Displacement and Stress Analysis of Suspension Systems using ANSYS

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***Abstract*— A suspension system or shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The shock absorbers duty is to absorb or dissipate energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. The design of spring in suspension system is very important. In this work the shock absorber is been modeled using modeling software CREO-parametric and imported to the ANSYS software for further analyzes. The comparison of vibration on two different types of suspension systems with two loading condition is done using ANSYS software. The nitrox shock absorber was found to provide better performance.**

Keywords*— Shock Absorber, Coil Spring, Stress analysis, ANSYS, Displacement, Stress.

I. INTRODUCTION

A vehicle is a machine usually with wheels and engines used for transporting people or cargo. A motorcycle (also called a motorbike, bike) is a two or three-wheeled motor vehicle. The suspension system used in aircrafts landing produce discomfort of crew/passengers and the reduction of the pilot's ability to control the aircraft would be studied and have definite possibilities of improvement.

Design is an important industrial activity which influences the quality of the product. CREO- Parametric is a feature based, solid modeling program. As such, its uses are significantly different from conventional drafting programs. In conventional drafting (either manual or computer assisted), various views of a part are created in an attempt to describe the geometry. So the modeling of the coil spring is made by using CREO- Parametric. When the design is carried out using software the risk involved in design and manufacturing process can be easily minimized.

Designers and engineers primarily use structural simulation to determine the strength and stiffness of a product by reporting component stress and deformations. The type of structural analysis performs depends on the product being tested, the nature of the loads, and the expected failure mode. A short/stocky structure will most likely fail due to material failure (that is, the yield stress is exceeded). The Analysis involves discretization called meshing, boundary conditions and loading.

II. MODELING AND ANALYSIS

A. Modeling of the Suspension system

Using the design calculations, models are drawn using CREO parametric. The various part diagrams of the suspension system are drawn using CREO that are given below.

Fig.1. Assembly of shock absorber.

CREO- Parametric is a software application within the CAD/CAM/CAE category, along with other similar products currently on the market. CREO- Parametric is a parametric, feature-based modeling architecture incorporated into a single database philosophy with advanced rule-based design capabilities. The capabilities of the product can be split into the three main heading of Engineering Design, Analysis and Manufacturing. Later this model is imported to ANSYS software for analysis by varying the load applied and the results are observed. A solver mode in ANSYS software calculates the stress thereby reducing the time compared with manual work.

B. Engineering Design

CREO- Parametric offers a range of tools to enable the generation of a complete digital representation of the product being designed. In addition to the general geometry tools there is also the ability to generate geometry of other integrated design disciplines such as industrial and standard pipe work and complete wiring definitions.

Tools are also available to support collaborative development. A number of concept design tools that provide up-front Industrial Design concepts can then be used in the downstream process of the engineering product. These range from conceptual Industrial design sketches, reverse engineering with point cloud data and comprehensive freeform surface tools.

C. Analysis of Suspension system

Steps to analyze on ANSYS: -.

These are the steps that divide the complex model into small elements that become solvable. And the following steps are followed to analyze.

1.) Build Geometry: Construct a two or three dimensional representation of the object to be modeled and tested using the work plane coordinates system within ANSYS.

2.) Define Material Properties: Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties.

3.) Generate Mesh: At this point ANSYS understands the makeup of the part. Now define how the Modeled system should be broken down into finite pieces.

4.) Apply Loads: Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

5.) Obtain Solution: This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved.

6.) Present the Results: After the solution has been obtained, there are many ways to present ANSYS' results, choose from many options such as tables, graphs, and contour plots.

III. PRESENT WORK

Analysis of the suspension system is carried out in ANSYS. The displacement vector sum and von-mises stress are observed and compared between the suspension systems.

TABLE I. SPECIFICATIONS OF THE SUSPENSION SYSTEMS

Details	Suspension system 1	Suspension system 2
Type of suspension	Three step adjustable suspension	5 way adjustable nitrox suspension
Material	Structural steel	Chrome vanadium
Material specification	ASTM A227	ASTM A231
Young's modulus (EX)	207000 MPa	207000 MPa
Modulus of rigidity(G)	79300 MPa	79300 MPa
Poisson's Ratio (PRXY)	0.25	0.25
Density	0.000007860 kg/mm^3	0.000007860 kg/mm^3

A. Analysis for load of 1417 N

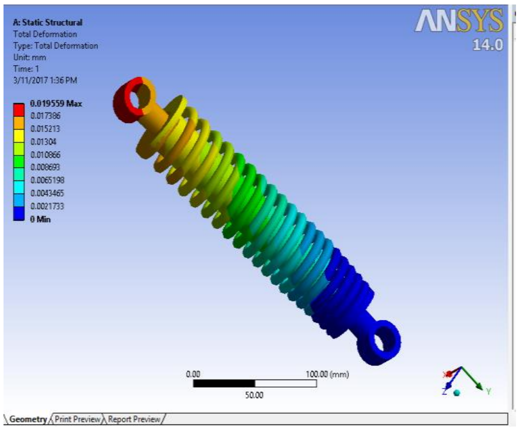

Fig.2. Displacement vector sum of normal system

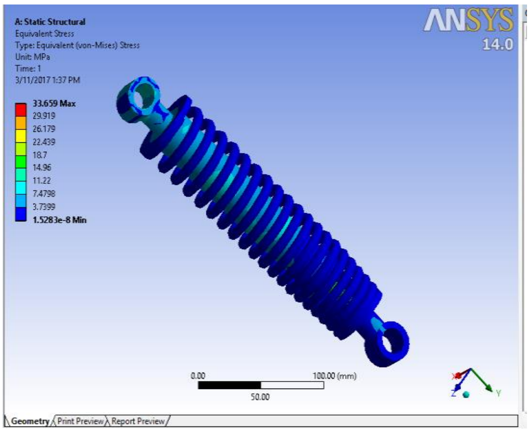

Fig.3. Von-mises stress on normal system

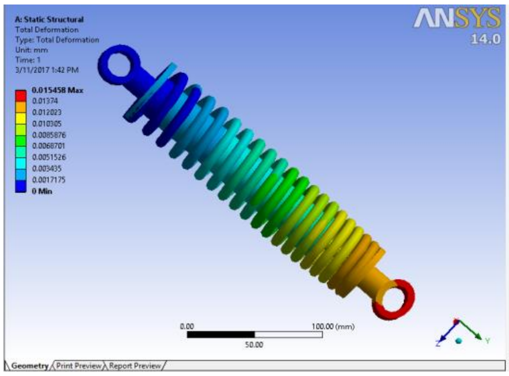

Fig.4. Displacement vector sum of nitrox system

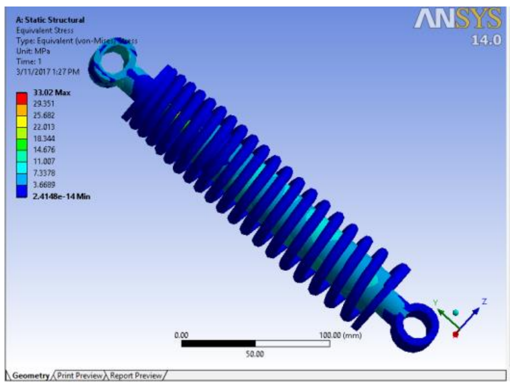

Fig.5. Von-mises stress of nitrox system

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B. Analysis for a load of 1652 N

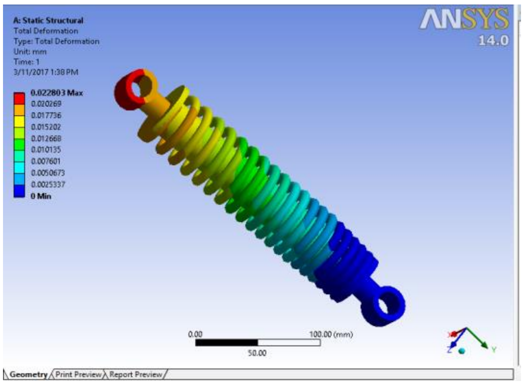

Fig.6. Displacement vector sum of normal system

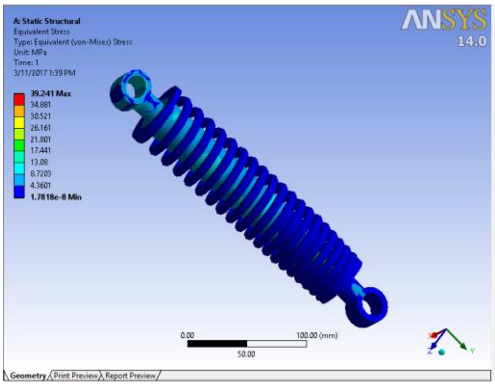

Fig.7. von-mises stress of normal system

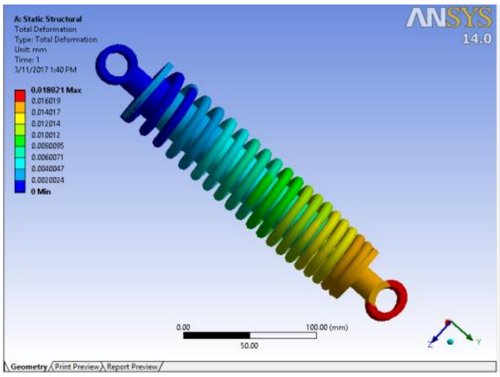

Fig.8. Displacement vector sum of normal system

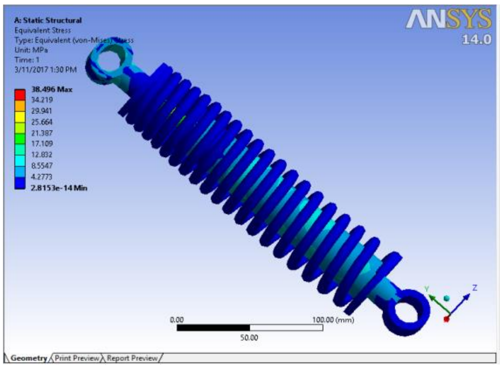

Fig.9. von-mises stress of nitrox suspension system

IV. RESULTS AND DISCUSSION

The observation of the displacement and von-mises stress for different suspension system with two load conditions are given in table II.

TABLE II. DISPLACEMENT AND STRESS OF SUSPENSION SYSTEMS

Sl. No.	LOAD	DISPLACEMENT (mm)		VON-MISES STRESS (MPa)	
		NORMAL	NITROX	NORMAL	NITROX
1.	1417 N	0.01955	0.01545	33.659	33.021
2.	1652 N	0.02280	0.0180	39.241	38.496

Analysis of vibration using ANSYS can be used to predict the failure of springs in suspension system. Moreover, Structural analysis approach using CREO and ANSYS would be used to reduce design cycle time, number of prototypes and more importantly, testing time and its associated costs.

V. CONCLUSION

From the analysis the results are summarized as follows.

- The displacement of the nitrox suspension system is minimum when compared to the normal suspension system. Hence the nitrox system provides more comfortable ride to the passenger(s).
- From the structural analysis, the displacement of the nitrox suspension system is less (20%) compared to the normal suspension which provides high comfort.
- The analyzed stress values are lower than their respective yield stress values. It is a non-destructive testing strategy, based on model generation.
- It was clear that by using nitrox suspension, we can optimize the level of vibration and it is also possible to increase the comfort level.

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