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Design And Analysis of Two Wheeler Suspension Spring

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ABSTRACT

In modern trends of the automobile industry, the ride comfort for drivers is the safety and suspension performance of a vehicle. In vehicles, vibration is one-factor causing damages to the base of the vehicle, wear and tear, etc. Vibration control is a major factor to satisfy customers. In this study, the suspension system in the vehicle is the main component to control the vibration. From the concept of suspension system in a vehicle, there are different approaches in the suspension system such as to modified design in suspension, the alternate system instead of the conventional method, Material changing, etc.

In this work from the suspension system, spring is playing an important component that withstands the load and causes vibration. Analytical work is carried out by changing the material properties of the spring resulted from that vibration has reduced in composite material. The existing material in the suspension spring is a steel alloy that withstands vibration to a certain limit beyond that it gets failed and breaks. To overcome such a problem in this work we propose new material based on MMC (Carbon Steel 50%, Copper 25%, and Magnesium 25%). By validating the analytical result structurally by deformation, equivalent stress, and dynamically observed vibration, etc. Finally, the Comparative analysis has derived and concluded for the feasible material in spring manufacturing. Modeling work is done with SOLIDWORKS Software and analysis is carried out with ANSYS software which is best for FEM.

I. INTRODUCTION

An automobile is a machine commonly with wheels and engines used to transport humans or cargo. There are many types of vehicles (bike, auto, bus, and lorry, etc.,) to transport the passenger to the desired position. Most people are absorbing the pains after completing their journey or travel due to excessive vibration on the vehicle and from the engine. The suspension is provided to the vehicle to avoid vibration. Vibration is the backward and forward or repetitive movement of an item from its factor of relaxation.

The arrangement of springs and damper is made in such a way that it forms a system which protects vehicle chassis from various shocks and vibrations. For so many years, various types of suspensions are being used. Their manufacturing and modification are done based on road conditions and demand from the market. But nowadays there is a high demand for superior suspensions that provides high performance and comfortable ride. So, in this condition the conventional types of suspensions like Leaf Springs, Coil Springs, Mac Pherson strut, Wishbone type suspension, etc. are not used because they are unable to fulfill the requirement.

II.LITERATURE REVIEW

Sourabh et al. [1] the overall stability of the suspension system has been observed since this is the main requirement of the suspension system. The system's load-carrying capacity is also improved. But it can also be used in heavy applications.Load deflection results for hybrid helical spring shows large variations in deformations up to 171.723N. Subsequently, the variations in deformations reduced as there is a lesser gap between the coilson comparing the deflection values of hybrid composite helical springs with that of conventional steel spring, it is observedthat 60% of the load that is required for steel spring is sufficient for the full compression of hybrid composite spring to say the **Bhaskar*et al.* [3].**

Karthikeyan*et al.* [4] Implementation is carried out by mixing traditional steel with composite material from copper and magnesium. This succeeded in reducing the weight, increasing the system's rigidity.The composite helical springs can be effectively used in automobiles without affecting the performance of the suspension system of the vehicles. They provide around 50-7-% weight reduction as compared to that of steel spring to present by **Sujit*et al.* [5].**

Anil Antony Sequeira*et al.* [6]the common steel material modulus was 25.47 and 21.42 for the Kevlar material and 43.75 for the carbon content. Consequently, carbon has a high stiffness-to-weight ratio relative to other materials, making it a final factor in determining the type of material to be used in the spring production. The deep study of composite material we decided to manufacture composite helical coil spring, in that design spring mould and then go to manufacture spring By using glass fibers epoxy and carbon +glass fiber epoxy we manufacture two springs and conclude that the carbon + glass fiber spring has compression strength 15.78%, maximum compression 10.16%, shear stress 5%, the weight of spring 13.5%, failure load 12.5% better than glass fiber epoxy spring is developed by **ShrikantDevidasSakhare*et al.* [7].**

KarthikMahadevan et al. [9]to reduce the weight of the suspension spring and thus improve the overall performance of the vehicle, it is necessary to reduce the weight of the suspension system by modifying the helical spring material. The vehicle's total weight will also be decreased by reducing the weight of the suspension spring. Composite materials are chosen consisting of low carbon steel combined with vanadium and chromium, as well as other stainless steel composite material with vanadium and chromium. The use of these composite materials would reduce the weight of the suspension spring instead of traditional steel.It also noted that E-glass materials are less deforming than other materials. Although deformation is low when the load is given to the material from E-Glass, it is best to make a suspension spring to say the **Rajkumar*et al.* [11].**

III. PROBLEM IDENTIFICATION

Helical spring is the most important part of the two-wheeler suspension system. Every organization wants to reduce the cost of the material used in the different parts. Most of the time due to continuous loading, the spring manufacturer used more factors of safety to design the spring. But, keeping a higher factor of safety, the cost of material used to manufacture the spring becomes high. Therefore, our project aim is to keep the minimum factor of safety for the suitable operation of helical spring. The reduction in material leads to a reduction in the overall cost of the spring.

IV. MATERIAL SELECTION

Table 4.1 Metal Matrix Composite Properties

Material properties	**Carbon steel 50%**	**Copper 25%**	**Magnesium 25%**	**MMC**
Density kg/m^3	3925	2240	437.5	6602.5
Young's modulus (Gpa)	100	32	11.375	143.37
Poisson ratio	0.13	0.09	0.07375	0.2937

The existing material is steel alloy whereas the alternate material is a composition of Metal Matrix-based equal percentage. The properties of the selected material are provided in Table 4.1.

V. DESIGN OF SUSPENSION SPRING

SOLIDWORKS is a highly productive 3Dimensional CAD software tool with advanced analytical tools including design optimization to help stimulate physical behaviors such as kinematics, friction, pressure, deflection, vibration, temperature, and fluid flow to suit all design forms. The suspension spring model and dimension represented Fig. 5.1 & 5.2.

Fig. 5.1 Suspension spring in Solid Works

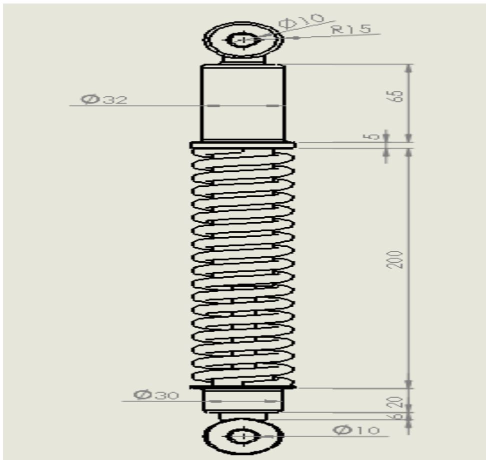

Fig. 5.2 Suspension spring with dimension

Furthermore, suspension spring design converted to the IGES file format, it's useful to the imported any software.

VI. ANALYSIS OF SUSPENSION SPRING

ANSYS is preferred-purpose FEA software. Finite Element Analysis is a numerical approach of discretizing a complicated design into very small pieces (of user-specific length) known as factors. The software Implements equations that govern the behavior of these factors and solves all of them growing a comprehensive explanation of how the device acts as an entire. Those consequences can be supplied in tabulated or graphical forms. This sort of analysis is typically used for the design and optimization of a model some distance too complicated to research by way of hand.

Analysis and outcomes with distinctive cases: in this step, we will display the meshing view of the spring version and take the specific spring go segment and analysis of this model the use of ANSYS 15.0 software and get outcomes. Analysis and outcomes with different cases: on this step we can show the meshing view of the spring model and take the distinct spring move phase and evaluation of this model the use of ANSYS 15.0 software and get effects.

Fig 6.1 shows the meshing of the suspension system for a vehicle which is discretized into the number of elements and nodes to improve the perfection of the result.

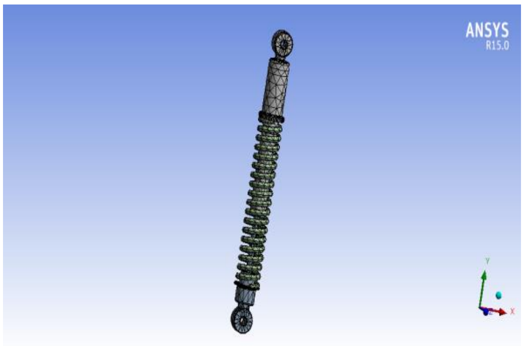

Fig. 6.1 Meshing

To predict the material strength of MMC & Steel material based on structural analysis. The load and boundary conditionsare represented in Fig. 6.2.

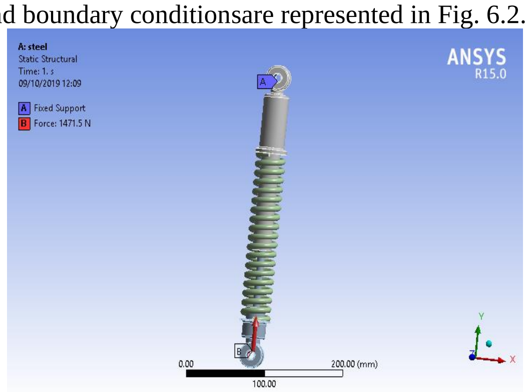

Fig. 6.2 Load & Boundary Condition

The structural analysis is helpful to identify the material stress value in both Steel & MMC. The stress value and graphically represented in Fig. 6.3 & 6.4.

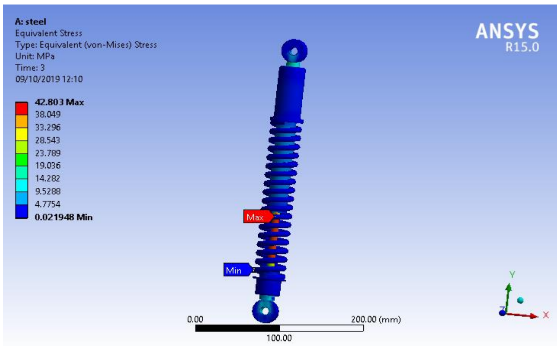

Fig. 6.3 Stress Value in Steel Material

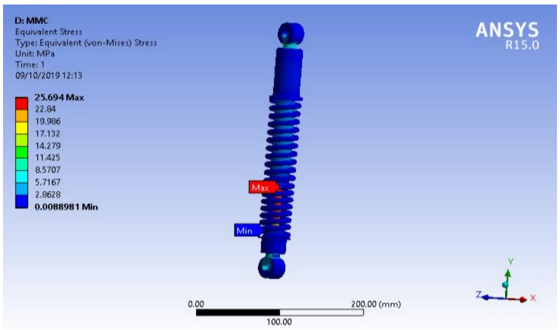

Fig. 6.4 Stress Value in MMC

Table 6.1 Comparison of Steel & MMC Material

Description	Steel	MMC
Deformation (mm)	0.022349	0.022357
Equivalent Stress (MPa)	42.803	25.694
Elastic Strain	0.00022523	0.00022529

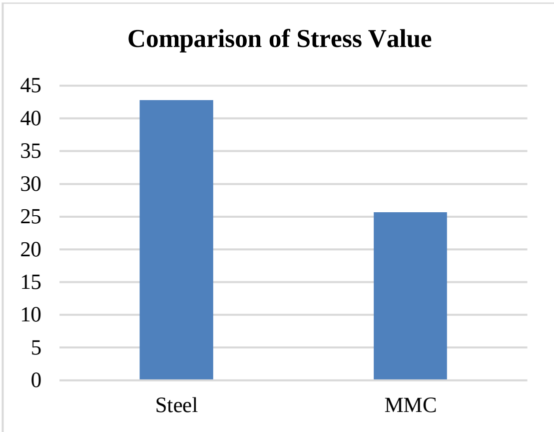

Fig. 6.5 Comparison of Stress Value

To validate the stability of the suspension, structural analysis was done by varying the spring material. The analytical result shows that composite material is better performance compared with steel. The structural analysis result is maximum stress in steel 42.803MPa whereas in metal matrix composite material is 25.694MPa. So its MMC material is lifetime is increased.

The suspension spring most important one of the vibration controls, it checks the natural frequency in Steel and MMC material based on modal analysis.The Comparative of natural frequency in five different modes represented in Table 6.2 and MMC material modes shape graphically representedin Fig. 6.6 to 6.10.

Table 6.2 Comparative Natural Frequency

Modes	Natural Frequency (Hz)	
	Steel	MMC
1	98.152	98.139
2	98.531	98.607
3	270.51	271.22
4	272.27	274.83
5	368.70	346.00

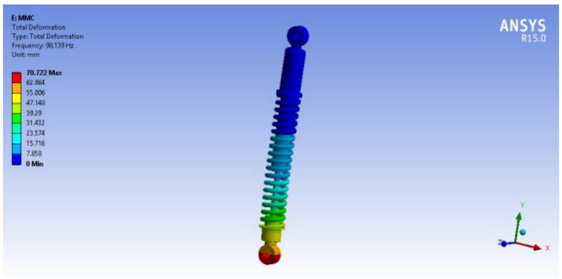

Fig. 6.6 Natural Frequency of MMC (Mode 1)

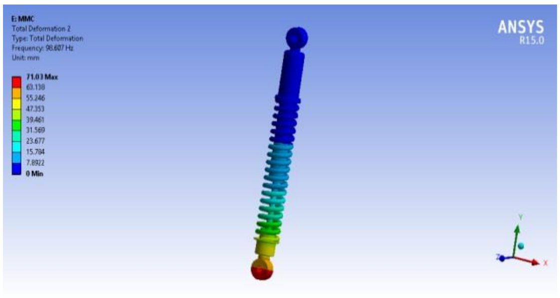

Fig. 6.7 Natural Frequency of MMC (Mode 2)

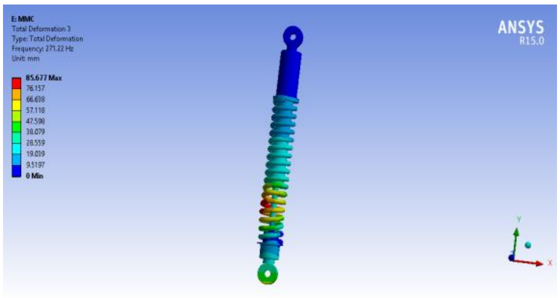

Fig. 6.8 Natural Frequency of MMC (Mode 3)

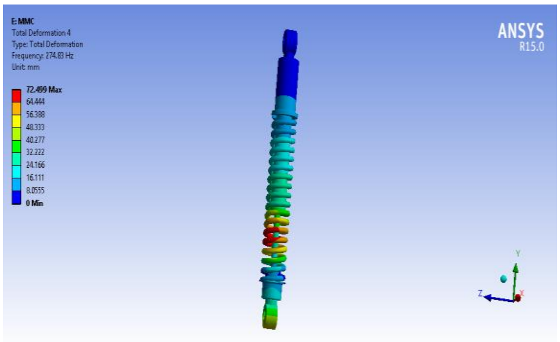

Fig. 6.9 Natural Frequency of MMC (Mode 4)

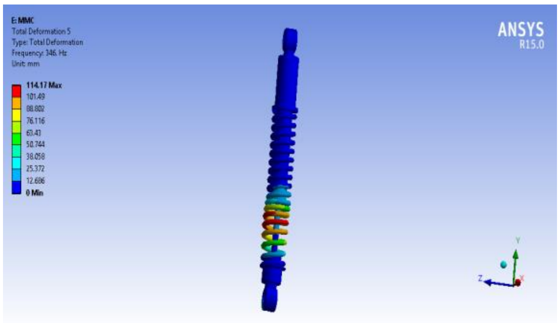

Fig. 6.10 Natural Frequency of MMC (Mode 5)

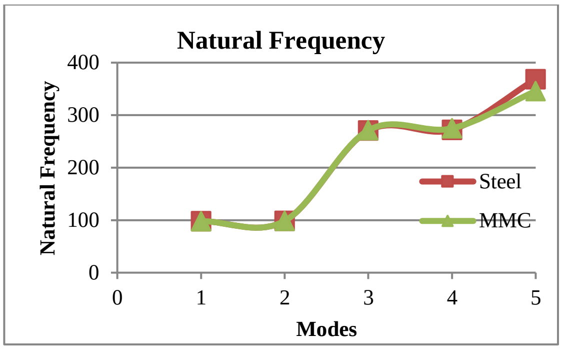

Fig. 6.11 Comparison of Natural Frequency

HARMONIC ANALYSIS

Most applications in science and engineering of harmonic analysis start with the concept or hypothesis that a phenomenon or signal consists of several individual oscillatory components. The mathematical approach is often to attempt to explain the system through a differential equation or equation method to determine the essential characteristics, including the frequency, amplitude, and parts of the oscillatory machinery.

The suspension spring to validate the 250Hz acting and predict the deformation and stress value in Steel and MMC materials, its comparative result is represented in Table 6.3.

Table 6.3 Comparative of 250Hz frequency

Description	Steel	MMC
Deformation (mm)	0.028067	0.036564
Stress (MPa)	5.0284	4.9419

The total deformation and stress value of steel material graphically represented in Fig. 6.12 & 6.13.

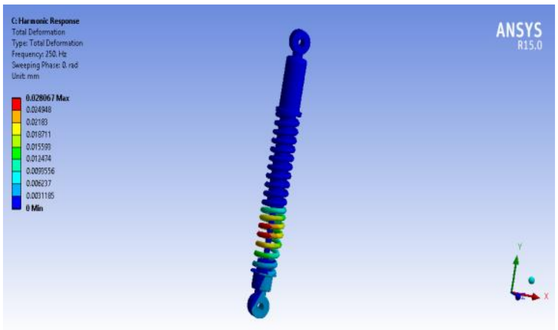

Fig. 6.12 Deformation of Steel Material

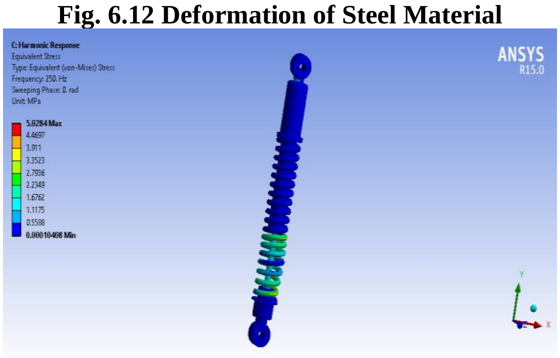

Fig. 6.13 Stress Value of Steel Material

The total deformation and stress value of MMC material is graphically represented in Fig. 6.14 & 6.15.

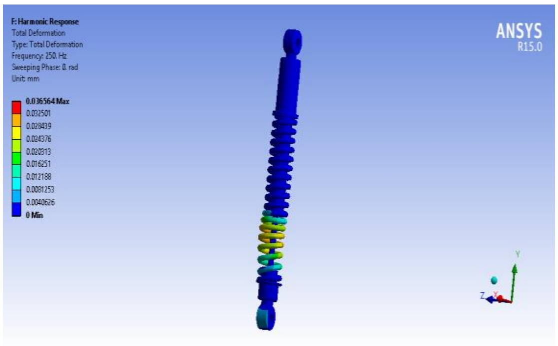

Fig. 6.13 Deformation of MMC Material

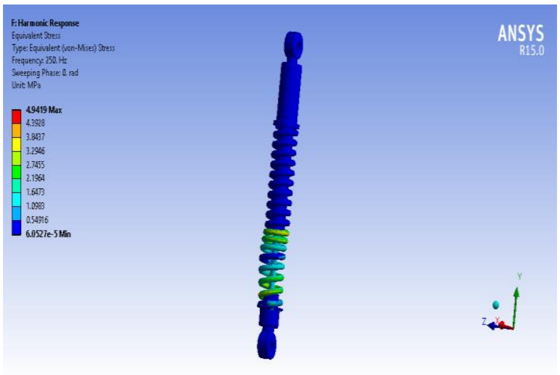

Fig. 6.14 Stress Value of MMC Material

In this project, the vehicle suspension is designed and analyzed by using Solid Works and ANSYS respectively. Solid works are generally used for creating a 3d modeling to design the suspension model. ANSYS is a general-purpose FEA software package. To validate the stability of the model, the structural analysis of the vehicle is done by varying different spring materials like steel and MMC. The modal analysis is completed to determine the deformation for different frequencies for the number of modes. The maximum deformation and stress intensities of the materials are given in Table 6.1 & 6.2. The proposed design is validated by using structural analysis and modal analysis.

By comparing the results of the existing and proposed material, the displacement values are increased concerning the stress reduced for the proposed material. So, it concludes that the proposed material is safe for spring. From the analysis results, it is clear that the optimal stress intensities and maximum displacement values are obtained for MMC material.

VII. CONCLUSION

The analysis of the vehicle suspension is done by using ANSYS software and modeling with Solid Works. To validate the stability of the suspension, structural, and modal analysis was done by varying the spring material. The analytical result shows that MMC material withstands high vibration compared with steel. It shows that steel has a frequency of 250Hz with a displacement of 0.028067mm for 250kg in. Simultaneously for MMC material resulted in the 250Hz frequency achieved 0.036564mm for 250kg load in modal analysis. While structural analysis resulted that stress in steel for 250kg 5.0284MPa whereas in MMC4.9419MPa. It resulted that nearly 2% of vibration reduction is in MMC material has proved and suggested for vehicle suspension manufacturing.

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