Design & Testing of Telescopic Shock Absorber by Finite Element Analysis

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***Abstract* — In this paper, design parameters and performance analysis of telescopic shock absorber has been carried out. For this study a shock absorber of Hero Honda Bike has been taken. This paper is carried out with the aim of redesigning the telescopic shock absorber by using reverse engineering approach. The scope of study for this paper includes, experimention of suspension systems and to reduce bouncing problem in vehicle, apply static structural analysis on the shock absorber spring and Finite Element Analysis (FEA). To study the stress pattern of shock absorber in its loaded condition,Also in this paper we carried out the study of solid model of Shock absorber is prepared with the help of CATIA V5 software. Pattern of stress distribution in 3D model of shock absorber spring is obtained using ANSYS 14.5 software. In this present work, the obtained stresses by using finite element analysis with different coil spring material and are discussed comparatively to reduce stress & Deformation. This study will improve the stability and performance of the shock absorber.**

***Key Words* — Shock Absorber, Reverse Engineering Method, CATIA V5, ANSYS(FEM)**

I. INTRODUCTION

A shock absorber is a mechanical device designed to smooth out or damp shock impulse, and convert kinetic energy to another form of energy (usually thermal energy, which can be easily dissipated). It is a type of dashpot Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston.

One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads.

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. Shock absorbers use valving of oil and gasses to absorb excess energy from the springs. Spring rates are chosen by the manufacturer based on the weight of the vehicle, loaded and unloaded [1]. Some people use shocks to modify spring rates but this is not the correct use. Along with hysteresis in the tire itself, they damp the energy stored in the motion of the unsprung weight up and down. Effective wheel bounce damping may require tuning shocks to an optimal resistance.

Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars are used in torsional shocks as well. Ideal springs alone, however, are not shock absorbers, as springs only store and do not dissipate or absorb energy. Vehicles typically employ both hydraulic shock absorbers and springs or torsion bars. In this combination, "shock absorber" refers specifically to the hydraulic piston that absorbs and dissipates vibration.

Fig. 1. Rear Shock Absorber

II. METHODOLODY

A. General Parameters for Shock Absorber

Material: **Stainless Steel & Alluminium Alloy**
Modulus of rigidity G = 83000 Pa
For **Spring**,
Mean diameter of a coil D=43mm
Diameter of wire d = 7mm
Total no of coils n1= 18
Outer diameter of spring coil D0 = D +d =50mm
No of active turns n= 14
Pitch of Coil = 12mm
Height = 121mm

For **Damper Rod**,
Diameter of Rod = 9mm
Diameter of Base of Rod = 21.5mm

For **Washer**,
Inner Diameter = 27.5mm
Outer Diameter = 50mm

Considering Hero Passion Plus Bike 100 cc,
Weight of bike = 116kg = 1137.96N
Let, weight of 1 person = 85Kg = 833.85N
Weight of 2 persons = 85×2=170Kg = 1667.7N
Weight of bike + persons = 286Kg = 2805.66N
Considering Damping Force = 140N For1.6 mm InnerHole

B. List of Component

1. Spring : Stainless Steel
2. Damper : Alluminium Alloy
3. Damper or Piston Rod : Stainless Steel
4. Washer : Carbon Steel
5. Bush : Plastic
6. Height Ajuster – Stainless Steel

C. Introduction of CATIA V5

CATIA is a computer aided three-dimensional interactive application and it is a multi-plat form computer-aided design (CAD)/computer-aided manufacturing (CAM)/computer-aided engineering (CAE) software suite developed by the French company Dassault Systems. CATIA supports multiple stages of product development including computer-aided design (CAD), computer-aided manufacturing (CAM) and computer-aided engineering (CAE). CATIA facilitates collaborative engineering across disciplines around its 3D experience platform, including shape, design and surfacing, mechanical engineering and systems engineering, electrical fluid and electronics systems design, CATIA enables the creation of 3dimensional parts from 3D sketches,composites, molded, sheet-metal, forged or tooling parts up to the definition of mechanical assemblies. The software provides advanced technologies for mechanical surfacing and BIW. It provides tools to complete product definition, including functional tolerances as well as kinematics definition

D. Introduction to ANSYS

ANSYS is a general purpose finite element analysis(FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designed size) called elements. The software implements equation that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then canbe presented in tabulated or graphical forms.This type of analysis typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equation.

E. Parts of Actual Shock Absorber

Fig. 2. Spring

Fig. 3. Damper with damper rod

Fig.4. Bush

Fig.5. Washer

III. Modelling & Drafting of Shock Absorber

In this paper, We used intial dimensions of shock absorber for design & dimensions measured by Vernier Calliper in mm.Following are parts & assembly of shock absorber designed by CATIA V5 software.

A. Model of Shock Absorber

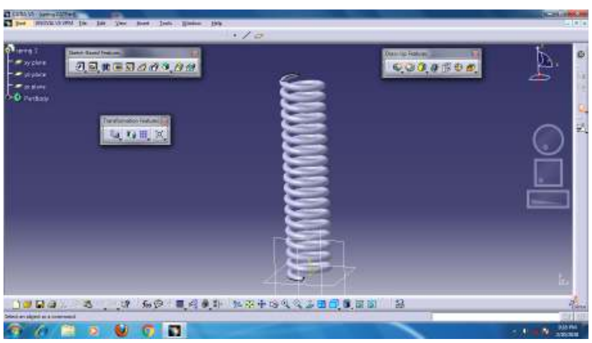

Fig.6. Spring

Fig.7. Damper rod

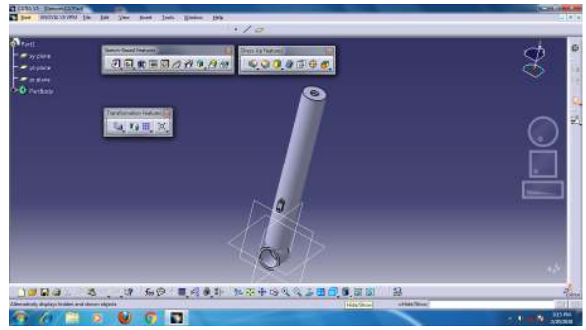

Fig.8. Damper

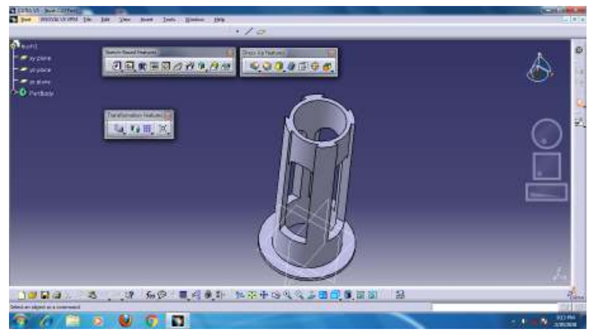

Fig.9. Bush

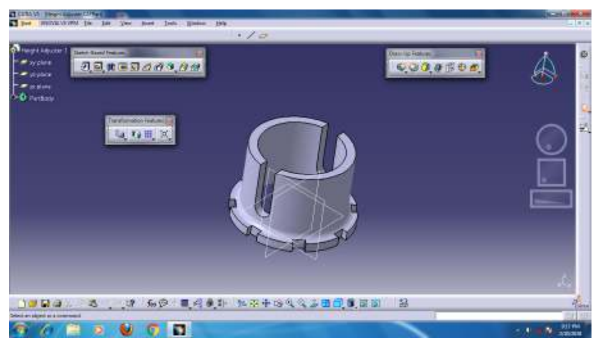

Fig.10. Height Ajuster

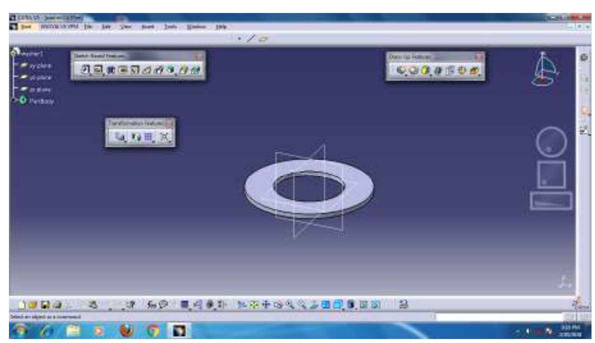

Fig.11. Washer

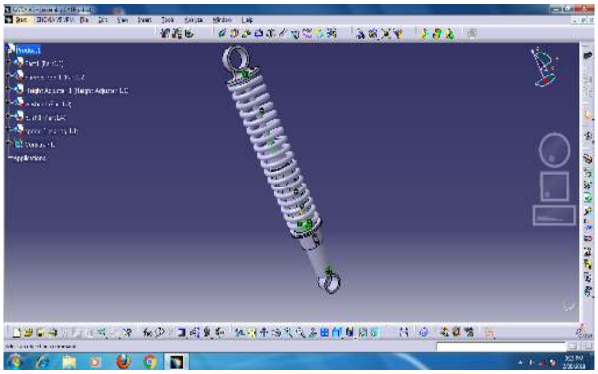

Fig.12. Assembly of Shock Absorber

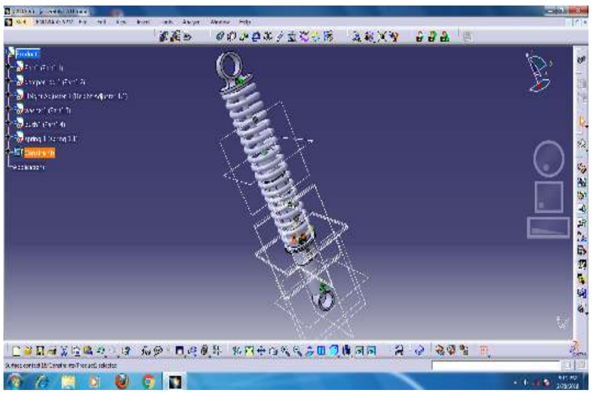

Fig.13. Assembly with Planes

B. Drafting of Shock Absorber

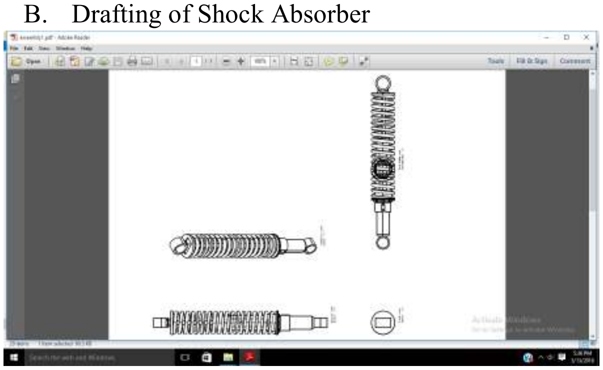

Fig.14. Assembly Drafting

V. Analysis of Shock Absorber

In this paper, We used engineering data module in ANSYS software for selecting stainless steel material & to apply it on shock absorber parts.Following are the analysis results shows:

1. Elastic Strain Intensity – 0.00081799(Max.)

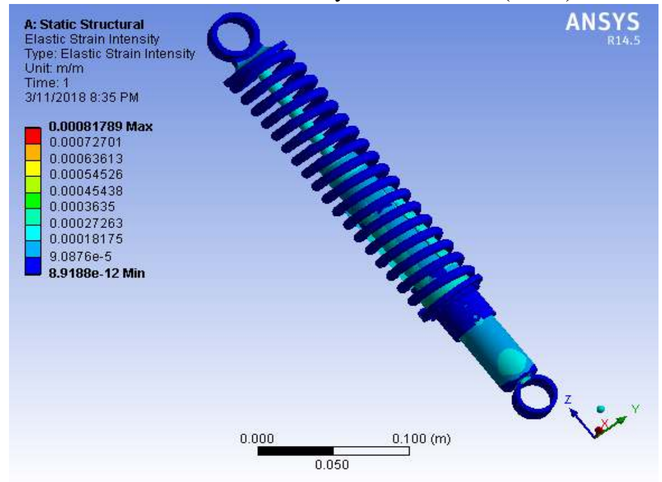

Fig.15. Elastic Strain Intensity

2. Equivalent Elastic Stain – 0.00065124 mm (Max.)

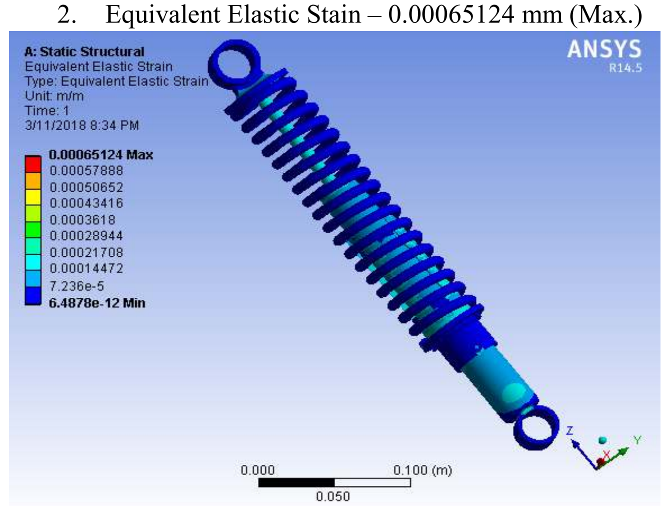

Fig.16. Equivalent Elastic Stain

3. Equivalent Stress – 9.572e7 Max

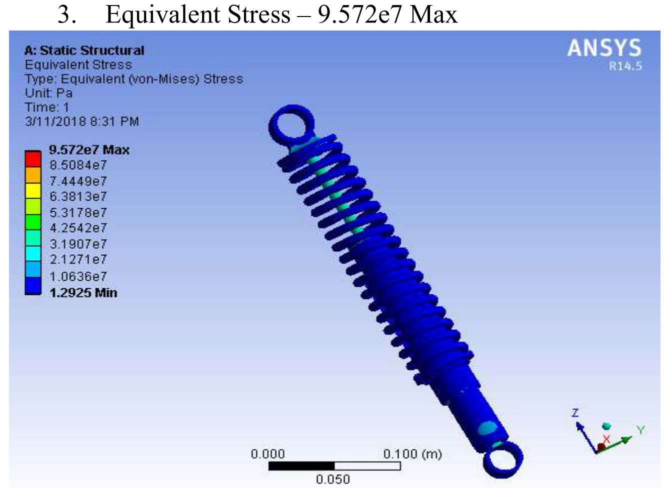

Fig.17. Equivalent Stress

4. Normal Elastic Strain – 0.00032849(Max)

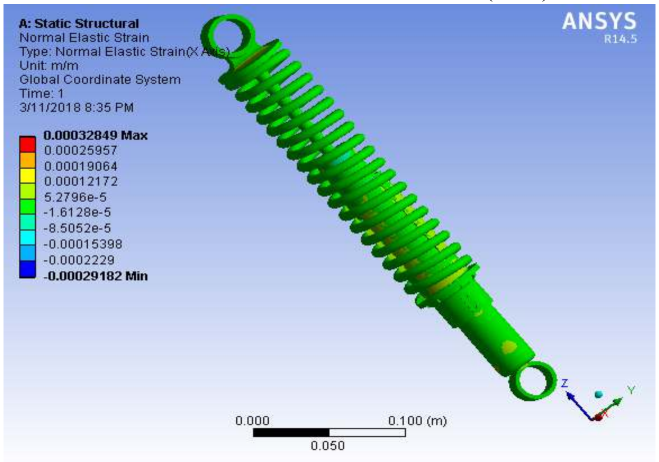

Fig.18. Normal Elastic Strain

7. Shear Stress – 2.7904e7(Max)

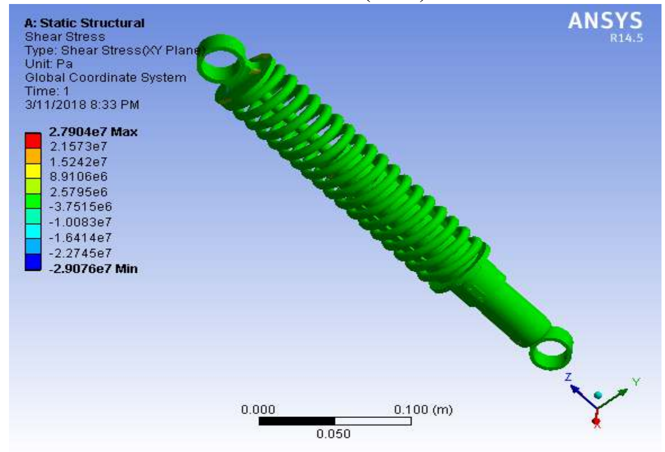

Fig.19. Shear Stress

5. Normal Stress – 8.904e78(Max)

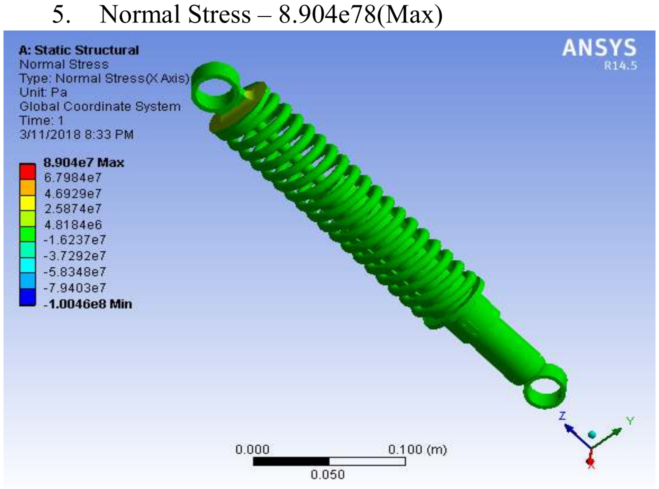

Fig.19. Normal Stress

8. Stress Intensity – 1.0883e8(Max)

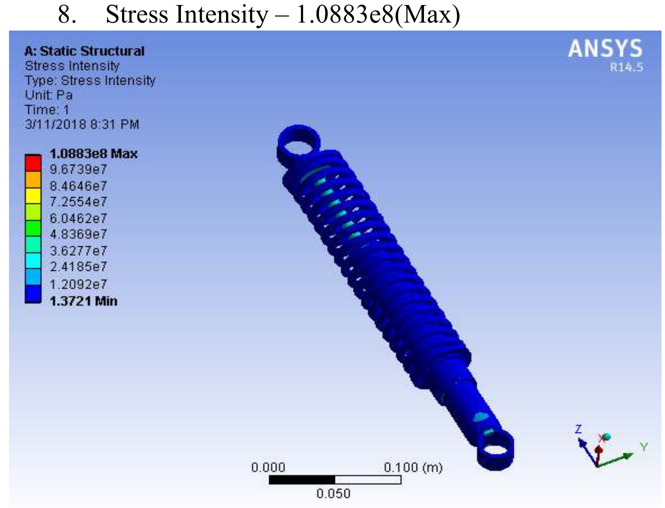

Fig.22. Stress Intensity

6. Shear Elastic Strain – 0.0003788mm(Max)

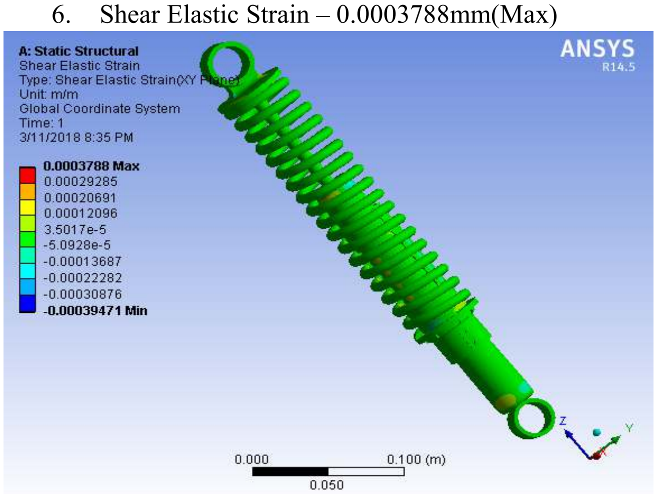

Fig.20. Shear Elastic Strain

9. Total Deformation5.7873e-5(Max.)

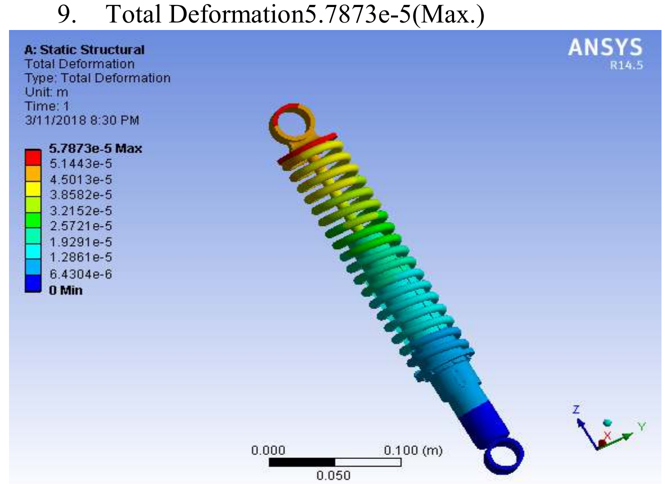

Fig.23. Total Deformaytion

VI. Results

Sr. No.	Stresses (Unit-Pa)	Maximum values	Minimum values
1	Equivalent stress	9.572e7	1.2925
2	Shear stress	2.7094e7	-2.9076e7
3	Normal stress	8.904e7	-1.00846e8
4	Stress intensity	1.0883e7	1.3721

Conclusion

In this paper, Reverse engineering design & analysis approach is presented to create design of shock absorber.

Finally, by observing the structural analysis results, the stress values obtained by software is less than permissible stress value for stainless steel material,so design is safe.

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