufactured from carbon fiber roving is less than the glass fiber and glass fiber/carbon fiber roving springs. The stiffness of the carbon fiber springs is greater than the other two types of composite coil springs. The cost of the glass fiber springs are 25% more than the steel springs and the cost of the carbon fiber springs is 200%more than the steel springs. The selection of the glass fiber or a carbon fiber springs depends upon the cost and application of the spring which can be compensated by saving the fuel from weight reduction. As compared to steel springs of the same dimensions, the stiffness of composite coil springs is less. In order to increase the stiffness of the spring the dimensions of the composite spring is to be increased which in turn increases the weight of the spring. Hence the application of the composite coil springs can be limited to light vehicles, which requires less spring stiffness, e.g. electric vehicles and hybrid vehicles.

AmolD.Halwar, Bhushan R. Mahajan[2] 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 behaviour 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.

H.R.Sapramer and Dr.G.D.Acharya [3] in this paper mainly focuses on the measurement characteristics of shock absorber .The shock absorber is characterized by its instantaneous value of position ,velocity, acceleration ,force ,pressure ,temperature etc and various plots among these parameters. For the measurement of listed parameter of the shock absorber a test rig is designed and developed .An experiment on test rig is carried out at different speeds and loads which lead to the output in terms of sinusoidal waveform on attached oscilloscope. The waveform is used to find out the characteristics at different load speed combination. The results obtained are used to find out behavior of shock absorber at different speed and loads. From result At various loads and speed combinations the readings on the test rig is taken with the help of various sensors mounting on the test rig and by using data , characteristics of the shock absorber is calculated.

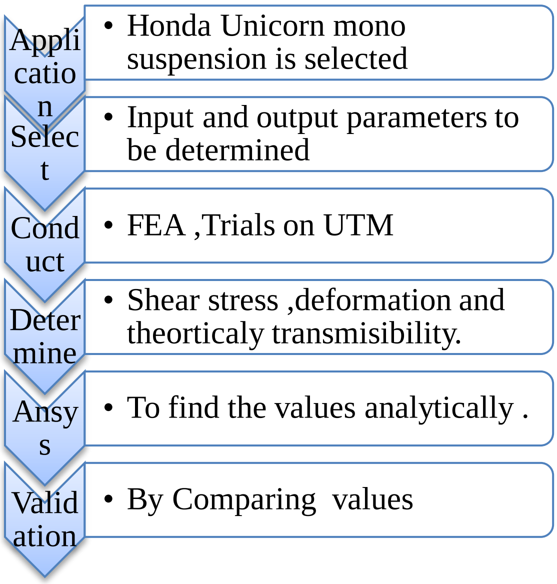
K.Vinaykumar R.Rudarbhiramu[4] in this paper the front suspension in motorcycle is telescopic forks which are replaced by Mono shocks that gives a superior vehicle handling and provides safety while braking. Mono shocks also allows the rider to fine tune the machine to give better control over the machine 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.

ChaudhariArati G.,Shilawatpooja S[5].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 rig s desinged 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 behaviour of shock absorber at various speeds and loads.

S.k.v..Mutha, SaurabhMetkar[6] 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[7] 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. In the design of this kind of spring both the elastic characteristics and fatigue strength have been considered as significant aspects. In addition to this particular elastic property as a consequence of the research effort in reducing the mass of components typical of the automotive industry these springs have to face very high working stresses. 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. The design of spring in suspension system is very important .In this work a helical type of spring is designed and a 3D model is created using Catia and structural analysis has been conducted on the helical compression spring bby varying the spring material such as structural steel, stainless steel and chromium vanadium. 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.

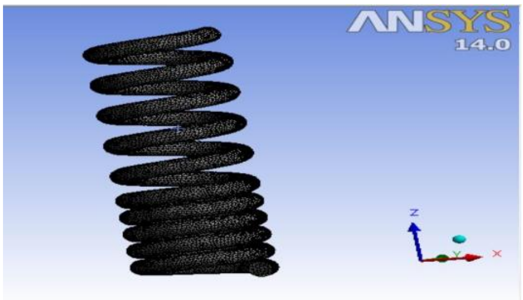
3. Methodology



4. FEA for spring:

- Spring ends-Plain and ground ends
- Maximum Diameter(D_o)=69.30mm
- Original Length of Spring=195mm
- Wire diameter(d)=12.25mm
- Mean Diameter($D_{m)}$=57.05mm; D_m= D_o-d=69.30-12.25=57.05mm
- Spring Index=(D_m/d)=(57.05/12.25)=4.657mm

Fig Model Generation for spring



Type of meshing: Tetrahedron

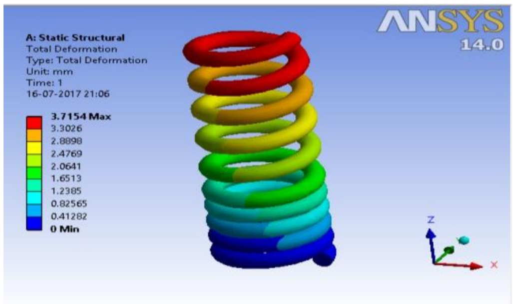


Fig : Deformation at 500N

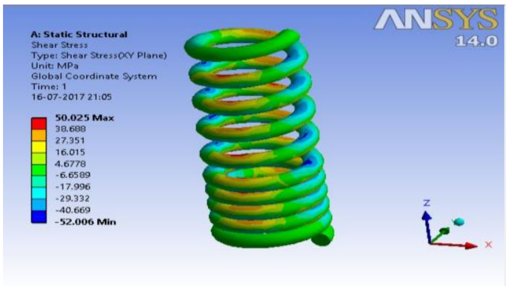


Fig Shear stress

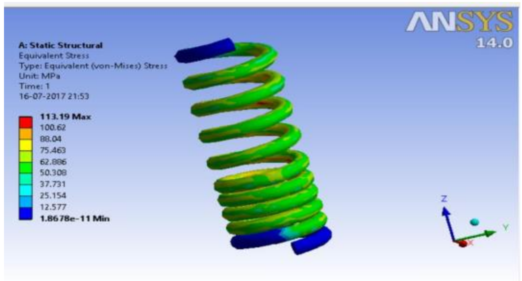


Fig : Equivalent stress

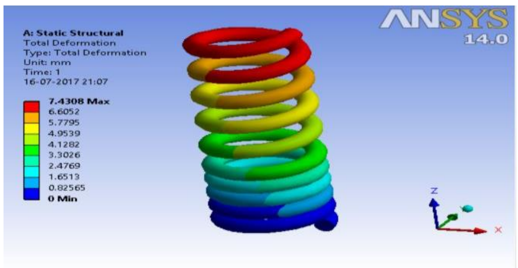


Fig : Deformation at 1000N

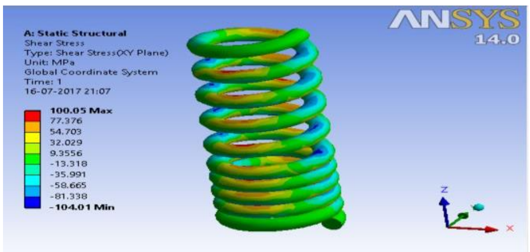


Fig : Shear stress

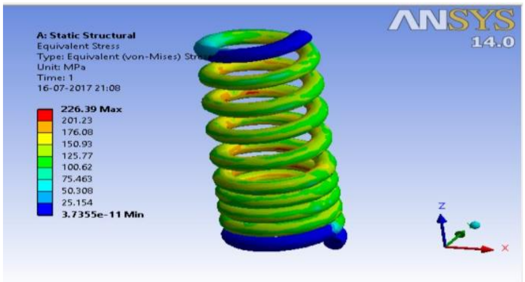


Fig: Equivalent stress

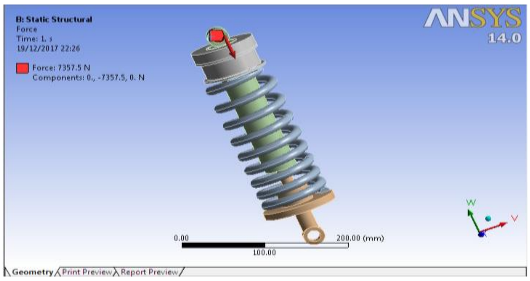


Fig : Shock Absorber Boundary Conditions.

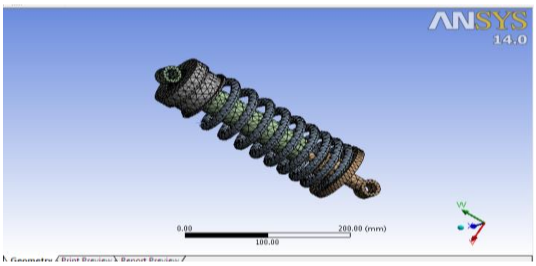


Fig : Shock Absorber Mesh Model.

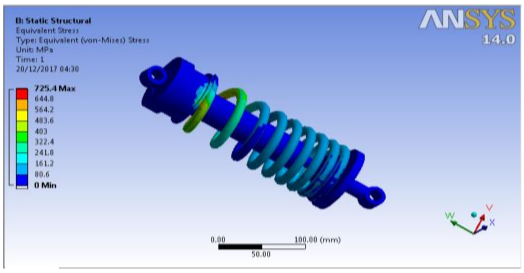


Fig : Shock Absorber Stress at 7357.50 N Load

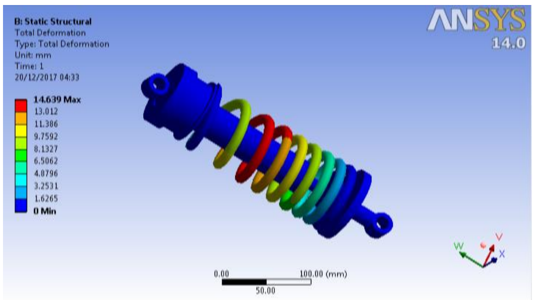


Fig : Shock Absorber coil Deformation at 7357.50 N Load.

4.1 Determination of stresses at different loads in spring:

- **Shear stress in spring.**

$$\tau_T = Kw\left(\frac{8WDm}{\pi d^3}\right)$$

$$= 1.3370 \times \left[\frac{8500 \times 57.05}{\pi \times 12.253}\right]$$

$$= 1.3370 \times \left[\frac{228.2 \times 103}{5.77 \times 103}\right]$$

$$T_T = \frac{52.87N}{mm^2}$$

4.2 Transmissibility Calculations:

Force transmitted (F_{Tr}) in N = Compression x spring stiffness

Power input (P) in Watt, P = E x A

Input torque (T) in N-m, $T = \frac{P \times 60}{2\pi N}$

Force applied (Fa) in N, $F_a = \frac{T}{R}$,

Where, R = Radius of Cam with lobe = 0.045 m

Transmissibility $Tr = \frac{F_{Tr}}{F_a}$

- **Load consideration:**

Total wt of bike = 120 kg
Total wt of two person = 130 kg.
Total Static Load= 120+130= 250 kg
Load in Newton= 250* 9.81= 2452.5 N
Dynamic wt is 3 times static wt= 3* 1395.5 = 7357.5N

5 .EXPERIMENTAL SETUP:

Fig. Universal Testing Machine

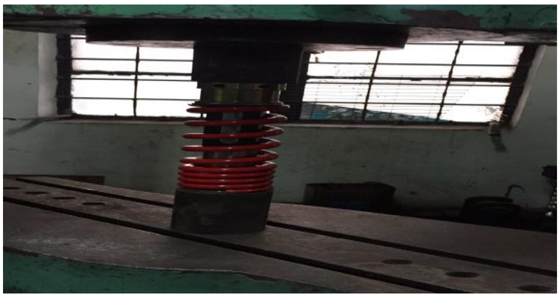


Fig Universal Testing Machine with spring

Fig. Universal Testing Machine with Shock Absorber.

Table: Experimental Stress Analysis of Shock absorber

Loading N		Stresses on the shock absorber coil spring (Mpa)	Deformation of the shock absorber coil spring(mm)
Bike load	1177.20	358.76	6.00
Bike load + 1 person	1814.85	450.00	8.00
Bike load + 2 person	2452.50	525.60	12.00
Bike load + 2 person + dynamic load	7357.50	730.00	18.00

Fig .Shock Absorber Transmissibility Testing Machine

- Observation Table.

SR. NO	Voltage (E)	Current (A)	Frequency (Hz)	Motor Speed (RPM)	Compression of spring (mm)
1	95.7	1.5	12.50	40	16.7
2	171.00	1.6	15.60	74	8.30
3	252.00	1.7	25.00	119.7	5.00
4	333.00	1.8	38.00	160	4.20

6 Comparative Results:

1) For spring

Sr No.	Load (N)	Shear Stress			Deformation (mm)
		Theoretical	Analytical Value EN 48	Von Mises Stress(MPa)	
1	500	52.87	50.025	113.19	3.7154
2	1000	105.756	100.05	226.39	7.4308
3	1500	154.62	150.07	339.18	11.146
4	2000	211.51	200.1	452.78	14.862
5	2500	264.06	250.12	565.97	18.577
6	3000	317.27	300.15	679.16	22.292
7	3500	370.14	350.17	792.36	26.008
8	4000	423.02	400.2	905.55	29.723

2) Comparative results of shock absorber

Loading N	Stresses on the shock absorber coil spring (Mpa)	Deformation of the shock absorber coil spring(mm)	Stresses on the shock absorber coil spring (Mpa)	Deformation of the shock absorber coil spring(mm)
Bike load	349.25	4.46	358.76	6.00
Bike load +1 person	439.91	6.58	450.00	8.00
Bike load +2 person	512.68	10.5	525.60	12.00
Bike load +2 person +dynamic load	716.78	15.5	730.00	18.00

7. 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.

2) It is clear that 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.

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